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Original Article

Performance analysis of goalkeepers and final team rankings in men's international handball championships

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Abstract
This study's objectives were (i) to analyse whether there are goalkeeper game-related statistics that differ depending on the team's final ranking, and (ii) to develop a multivariate model of the relevance of those game-related statistics for that final ranking. Sixty-five matches of the 2020 European Men's Handball Championship were analysed. The dependent variable was the team's final ranking (three groups were considered: 1st to 4th place, 5th to 12th place, 13th to 24th place). The independent variables were the goalkeeper game-related statistics. A validation of the data showed the internal consistency and reliability to be very good. A one-way ANOVA with Bonferroni post-hoc test was used to examine differences between the ranking groups. The data were subjected to a regression and classification tree multivariate analysis. There were differences between groups in total shots efficiency (teams 1st to 12th higher than teams 13th to 24th, $F=3.21$, $p<0.044$). The regression and classification tree model correctly classified 60% of the records in the three groups depending on the final ranking of the team on the basis of five variables (with 10 emergent nodes): 7 m shots efficiency, 9 m shots (saves and efficiency), total shots efficiency, and total shots. This seems to indicate that the actions of the goalkeepers alone (7 m shots efficiency) and their actions which are influenced by the defensive actions of their team-mates (9 m shots both saves and efficiency, total shots efficiency, and total shots) are relevant for their team's final ranking. The importance of saves and efficiency from 9 m is suggestive of the relevance of the goalkeeper's specific work at this distance.
Keywords: Handball, goalkeepers, performance, classification tree

Introduction

Handball is a very popular team sport around the world, and has been an Olympic event since 1972 (Massuça & Fragoso, 2011). In the 2016 Olympic Games in Brazil, it was the second most popular sport after association football in terms of spectator attendance and ticket sales (Mavropoulou et al., 2018). In Europe especially, the "cultural gene" of handball has played an important part in the modern game whose increasing popularity and participation has led it to become one of the region's top sports (Laver et al., 2018).

Elite handball players have specific anthropometric, physical, technical, tactical and psychological characteristics (Sporis et al., 2010) that allow them to demonstrate their own personal capacity and skills in game situations (Nicholls, 2003; Ames, 1992). In comparing elite with non-elite handball players, it can be affirmed that elite handball players are: (i) physically stronger (taller, heavier, and with greater muscle mass); (ii) their upper limbs are longer; (iii) they are faster and more agile; (iv) they have better game tactics and technical skills; (v) they are emotionally stronger; and (vi) they come from a higher socioeconomic level (Massuça et al., 2014).

Handball is an intermittently high intensity team sport (Krüger et al., 2014). A coach must design training programs that take into account not only their players' physical, technical, and tactical characteristics but also their position on the court (Di Salvo et al., 2007). The game actions the players perform differ greatly according to their positions (Sporis et al., 2010). Normally, player positions are classified into pivots, wings, backcourts, and goalkeeper (Krüger et al., 2014). The training of the wings is characterized by special attention being paid to speed, acceleration, and jumps, while for the backcourt players the focus is on jumps, throwing speed, and passes (Karcher & Buchheit, 2014). Training for goalkeepers and pivots emphasizes tactical and technical performance. Also, pivots should focus on improving drop jumps (Schorer et al., 2009). With regard to anthropometric characteristics, wings are the shortest players and pivots the heaviest with the highest body mass

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indices (Krüger et al., 2014). Given the scarcity of studies on goalkeepers, and that these players have a specific profile, there is a clear need for more studies on this position (Karcher & Buchheit, 2014).

The handball goalkeeper is the only player who can use their lower limbs to stop the ball (within the 6 m area). Due to this particularity, their role is completely different from that of the rest of the players, but it must contribute to the team's actions both defensively and offensively (Hatzimanouil, 2011). The success of the goalkeeper's actions depends to a large extent on their speed of reaction and their anticipation of the attackers' actions. The soccer goalkeeper has a similar role in which visual mechanisms are especially relevant (Bideau et al., 2004), although the greater size of the field of play, and hence the distances from which shots are made, means that they have more time to decide what action to take (Rojas et al., 2012). Likewise, in both handball and soccer, the trajectory of the ball and the goalkeeper's perception of it influence the potential of the save that the goalkeeper may make (Gutiérrez-Dávila et al., 2011).

In team sports, the players need to stay connected with each other to look for appropriate and effective offensive and defensive actions (Wagner et al., 2014). In general terms, the goalkeeper can be said to play a role between defence and attack in the sense that there is an interaction between the team's performance, which to a large extent is determined by attack, and the goalkeeper's actions in defence. It is especially the case that when many are games involved, as in a championship or a tournament, the goalkeeper affects their team's final ranking. One study used data from the last six seasons of the Spanish men's handball league to examine the influence of the goalkeeper's efficiency on team performance (Pascual et al., 2010). Even allowing for this being an analysis of a specific championship of a single country with its own particular characteristics, it did show that the greater the goalkeeper's efficiency, the higher the team's ranking. In particular, the top teams have better goalkeeper efficiency than the rest, and the greater the goalkeeper's effectiveness in a game, the more likely their team is to win that game.

Although the evolution of the goalkeeper’s game can influence the final result and ensure a team’s victory in 50% of games, this fact is only stated theoretically, as it was reported by a questionnaire answered by a number of team handball specialists (Catalin, Ion, Gheorghe & Julien, 2018). Besides, although Angulo, Romero, López-Gómez (2022) stated that goalkeepers play a crucial role in handball, and it is well known that the goalkeeper’s performance can predict the team’s ranking in major events, recently only Hansen et al. (2017) have tried to find a relationship between the goalkeepers’ saves statistics and the final team rankings. More specifically, Hansen et al. (2017) stated that the rate of saves is important in order for teams to achieve a higher ranking. Thus, it seems that a team with a higher savings percentage is more likely to end up within the top ranked teams of a tournament. In conclusion, goalkeepers’ save percentage showed a moderate to high relation with championship success. Although these authors reached this result using a statistical analysis in which they analyzed the correlation between number of saves (performance) and team ranking, they did not try to develop a model of the relevance of game-related statistics with final ranking and goalkeepers.

In the past, Fuertes, Penas & Martinez (2010), stated that a 1% improvement in the saving rate leads to an increase of 0.57 in the final position ranking, in the first Spanish handball division. Although these authors tried to find a relationship between goalkeepers’ save statistics and the final team rankings, we must take into account that they did not include in their sample major events such as European Handball Championships, World Championships or Olympic Games. They also did not include elite handball goalkeepers as their sample was from the Spanish division. The difficulty and importance of this attempt (to develop a model) was stated by Schwenkreis (2019), who presented a methodology that allows the effectiveness of a single handball player to be quantified. The same author in conclusion stated that the evaluation of the performance of a handball goalkeeper in a match is insufficient and difficult.

Performance analysis has become one of the main topics of interest in sports science research (Ferrari et al., 2019), with match analyses especially standing out (Trejo & Planas, 2018; Valeria et al., 2017; Zapardiel et al., 2017). Game-related statistics and observational studies carried out during play have been used to determine performance requirements during a match (Prieto et al., 2018). In general, the data are analysed after a tournament, with the records being saved in digital format (Debanne, 2017; Dello et al., 2018; Ferrari et al., 2018). The factors analysed are principally focused on: (i) the shots corresponding to different positions, distances, and game situations, (ii) differences between the winning and the losing teams, (iii) the importance of time-outs for teams and coaches, and (iv) the relative influence on the result of playing at home or away. As well as the above, there is a need to conduct more studies centred on defensive actions (Ferrari et al., 2019). In this sense, there have been very few studies of elite goalkeepers and their performance characteristics (Hansen et al., 2017), and almost all of those studies have focused on the "save" statistics – in particular, on the percentage of saves and their connection with the thrower and their position (Hansen et al., 2017).

Research studies systematically analysing games and players’ actions have come to provide players with crucial feedback for training and game play (Ferrari et al., 2014). In order to better explain and understand the outcome of a game, it is essential to analyse how the elements which lead to success or failure are related (Ferrari et al., 2014). Coaches and technical staff can then intervene to improve their training plans, since game analyses let them evaluate the personal behaviour patterns and characteristics of their players in detail (Hatzimanouil et al., 2017). There is a gap in the literature because no research has been undertaken to develop a model of the relevance of a goalkeeper game-related statistics for a final ranking of an important tournament (i.e. European Handball Championship, World Championship or Olympic Games). In this sense, it is hoped that the present study may provide scientists and coaches with relevant and novel information, in that there have been very few studies on the performance characteristics of elite goalkeepers or on their influence on their team's final ranking in major tournaments (Hansen et al., 2017). The particular objectives of this study were: (i) to analyse whether there are goalkeeper game-related statistics that differ depending on the team's final ranking, and (ii) to develop a multivariate model of the relevance of those game-related statistics for that final ranking.

Material and Methods

Participants and procedures

Sixty-five matches were analysed. All the data were retrieved from the results of the VIII Men's EHF European Handball Championship held in Austria, Sweden, and Norway in January 2020 (https://men2020.ehf-euro.com/home/). The authors obtained the due authorization from the European Handball Federation for the use of the data for scientific purposes. The analysis of public data taken from websites is habitual in the field of handball (Hatzimanouil, 2019; Pollard & Gómez, 2012; Saavedra et al., 2018). No informed consent was necessary because the information on the website that was used in the study is in the public domain.

The dependent variable in the study was the goalkeeper's team's final ranking (three groups were considered: 1st to 4th place, 5th to 12th place, 13th to 24th place). The independent variables were the game-related statistics listed in Table 1. The data were retrieved manually (i.e., not in any automated fashion) by one of the technicians, checked by one of the authors, DL, and entered manually into an Excel file. They were then subjected to a random check by another of the authors, JMS, in order to detect possible errors. Once this data cleansing process had been completed, the data were subjected to statistical analysis.

The validity of the data was examined following standard procedures used in observational methods (Anguera, 2003; Anguera et al., 2017). An instrument with which to register observations was developed using the LINCE software package (Gabín et al., 2012), assigning the variables to seven groups in accordance with the corresponding criterion: total (saves and shots), 6 m (saves and shots), 7 m (saves and shots), 9 m (saves and shots), wing (saves and shots), fast-break (saves and shots), and breakthroughs. The reliability of the data was checked using Cronbach's alpha (α) for internal consistency, and the intra-class correlation coefficient (ICC) and Cohen's kappa (κ) for inter-rater reliability (Cohen, 1960). Two randomly chosen matches were analysed, calculating the intra-rater internal consistency and reliability (at two different times) and inter-rater internal consistency and reliability (comparison of the observation record with the record downloaded from the official website). The cut-off points, between 0 and 1 [36], were as follows: for α (internal consistency) ≤0.50 unacceptable, 0.51-0.60 poor, 0-61-0.70 questionable, 0.71-0.80 acceptable, 0.81-0.90 good, and ≥0.91 excellent [37]; for ICC (reliability) ≤0.50 poor, 0.51-0.75 moderate, 0.76-0.90 good, and ≥0.91 excellent (Hatzimanouil et al., 2017); and for κ (reliability) <0.01 no agreement, 0.01-0.20 poor, 0.21-0.40 discrete/regular, 0.41-0.60 moderate, 0.61-0.80 good, and 0.81-1.00 very good (Landis & Koch, 1977). Table 2 lists the internal consistency and reliability of the intra-rater and inter-rater means. Both can be considered to be good or very good.

Table 1. Definitions of game-related statistics.

Variable	Definition
Total saves	Total number of shots saved
Total shots	Total number of shots received (with or without goal)
Total shots efficiency	Percentage of shots saved relative to the number of shots made by the attackers
6 m saves	Total number of shots from 6 m saved
6 m shots	Total number of shots from 6 m received (with or without goal)
6 m shots efficiency	Percentage of shots from 6 m saved relative to the number of shots made by the attackers
7 m saves	Total number of shots from 7 m saved
7 m shots	Total number of shots from 7 m received (with or without goal)
7 m shots efficiency	Percentage of shots from 7 m saved relative to the number of shots made by the attackers
9 m saves	Total number of shots from 9 m saved
9 m shots	Total number of shots from 9 m received (with or without goal)
9 m shots efficiency	Percentage of shots from 9 m saved relative to the number of shots made by the attackers
Wing saves	Total number of shots from the wing area saved
Wing shots	Total number of shots from the wing area received (with or without goal)
Wing shots efficiency	Percentage of shots from the wing area saved relative to the number of shots made by the attackers
Fast-break saves	Total number of shots saved in fast-break situations

Fast-break shots	Total number of shots received in fast-break situations (with or without goal)
Fast-break efficiency	Percentage of shots saved in fast-break situations relative to the number of shots made by the attackers
Breakthrough saves	Total number of shots saved in breakthrough situations
Breakthrough shots	Total number of shots received in breakthrough situations (with or without goal)
Breakthrough efficiency	Percentage of shots saved in breakthrough situations relative to the number of shots made by the attackers

Table 2. Validity coefficients for intra- and inter-rater internal consistency (Cronbach's alpha – α) and reliability (intra-class correlation coefficients – ICC – and Cohen's kappa – κ).

Variable group	Intra-observer			Inter-observer		
	α	ICC (95%)	κ	α	ICC (95%)	κ
Total	0.95	0.95	0.97	0.83	0.83	0.78
6 m	0.92	0.85	0.97	0.66	0.64	0.70
7 m	1.00	1.00	1.00	1.00	1.00	1.00
9 m	0.96	0.92	0.96	0.88	0.88	0.79
Wing	0.89	0.89	0.95	0.78	0.78	0.82
Fast-break	1.00	1.00	1.00	0.89	0.88	0.78
Breakthroughs	0.81	0.81	0.95	0.70	0.66	0.76
Mean	0.93	0.92	0.97	0.82	0.81	0.81

Table 3. Matrix of correlations between the variables studied (the values in boldface have p<0.05).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
Total saves (1)	—																				
Total shots (2)	**0.400**	—																			
Total efficiency (3)	**0.927**	0.042	—																		
6 m saves (4)	**0.338**	0.139	**0.307**	—																	
6 m shots (5)	0.154	**0.389**	0..017	-0.005	—																
6 m shots efficiency (6)	0.124	-0.049	0.152	-0.081	0.138	—															
7 m saves (7)	0.151	0.078	0.146	-0.080	-0.015	-0.081	—														
7 m shots (8)	0.135	0.155	0.085	-0.012	-0.071	-0.142	**0.600**	—													
7 m shots efficiency (9)	0.102	0.033	0.107	0.061	0.005	0.107	**0.828**	**0.258**	—												
9 m saves (10)	**0.527**	0.077	**0.548**	0.090	**-0.217**	**0.246**	-0.174	-0.154	-0.096	—											
9 m shots (11)	0.174	0.094	0.151	0.165	**0.285**	**0.451**	-0.015	-0.165	-0.039	**0.706**	—										
9 m efficiency (12)	**0.518**	-0.036	**0.589**	-0.008	-0.071	-0.026	-0.140	-0.106	-0.098	**0.703**	0.073	—									
Wing saves (13)	**0.460**	**0.214**	**0.420**	0.084	-0.083	0.128	0.029	0.117	0.013	0.153	**0.244**	0.008	—								
Wing shots (14)	0.083	**0.316**	-0.026	-0.146	0.013	**-0.204**	-0.042	0.032	-0.041	**-0.315**	**-0.463**	-0.032	**0.586**	—							
Wing shots efficiency (15)	**0.439**	0.070	**0.466**	0.024	-0.073	0.009	0.089	0.148	-0.009	-0.087	**-0.192**	0.063	**0.739**	0.089	—						
Fast-break saves (16)	**0.248**	0.139	**0.213**	**0.346**	0.062	**0.403**	0.069	-0.045	0.042	0.014	0.030	0.035	0.141	0.038	0.035	—					
Fast-break shots (17)	0.001	**0.318**	-0.119	0.016	0.016	0.034	0.031	0.055	0.026	0.080	0.154	0.042	0.001	0.010	0.073	**0.311**	—				
Fast-break efficiency (18)	**0.228**	0.010	**0.238**	**0.266**	0.047	**0.318**	0.084	-0.067	0.127	0.022	0.094	-0.010	0.150	0.063	-0.009	**0.805**	-0.076	—			
Breakthrough saves (19)	**0.362**	**0.303**	**0.255**	0.005	0.076	0.017	0.075	0.034	0.107	0.105	0.043	0.064	0.044	0.153	0.175	0.009	0.047	0.044	—		
Breakthrough shot (20)	0.032	**0.250**	-0.072	-0.172	-0.099	-0.135	0.074	-0.009	0.101	**-0.180**	**-0.254**	-0.047	0.065	-0.039	**0.223**	-0.024	0.134	-0.008	**0.573**	—	
Breakthrough efficiency (21)	**0.365**	0.099	**0.361**	**0.243**	0.048	**0.297**	-0.142	-0.061	-0.145	**0.328**	**0.316**	0.140	0.018	-0.167	0.012	0.064	-0.105	0.079	**0.705**	0.013	—

Statistical analysis

Basic statistical descriptors (mean and standard deviation) were calculated for the goalkeepers in each of the teams' final rankings groups (first group: 1st to 4th place; second group: 5th to 12th place; third group: 13th to 24th place). A one-way ANOVA was used to establish the differences in game-related statistics according to the team's final ranking. The Bonferroni post-hoc test was used to compare means. For the multivariate analysis, classification and regression trees (CRTs) were used. This technique determines rules to predict the distribution of data by dividing it into segments of homogeneity with respect to the dependent variable, also calculating the corresponding values of normalized importance (NI) (De Ath & Fabricius, 2000). In this case, the dependent variable was the team ranking group (first group: 1st to 4th place; second group: 5th to 12th place; third group: 13th to 24th place). The Gini impurity measure (values between 0 and 1) was applied to determine the level of impurity of the nodes. Values far from 0 indicate greater statistical power since the nodes would be more different from each other. To address overfitting, a pruning procedure was applied with a standard error equal to unity. For validation of the model, cross validation was implemented consisting of randomizing and dividing the data up to ten times, using 90% of the cases for learning and reserving the other 10% for the final test (Thornton et al., 2016). A p-value of <0.05 was considered to be statistically significant. The statistical analysis was performed with the software package IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp. Released 2017. Armonk, NY: IBM Corp).

Results and Discussion

Table 4 presents the mean scores and their standard deviations for each group (first group: 1st to 4th place; second group: 5th to 12th place; third group: 13th to 24th place), and the results of the one-way ANOVA with the Bonferroni post-hoc test. Only the variable "total shots efficiency" showed differences between groups (first and second groups greater than third group, F=3.215, p=0.044).

Figure 1 shows the CRT describing the variables that were of greatest importance in its construction. The model correctly explained 60% of the cases using five predictor variables. The NI of each of these variables is expressed as a percentage. The standard error of the ranking in the model was 0.04, and the estimated risk was 0.55. At the first level, the variable with the greatest predictive power selected by the model was 7 m shots efficiency (node 0) (NI = 100%), correctly classifying 26.6% of the goalkeepers belonging to the first group teams. If the value of 7 m shots efficiency was ≤46.429, the correctly classified percentage of the first group was greater (30.5%) (node 1), but if the value was above this threshold then the percentage correctly classified was very low (5.3%) (node 2). At the next level, the variable 9 m shots efficiency (NI = 98.6%) correctly classified 33.0% of the goalkeepers in the first group if the value of that variable was ≤60.556 (node 3), while if the value was above that threshold then there were no correct classifications (0%) (node 4). The third variable selected by the model was total shots efficiency (NI=73.0%) which emerged from node 3. It correctly classified 23.0% of the goalkeepers of the first group if its value was ≤30.152 (node 5), and if its value was above that threshold then it classified 50% (node 6). From this last node, there emerged the fourth predictor variable, total shots (NI=38.4%), correctly classifying 37.0% of the goalkeepers of the first group if its value was ≤40.500 (node 7), and 88.9% (node 8) if its value was greater. The last variable selected, 9 m saves (NI=48.0%), emerged from node 7, correctly classifying 63.6% of the first group goalkeepers if its value was ≤4.500 (node 9), but only 18.3% (node 10) if its value was greater.

Table 4. Values for each of the game-related statistics. Mean, standard deviation, and one-way analysis of variance (ANOVA) with the Bonferroni post hoc test for differences between groups.

Variable	1st Group (1st to 4th) A	2nd Group (5th to 12th) B	3rd Group (13th to 24th) C	F	p	Diff.
Total saves (n)	10.98 ± 13.74	10.72 ± 3.37	9.53 ± 2.07	1.815	0.167	n.s.
Total shots (n)	36.55 ± 5.39	37.86 ± 3.86	38.13 ± 4.58	1.279	0.282	n.s.
Total shots efficiency (%)	29.60 ± 7.68	28.46 ± 8.86	24.87 ± 7.16	3.215	0.044	A,B>C
6 m saves (n)	1.88 ± 1.54	1.75 ± 1.43	2.15 ± 2.74	0.455	0.630	n.s.
6 m shots (n)	6.88 ± 3.07	7.16 ± 3.13	7.03 ± 3.91	0.730	0.929	n.s.
6 m shots efficiency (%)	26.15 ± 19.32	24.35 ± 18.14	47.46 ± 26.46	1.342	0.265	n.s.
7 m saves (n)	0.67 ± 1.05	0.81 ± 1.06	0.50 ± 0.70	1.067	0.347	n.s.
7 m shots (n)	3.30 ± 1.99	2.95 ± 1.67	3.09 ± 2.02	0.383	0.683	n.s.
7 m shots efficiency (%)	13.47 ± 18.22	24.41 ± 31.02	13.34 ± 17.25	2.800	0.055	n.s.
9 m saves (n)	4.42 ± 2.46	4.42 ± 2.42	3.88 ± 2.71	0.568	0.57	n.s.
9 m shots (n)	11.39 ± 4.63	11.75 ± 3.48	11.68 ± 6.55	0.061	0.940	n.s.
9 m shots efficiency (%)	38.53 ± 12.96	37.49 ± 18.43	31.94 ± 14.60	1.717	0.184	n.s.
Wing saves (n)	2.64 ± 2.22	2.40 ± 1.77	2.35 ± 1.77	0.220	0.803	n.s.

Wing shots (n)	7.52 ± 3.77	8.28 ± 3.38	7.74 ± 3.68	0.549	0.579	n.s.
Wing shots efficiency (%)	31.85 ± 21.88	29.97 ± 21.89	26.88 ± 18.51	0.466	0.628	n.s.
Fast-break saves (n)	0.52 ± 0.67	0.54 ± 0.68	0.38 ± 0.92	0.513	0.600	n.s.
Fast-break shots (n)	3.12 ± 1.97	3.44 ± 2.05	3.85 ± 3.18	0.790	0.465	n.s.
Fast-break efficiency (%)	16.72 ± 23.49	17.18 ± 24.99	9.56 ± 21.55	1.007	0.369	n.s.
Breakthrough saves (n)	0.73 ± 0.80	0.74 ± 0.95	0.88 ± 1.06	0.305	0.738	n.s.
Breakthrough shots (n)	3.82 ± 2.50	3.84 ± 2.51	3.82 ± 2.68	0.001	0.999	n.s.
Breakthrough efficiency (%)	16.18 ± 17.80	20.90 ± 27.87	22.51 ± 26.05	0.566	0.569	n.s.

n.s., not significant.

Figure 1. Regression tree generated by decision tree analysis applied to the study's predictor variables (game-related statistics) according to the group variable (first group: 1st to 4th place; second group: 5th to 12th place; third group: 13th to 24th place). Seven_eff, 7 m shots efficiency; Nine_eff, 9 m shots efficiency; Total_eff, total shots efficiency.

The objectives of this study were (i) to analyse whether there are goalkeeper game-related statistics that differ depending on the team's final ranking, and (ii) to develop a multivariate model of the relevance of those game-related statistics for that final ranking. By choosing the last European Championship played, we were able to analyse the most recent data available. This is especially relevant when considering that this championship was to be the last major international championship before the Olympics. Similarly, game-related statistics are commonly used to study competition performance in handball (Hatzimanouil 2019; Pollard et al., 2012; Saavedra et al., 2018). This type of study provides coaches with scientific support to interpret and apply sources of game-related statistics in training. The main findings of this study are centred around the fact that the most determinant variable was total shots efficiency, which differed between groups according to the teams' final rankings. The multivariate model (CRT) managed to correctly classify 60% of the goalkeepers based on the teams' final ranking group (first group: 1st to 4th place; second group: 5th to 12th place; third group: 13th to 24th place) with five predictor variables: 7 m shots efficiency, 9 m shots efficiency, total shots efficiency, total shots, and 9 m saves. Although there have been previous studies analysing the role of the goalkeeper based on the final result (win/lose) or in other contexts, to the best of our knowledge this is the first study to have analysed the goalkeeper's role from this multidimensional perspective, discriminating the variables predictive of the goalkeepers' performance in the highest classified teams.

The results showed that the goalkeepers of the first and second groups were more effective than those of the third group with respect to total shots efficiency ($F=3.215$, $p=0.044$) (Table 3). This variable expresses the total number of saves in relation to the number of shots the goalkeeper received. These results coincide with those of a study of the Men's World Championship that found a correlation between this variable and the final team ranking ($R^2=0.46$),10 and of a study of the Women's European Championship in which A-class goalkeepers had greater total shots efficiency than C-class goalkeepers [29]. Along the same lines, a study carried out on the Spanish men's handball league found the best classified teams to present greater efficacy in goalkeeper stops and in shots ($R^2=0.74$) (Pascual et al., 2010)]. A later study found differences in total shots efficiency between the four top ranked teams and the rest in both the Olympic Games and the European Championships (Valentin 2018). Similarly, previous studies have found this variable (total shots efficiency) to differentiate (Daza et al., 2017; González et al., 2017) or discriminate (Saavedra et al., 2017)] the winning from the losing teams. A goalkeeper's effectiveness is a determining factor in a team's performance. This may be due both to the technical-tactical quality of the expert goalkeeper (Le Menn et al., 2019) and to the good tactical functioning of the defenders-goalkeeper pairing for all distances (Ferrari et al., 2018) and all throwing positions (Križan & Mikulič, 2018). The main objectives of defensive action (defenders-goalkeeper pairing) are to make it difficult for attackers to shoot from areas close to goal (6 m and breakthroughs) and to protect the central area (since it is the area with greatest shooting angle) (Hatzimanouil et al., 2017).

With respect to the multivariate (CRT) model that was developed, it was able to correctly classify 60% of the goalkeepers into the three ranking groups that had been defined. This classification used the values of five variables that emerged from the tree's 10 nodes (Fig 1). It has to be stressed that using three groups for the performance analysis – thus allowing greater precision than two groups (O'Donoghue & Holmes, 2015) – lessens the predictive power of the tree, but adds to the quality of the information (i.e., the applicability of the study). The variables selected by the model were 7 m shots efficiency, 9 m shots efficiency, total shots efficiency, total shots, and 9 m saves. The first variable to emerge from the tree was 7 m shots efficiency. Although this penalty shot is a game action that occurs relatively rarely during the game, it is one in which the attacker has everything in their favour to score a goal, while the keeper has to use anticipation and intuition to parry it (Le Menn et al., 2019). It should be borne in mind that, together with that of fast-breaks, the stopping efficiency on 7 m shots is one of the lowest (Saavedra et al., 2017), with the expectation being that a goal will be scored. Regardless of the importance of the goal avoided (of the six games of the "final weekend" of the championship analysed, five ended with a goal difference of just two or less), stopping a penalty shot can serve to spur on the team that made the stop (Saavedra et al., 2018). At the next level, there emerged 9 m shots efficiency. Unlike 7 m shots efficiency, for this variable the goalkeeper's effectiveness depends largely on the defenders-goalkeeper pairing. Throws from 9 metres are made with opposition due to the space available and the players' size, so this type of throw is less efficacious (Križan & Mikulič, 2018). To all this has to be added the possibility that six (without the goalkeeper) are playing against seven, so that the spaces would be further reduced without any increase in the effectiveness of the throw (Hatzimanouil et al., 2017). The third variable that emerged in the model was total shots efficiency. This was foreseeable since previous studies have shown this variable to be related to a team's final competition ranking [10]. Other models have differentiated (Daza et al., 2017; González et al., 2017) or discriminated (Saavedra et al., 2017) between winning and losing teams thanks to this same variable. The fourth variable selected, total shots, indicates that the better ranked teams receive a greater number of shots, which is no guarantee of greater effectiveness on the part of the attacker executing the throw. Finally, the last variable is again related to the 9 metres distance. It is 9 m saves, highlighting the importance of stops from this zone since it is from there that most of the shots in a match are made [49]. Furthermore, 9 m throws allow the goalkeeper to get in position, and thus to have more reaction time in which to follow the track and direction of the ball, allowing an expert goalkeeper's cognitive content and processes to intervene to a greater extent [46]. The results seem to highlight the importance both of the goalkeeper's individual actions (7 m shots) and of those that can be influenced by the defensive actions of their team-mates (9 m shots and total shots). This fact seems to make sense since both actions have been shown to be relevant for the final performance of a match [12].

This study has a number of limitations. First, not many games were analysed, and, as it was a European Championship, there was greater homogeneity at the team level than, for example, in the Olympic Games. Nevertheless, the analysis was of the world's best goalkeepers. Second, the game actions were analysed from a static perspective (Prieto et al., 2018), i.e., without taking their preceding or following actions into account. Thus, for example, a goalkeeper stop could have been influenced by some good defensive action that made it hard for the attacker to execute the throw (Križan & Mikulič, 2018). Thirdly, the goalkeeper's individual characteristics (height, weight, or years of experience, for example) were not taken into account, and neither was the influence of the actions that the goalkeeper repeats throughout a match (for example, saves from seven metres). These two issues do influence game-related statistics, and this fact should be taken into account when interpreting the results. Finally, it should be noted that the variables put into the multivariate analysis included total values (n) and efficiency (%), so that some of those variables will be interrelated (Table 3).

Conclusions

The conclusions to be drawn from the present study are that the better classified teams (1st to 12th) have a greater total shots efficiency than the lower classified teams (13th to 24th). The multivariate analysis revealed the relevance of certain goalkeeper actions to the team's final ranking. It correctly classified 60% of the teams thanks to five variables: 7 m shots efficiency, 9 m shots (saves and efficiency), and total shots (saves and efficiency). This seems to indicate that the actions of the goalkeepers alone (7 m shots efficiency) and their actions which are influenced by the defensive actions of their team-mates (9 m shots both saves and efficiency, total shots efficiency, and total shots) are relevant to their team's final ranking. The importance of saves and efficiency from 9 m is suggestive of the relevance of the goalkeeper's specific work from this distance. This study has highlighted the importance of the goalkeeper's performance to the final ranking of the team. In this sense, the results suggest the relevance of efficiency and/or total stops from the 7 and 9 metre positions, so that coaches should place special stress on training the goalkeeper in situations that involve shots from these distances. Nevertheless, future research needs to address the relationships between game statistics and individual goalkeeper performance indicators, and between these indicators and those of team performance.

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