2021, ***Retos***, *41*, 798-803
 ISSN: Edición impresa: 1579-1726. EdiciónWeb: 1988-2041 (https://recyt.fecyt.es/index.php/retos/index)

Relationship between effectiveness and match outcome in the Spanish Water Polo League
Relación entre efectividad y resultado del partido en la Liga Española de Waterpolo

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Abstract: The purpose of the present study was to identify the indicators of offensive effectiveness which best discriminate by match score (favourable, balanced or unfavourable) in water polo. The sample comprised 88 regular season games (2011-2014) from the Spanish Professional Water Polo League. Univariate (ANOVA test; Kruskal-Wallis test and Generalized Linear Model test (GLM)) and multivariate (Discriminant) analysis were used to compare favourable, balanced or unfavourable games, and effect sizes of the differences for the indicators were calculated. The results showed that favourable games had averages that were significantly higher for the success rate in even attacks and shots, power-play attacks and shots, counterattack and counterattack shots, shots from zone 1, 2, 3, 4, 5 and 6, drive shots, and shots after 1, 2 and more than 2 fakes. The indicators of offensive effectiveness that most discriminated were the success rate for drive shots (SC=-.624), even attacks and shots (SC=-.359 and SC=-.322, respectively), and for power-play actions and shots (SC=-.343 and SC=-.321, respectively). These results could help coaches when planning training and competition, providing them with the percentages of offensive effectiveness that must be reinforced in order to have more chances to win the match. This information can help coaches to evaluate their teams and to design training aimed at improving their weakest skills.
Key words*:* performance analysis, water polo, match outcome, discriminant analysis and notational analysis.

Resumen: El objetivo del presente estudio fue identificar los indicadores de eficacia ofensiva que mejor discriminan en función del resultado del partido (favorable, equilibrado o desfavorable) en el waterpolo. La muestra estuvo formada por 88 partidos de temporada regular (2011-2014) de la Liga Española de Waterpolo Profesional. Se utilizaron análisis univariados (prueba ANOVA; prueba de Kruskal Wallis y prueba del Modelo Lineal Generalizado (GLM)) y multivariante (discriminante) para comparar resultados favorables, equilibrados o desfavorables, y se calcularon los tamaños del efecto de las diferencias para los indicadores. Los resultados mostraron que los equipos con resultado favorables tenían promedios significativamente más altos para la tasa de efectividad en ataques y lanzamientos en igualdad, ataques y lanzamientos en superioridad, ataques y lanzamientos de contraataque, lanzamientos de zona 1, 2, 3, 4, 5 y 6, lanzamientos directos y después de 1, 2 y más de 2 efectividad en lanzamientos directos (SC=-.624), ataques y lanzamientos en igualdad (SC=-.359 y SC=-.322, respectivamente), y ataques y lanzamientos en superioridad (SC=-.343 y SC=-.321, respectivamente). Estos resultados podrían ayudar a los entrenadores a la hora de planificar los entrenamientos y la competición, proporcionándoles los porcentajes de efectividad ofensiva que se deben reforzar para tener más posibilidades de ganar el partido. Puede ayudar a los entrenadores a evaluar a sus equipos y diseñar entrenamientos destinados a mejorar sus habilidades más débiles.
Palabras clave: Análisis del rendimiento, waterpolo, resultado de partido, análisis discriminante y análisis notacional.

Introduction

Identifying the determinants of success in team sports is a major topic in the scientific community and the available research has grown intensively in the last few years (Sampaio, Lago, Casáis & Leite, 2010). Nowadays, coaches prepare the competition and training process using notational analysis with the aim of improving both the team´s and the players´ performances (Hughes & Franks, 2004; Ortega, Serna, Lupo & Sampaio, 2009; Leite, Baker & Sampaio, 2009). Notational analysis has been described as the process of recording, treatment and diagnostics of events that take place in competition (Drust, 2010).

Game-related statistics are very popular among coaches, a selection or combination of these statistics whose aim is to define some or all the aspects of performance is a performance indicator (Hughes & Batlett, 2002). Players and researches have used these performance indicators to improve the understanding of game performance in different types of competitions. Thus, a large number of research works have studied performance indicators in short term competitions such as Olympic Games, World Championships, or European

Fecha recepción: 23-06-20. Fecha de aceptación: 06-02-21
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Championships (Escalante, Saavedra, Mansilla & Tella, 2011; Escalante, Saavedra, Tella, Mansilla, García & Domínguez, 2012; Escalante, Saavedra, Tella, Mansilla, García & Domínguez, 2013; García-Marín & Argudo, 2017; Lupo, Condello, Capranica & Tessitore, 2014; Lupo, Condello & Tessitore, 2012a; Martínez & González, 2020; Sabio, Argudo, Guerra & Cabedo, 2021; Sabio, Guerra & Cabedo, 2018). For example, some research identified offensive characteristics (centre goals, power-play goals, counterattack goal, assists, offensive fouls, steals, blocked shots, and won sprints) and defensive characteristics (goalkeeper-blocked shots, goalkeeper blocked inferiority shots, and goalkeeper-blocked 5m shots) which distinguished performance for each phase in international championships (Escalante et al. 2013). They also graded a global efficacy (i.e. preliminary, classificatory, and final phases: 92%, 90%, and 83% respectively). Other studies have focused on analysing performance indicators in a regular season (García, Iglesias & Touriño, 2016; García, Touriño & Iglesias, 2015; Iglesias, García & Touriño, 2016; Iglesias, García & Touriño, 2018; Lupo, Tessitore, Mingati & Capranica, 2010; Lupo, Tessitore, Mingati, King, Cortis & Capranica, 2011). Specifically, from the data of a large and extensive sample in a water polo league, it has been) identified offensive indicators which distinguished performance based on the match score (favourable, balanced or unfavourable) and they suggest that winning teams (favourable games) have averages that are higher for counterattack attacks and shots, goals, and goals from zones close to goal (zone 5 and 6), whereas losing teams (unfavourable games) have higher averages in even attacks and shots, no goals shots, and shots originated from zones far from goal (zone 2 and 4) (Garcia et al. 2015). In the same way, Iglesias et al. (2016) searched for the differences between strong and weak teams depending on their final classification in the league competition, and they found that strong level teams made more counterattacks, counterattack shots, goals, penalties achieved, shots originated from zone 5 and 6, and shots after 2 fakes than weak level teams, whereas, they made less even attacks, even shots, no goals shots, shots originated from zone 2 and 4, and drive shots than weak level teams. A substantial contribution to the understanding of this performance analysis in team sports is the investigation of situational variables that can influence the team performance at a behavioural level, such as the quality of the opponent, the starting quarter score and the match location. (García, Touriño & Iglesias, 2017; Gómez, Delaserna, Lupo & Sampaio, 2014; Gómez, Lago-Peñas, Viaño & González-García, 2014; Ruano, Serna, Lupo & Sampaio, 2016).

Describing the success rate for the different offensive actions in water polo according to the match score and identifying performance indicators of offensive effectiveness associated with winning is useful to develop reference values for water polo matches. These values can be used by coaches and support staff to inform practical guidelines for technical and tactical development. Reference values can assist in understanding the variability of team performance, and aid coaches in establishing quantifiable objectives for training and competition performance, as well as aid in evaluating the efficacy of training interventions and tactical changes. Knowledge of performance indicators of offensive effectiveness can also be used to create performance profiles to predict team behaviours and performance outcomes. However, only a few studies have analysed performance based on indicators of offensive effectiveness between match scores in water polo competitions (Argudo, 2009; Argudo, Alonso, García & Ruiz, 2007; Argudo, Ruiz & Abraldes, 2007; Argudo, Ruiz & Abraldes, 2010; Hraste, Jelaska & Granic, 2016; Sabio et al. 2021). Therefore, the aim of the present study was to identify the indicators of offensive effectiveness which best discriminate between unfavourable, balanced and favourable match score in regular season games.

Material and Methods

Participants

Non-probability sampling was comprised of 88 games (2 performances for game, in total 176) corresponding to 10 teams from the First Spanish Professional Water Polo League during 3 seasons (2011-2014). This sample represented the 22.2% of all the matches played.

Measures

The dependent variable was the match score (unfavourable, balanced, and favourable). In relation to the match score, we considered a balanced score (difference d»3 goals), and an unfavourable or favourable score (difference > 3 goals) using k-means cluster procedures.

18 potential performance indicators of offensive effectiveness (Table I) were used as independent variables to compare the match score described previously. These variables are defined as the success rate of the offensive actions, namely, the percentage of offensive

actions (attacks and shots) of each type that end in goal (also, percentage of successful actions).

The offensive actions considered in this study have been used before for different researches (Escalante et al. 2012; García et al. 2015; García et al. 2016; Iglesias et al., 2016; Lupo et al. 2012a). They are grouped in four categories (see Table I): «Attack Situation» (even attack, power-play attack, counterattack and penalty), «Shot situation» (even shot, power-play shot, counterattack shot and penalty shot), «Zone» (shot from zone 1, 2, 3, 4, 5 and 6 (see Figure I)) and «Fakes» (drive shot, shot after 1 fake, shot after 2 fakes and shot more than 2 fakes).

Procedures

Data were obtained using video camera and a match analysis system (LongoMatch, System version 0.20.8, Barcelona, Spain). The camera was positioned at a side of the pool, at the level of the midfield line.

Data reliability was assessed through intra- and inter-observer testing procedures (James, Taylor & Stanley, 2007). Intra-observer reliability was assessed by the first author of this study, an experienced observer with more than 300 water polo matches analysed. Three randomly selected matches were coded and, after a 6-week period, the matches were re-analysed with the data being compared with those of the original coding sessions. The second author of this study, after two weeks training in data collection, completed inter-observer reliability testing. He coded each of the three matches, and his data were compared with those of the experienced observer´s first coding session. Intra- and inter-observer agreements were evaluated via Kappa index, and were globally 0.97 and 0.79, respectively.

Table 1.
List of performance indicators of offensive effectiveness clustered in four groups

Groups	Potential performance indicators	Definition
Attack Situation	% Successful even attacks (SEA)	Percentage of successful even attacks respect to total even attacks
	% Successful power-play (SPO)	Percentage of successful power-play attacks respect to total power-play attacks
	% Successful counterattack (SCO)	Percentage of successful counterattack attacks respect to total counterattack attacks
	% Successful penalties (SPE)	Percentage of successful penalties attacks respect to total penalties attacks
Shot Situation	% Successful even shots (SES)	Percentage of successful even shots respect to total even shots
	% Successful power-play shots (SPOS)	Percentage of successful power-play shots respect to total power-play shots
	% Successful Counterattack shots (SCOS)	Percentage of successful counterattack shots respect to total counterattack shots
	% Successful penalties shots(SPES)	Percentage of successful penalties shots respect to total penalties shots
Origin of shots (see Figure 1) ("Zone")	% Successful shots zone 1 (SS1)	Percentage of successful shots originated from zone 1 respect to total shots zone 1
	% Successful shots zone 2 (SS2)	Percentage of successful shots originated from zone 2 respect to total shots zone 2
	% Successful shots zone 3 (SS3)	Percentage of successful shots originated from zone 3 respect to total shots zone 3
	% Successful shots zone 4 (SS4)	Percentage of successful shots originated from zone 4 respect to total shots zone 4
	% Successful shots zone 5 SS5)	Percentage of successful shots originated from zone 5 respect to total shots zone 5
	% Successful shots zone 6 (SS6)	Percentage of successful shots originated from zone 6 respect to total shots zone 6
Technical Execution ("Fakes")	% Successful drive shots (SDS)	Percentage of successful drive shots respect to total drive shots
	% Successful shots after 1 fake (S1FS)	Percentage of successful shots after 1 fake respect to total shots after 1 fake
	% Successful shots after 2 fakes (S2FS)	Percentage of successful shots after 2 fakes respect to total shots after 2 fakes
	% Successful shots more than 2 fakes (SM2FS)	Percentage of successful shots more than 2 fakes respect to total shots more than 2 fakes

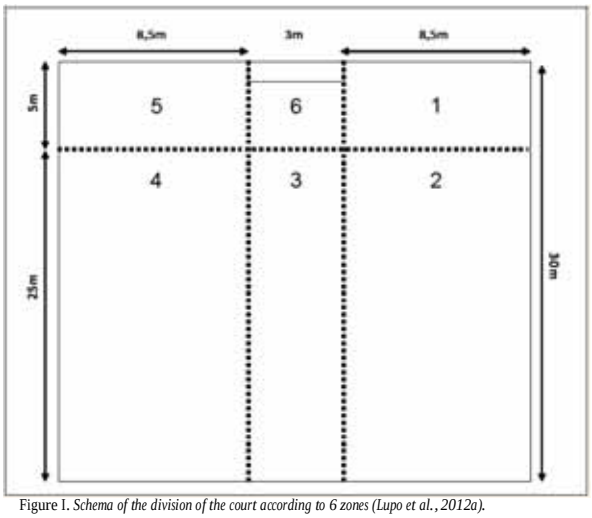

Figure I. *Schema of the division of the court according to 6 zones (Lupo et al., 2012a).*

Statistical analysis

The basic descriptive statistics (mean, standard deviation, count) of the offensive effectiveness variables were calculated separately on the match score. Normal distribution was checked with the Kolgomorov–Smirnov and Shapiro-Wilk tests. To compare the distribution of the variables between favourable, balanced or unfavourable score, 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.

Subsequently, the results were subjected to a discriminant analysis. The dependent variable was the match score, and the independent variables were those indicators of offensive effectiveness giving p-value <.05 in the one dimensional tests. Indicators with structural coefficients (SC) greater than or equal to 0.30 were considered relevant (Sampaio, Ibáñez, Lorenzo & Gómez, 2006; Tabachnick & Fidell, 2007).

The eigen value (small=0.1; medium=0.3; high=.5) (Cohen, 1988), 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. All statistical analyses were performed using SPSS software release 18.0 (SPSS Inc., Chicago, IL, USA).

Table 2.
Basic statistics (count, means ± standard deviation), comparison of means ANOVA test (A), Kruskal-Wallis test (K-W), Generalized Linear Model test (GLM) and effect size (ʔ2), for each indicator of offensive effectiveness depending on the match score (unfavourable, balanced and favourable) during three seasons (2011-2014)

	Unfavourable (n=41)		Balanced (n=94)		Favourable (n=41)		A	K-W	GLM	
	N	M±SD	N	M±SD	N	M±SD	F	CHI	CHI	η2
% Successful even attacks (SEA)	36.5±3.9	6.2±3.7	35.4±3.0	9.3±5.4	32.4±3.2	12.7±7.2	14.1***	23.2***	32.4***	.14
% Successful power-play (SPO)	8.6±3.1	30.7±20.1	8.9±2.7	37.1±17.9	9.2±2.4	45.9±15.2	7.5**	16.9****	24.2***	.08
% Successful counterattack (SCO)	3.4±2.5	23.3±30.2	4.2±2.4	30.8±27.7	7.3±3.9	35.8±20.5	2.2	10.2**	13.5**	.03
% Successful penalties (SPE)	.9±1.0	78.0±33.5	.8±1.1	83.0±32.5	1.2±1.0	80.1±35.3	.2	.6	.9	-
% Successful even shots (SES)	17.1±1.2	13.4±8.3	15.3±3.3	21.4±11.8	14.3±3.3	28.5±14.8	16.4***	25.5***	48.3***	.16
% Successful power-play shots (SPOS)	7.6±2.7	35.7±24.4	7.7±2.7	43.1±19.3	8.2±2.4	51.8±17.3	6.6**	15.2**	24.3***	.07
% Successful Counterattack shots (SCOS)	2.0±1.5	34.0±36.7	2.6±1.8	48.8±35.3	5.0±3.1	53.4±26.8	3.4*	9.0*	9.4**	.04
% Successful penalties shots(SPES)	.9±1.0	78.0±33.5	.8±1.1	83.0±32.5	1.2±1.0	80.1±35.3	.2	.6	.9	-
% Successful shots zone 1 (SS1)	2.2±1.2	25.0±34.0	2.0±1.5	35.6±37.1	2.5±1.7	47.9±34.2	4.1*	9.0*	11.1**	.05
% Successful shots zone 2 (SS2)	5.5±2.5	16.4±17.1	5.0±1.9	21.9±22.2	4.4±1.9	34.3±26.8	7.0**	11.9***	17.0***	.08
% Successful shots zone 3 (SS3)	8.3±2.2	21.0±13.1	8.0±2.7	29.2±18.1	8.9±2.6	37.6±18.9	9.4***	20.8***	23.1***	.10
% Successful shots zone 4 (SS4)	5.3±2.7	14.8±17.4	4.3±2.0	26.0±24.1	3.9±2.0	28.9±25.8	4.5*	8.7*	7.9*	.05
% Successful shots zone 5 SS5)	2.0±1.4	19.9±29.2	2.7±1.5	43.7±35.1	3.4±1.7	46.1±29.6	8.0***	16.4***	14.9**	.09
% Successful shots zone 6 (SS6)	4.3±2.1	37.3±24.9	4.6±2.5	42.0±27.9	6.5±2.9	54.4±20.3	5.0**	10.6**	14.9**	.06
% Successful drive shots (SDS)	19.3±4.4	22.6±7.7	17.8±3.4	30.8±11.8	18.1±3.5	43.5±12.3	37.1***	48.0***	73.0***	.300
% Successful shots after 1 fakes (S1FS)	5.3±2.3	25.3±26.1	5.9±2.5	32.6±21.2	6.4±2.5	36.4±19.5	2.7	11.5**	13.7**	-
% Successful shots after 2 fakes (S2FS)	1.6±1.1	19.2±32.5	1.6±1.3	39.8±37.9	2.6±1.7	37.3±35.7	3.8*	8.2*	8.9*	.051
% Successful shots more than 2 fakes (SM2FS)	1.3±1.1	15.0±32.6	1.1±.9	35.3±41.4	1.6±1.3	41.4±42.3	3.9*	8.3*	15.5***	.057

* P<.05; ** P<.01; ***P<.001

Results

Table II presents basic descriptors of offensive effectiveness by match score (favourable, balanced and unfavourable) in the men games, together with the corresponding one dimensional test results. There were sixteen indicators of offensive effectiveness that differed between the match scores. These indicators with statistically significant differences were SEA (p<.001), SPO (p<.01), SCO (p<.01), SES (p<.01), SPOS (p<.01), SCOS (p<.05), SS1 (p<.05), SS2 (p<.01), SS3 (p<.001), SS4 (p<.05), SS5 (p<.001), SS6 (p<.001), SDS (p<.001), S1FS (p<.01), S2FS (p<.05), and SM2FS (p<.05).

The results of the multivariate analysis are presented in Table III. The discriminant functions classified correctly 72.1% (original sample) and 48.8% (cross-validation) of the match score. In this discriminant analysis, the variables that had higher discriminatory power were SDS (SC=-.624), SEA (SC=-.359), SPO (SC=-.343), SES (SC=-.322), and SPOS (SC=-.321).

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

	Match score	
	Structure coefficients	
	SC1	SC2
% Successful even attacks (SEA)	-.359+	.106
% Successful power-play (SPO)	-.343+	.180
% Successful counterattack (SCO)	-.251	.131
% Successful even shots (SES)	-.322+	.225
% Successful power-play shots (SPOS)	-.321+	.143
% Successful Counterattack shots (SCOS)	-.294	.256
% Successful shots zone 1 (SS1)	-.236	.199
% Successful shots zone 2 (SS2)	-.101	.394+
% Successful shots zone 3 (SS3)	-.287	.264
% Successful shots zone 4 (SS4)	-.184	.282
% Successful shots zone 5 SS5)	-.230	.437+
% Successful shots zone 6 (SS6)	-.231	-.027
% Successful drive shots (SDS)	-.624+	.091
% Successful shots after 1 fake (S1FS)	-.095	.074
% Successful shots after 2 fakes (S2FS)	-.101	.394+
% Successful shots more than 2 fakes (SM2FS)	-.195	.379+
Box´s M	154.183 (p-value=.000)	
Eigenvalue	1.411	.269
Canonical Correlation Index	.765	.461
Wilk´s Lambda	.327	.788
Chi Square	83.329	17.769
Fd	36	17
Sig	.000	.404
	% Correct Classification (Original sample)	% Correct Classification (Cross-validation)
% unfavourable	85.7	61.9
% balanced	61.9	42.9
% favourable	78.3	47.8
% classification	72.1	48.8

+SC≥0.3

Discussion

The aim of the current study was to identify the indicators of offensive effectiveness which best discriminate between match scores (favourable, balanced or unfavourable) in regular men water polo seasons. The main findings of the study have shown that the performance indicators differentiating between unfavourable, balanced and favourable games were sixteen (even attacks and successful shots, power-play attacks and successful shots, counterattack and successful shots, successful shots from zone 1, 2, 3, 4, 5 and 6, successful drive shots, and successful shots after 1, 2 and more than 2 fakes). Similarly, the indicators of offensive effectiveness that most discriminated were the success rate for drive shots, following by the success rates for even attacks, power-play, even shots, and power-play shots, respectively. These results could help coaches plan and structure their training and competitions.

There were 16 performance indicators of offensive effectiveness that differentiated between the match scores. The results indicate that winning teams (>3 goals), made more successful even attacks and shots, successful power-play attacks and shots, successful counterattack and shots, shots from zone 1, 2, 3, 4, 5 and 6 that end in goal, successful drive shots, and shots after 1, 2 and more than 2 fakes ended in goal than losing teams, while the teams with balanced match scores made more successful shots after 2 fakes. These results are indicative of the importance of efficiency of actions in water polo. They are consistent with those of a study

of the five International Championships (World and European Championships) between 2007 and 2011 (Escalante et al. 2012) in which similar values of offensive performance indicators that differentiated winning and losing teams were found. In the same way, a study of the 10th Water Polo World Championship (Argudo et al. 2009), concluded that efficacy values in the micro-situations in numerical equality (even attacks), in counterattack and in simple temporary numerical inequality (power-play) were significantly different between winners and losers, while in the penalty they were not significantly different. Also, our results are in line with other team sports such handball, where the greatest effectiveness of the winning teams has been found in all the parameters of final actions of the attack (Foretic, Rogulj & Trninic, 2010). On the other hand, in basketball, the winning and losing teams play differently in regular season and playoff games (García, Ibáñez, De Santos, Leite & Sampaio, 2013). The regular season games were dominated by the importance of assists, showing the relevance of the teamwork during this phase. On the contrary, the playoff games were dominated by the importance of effectiveness in defensive rebounding (García et al. 2013). These findings highlight the interest in studying the effectiveness according to the type of competition, which is why values of offensive effectiveness in regular water polo seasons are provided in this study.

The performance indicators of offensive effectiveness introduced in the discriminant analysis were those that were significant in the one-dimensional tests. The correct classification percentages achieved by the model were 72.1% (original sample) and 48.8% (cross-validation). According to the first discriminant function the effectiveness indicator that most discriminated between match scores was SDS (SC=-.624), indicating that the winning teams made more successful drive shots. Considering that the most frequently performed technical shot was the drive shot (between 63%-70% over all performed shots) (García et al. 2015), it is not surprising that success in this type of shot is the most discriminant between match scores.

The second effectiveness indicator in terms of discriminate power was SEA (SC=-.359), followed by SPO (SC= -.343), SES (SC=-.322), and SPOS (SC=-.321), pointing out that the percentage of successful even and power-play actions and shots, were very important to distinguish between match scores. However, the winning teams (>3 goals) perform more counterattacks, while losing teams (>3 goals) perform more even attacks the study by (García et al. 2015). Although these results may seem contradictory they are really compatible, and highlight the importance not only of performing some specific actions but also of being effective in them. In fact, the effectiveness of power play shots was a performance indicator which discriminated between winning and losing teams in the final phase of the 2008 Olympic Games held in Beijijng (Escalante et al. 2011). In the same way, some authors (García et al. 2013) concluded that winning and losing teams had approximately the same opportunities to play with a numerical advantage, but in other studies the results to where they selected matches without penalties, showed the importance of the performance indicators related to numerical inequality (exclusion, power play attacks and shots) (García et al. 2016). These studies reinforce our results where the success in even and power play actions are very useful to distinguish between match scores.

Concerning the limitations of the current study, we should underline that, although the sample size was the largest one used in an analysis of these characteristics in water polo research, the sample was not random, because of the difficulty of achieving the match recordings. This generated an unbalanced design of the match scores (favourable, balanced or unfavourable).

Conclusion

In summary, the results of the current study are an important contribution to sport performance in water polo, since this paper presents reference values for the performance indicators of offensive effectiveness according to match score in regular men water polo seasons.

There are two main conclusions to be gathered from the study of these indicators. Firstly, the effectiveness of the teams was determinant to discriminate between match score, where the winning teams had significant higher averages in all indicators of offensive effectiveness except one (penalties). Secondly, the percentages of successful drive shots and successful even and power-play actions and shots were the offensive performance indicators that most discriminated between match score.

In practical applications, these results could help coaches when planning training and competition, providing them with the percentages of offensive effectiveness that must be reinforced in order to have more chances to win the match. This information can help coaches to evaluate their teams and to design

training aimed at improving their weakest skills.

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