ORIGINAL

SPORT PERFORMANCE ANALYSIS OF COMPETITIVE GOALBALL ACCORDING TO GENDER

ANÁLISIS DEL RENDIMIENTO DEPORTIVO DEL GOALBALL DE COMPETICIÓN EN FUNCIÓN DEL GÉNERO

Muñoz-Jiménez, J.[1]; Gamonales, J.M.[1]; León, K.[1]; Ibáñez, S.J.[1]

[1] Faculty of Physical Activity and Sport Sciences. University of Extremadura (Spain) suliwan@unex.es, martingamonales@unex.es, fleon@unex.es, sibanez@unex.es

Spanish-English translator: Rocío Domínguez Castells, rociodominguezcastells@gmail.com

ABSTRACT

The aims of the present study were to analyse elite Goalball through the definition and description of contextual variables, offensive variables, defensive variables and action effectiveness variables that appear during the game, as well as to assess the performance differences between men's and women's competitions. Five trained observers analysed all the offensive and defensive actions of the 71 matches of the European Goalball Championship, held in Munich (Germany) in 2009. In total, 16 variables were recorded in each of the 10648 throws performed in competition. Subsequently, descriptive and difference analyses of the variables proposed in the study were conducted in men's and women's competitions. The results revealed the existence of performance differences between men and women. In conclusion, significant differences based on gender exist in goalball competition performance.

KEYWORDS: Goalball, blind, performance, competition.

RESUMEN

Los objetivos del presente estudio fueron analizar el Goalball de alta competición a través de la definición y la descripción de las variables contextuales, variables ofensivas, variables defensivas y variable de eficacia de la acción que se desarrollan durante el juego, así como evaluar las diferencias en el rendimiento entre la competición masculina y femenina. Cinco observadores entrenados analizaron todas las acciones de ataque y defensa de los 71 partidos del Campeonato de Europa de selecciones nacionales de Goalball, celebrado en Múnich (Alemania), en 2009. En total, se registraron 16 variables en cada uno de los 10649 lanzamientos de la competición. Posteriormente se realizó un análisis descriptivo y de diferencias entre las variables planteadas en el estudio en competición masculina y femenina. Los resultados evidencian la existencia de diferencias en el rendimiento de hombres y mujeres. En conclusión, el Goalball es una modalidad deportiva con diferencias significativas en el rendimiento según el género de la competición.

PALABRAS CLAVES: Goalball, ciegos, rendimiento, competición.

1. INTRODUCTION

Goalball is a sport for the visually impaired where two teams of three players start from opposite end sides of a court of similar dimensions to a volleyball court, divided into two halves by a centre line (Morato, Furtado, Gamero, Magalhaes & Almeida, 2017). It was first practised after World War II in Germany as a form of rehabilitation for war veterans (Scherer, Karasiak, Da Silva & Petroski, 2012). Its aim was to develop the ability to concentrate and the physical capacities of soldiers who had lost sight (Pedersen & Greer, 2008; Tepfer & Lieberman, 2012). Nowadays, it is one of the most popular sports for the visually impaired at international level (Haegele & Wiegel, 2018), and it was included in the Paralympic Games in 1976 (De Campos et al., 2020).

Research available on this sport is of very diverse nature, related to different aspects of the game (Link & Weber, 2018). There are studies that analysed physical fitness in adolescent players with visual impairment (Da Cunha Furtado, Morato, Potenza & Gutiérrez, 2016; Goulart-Siqueira et al., 2019; Karakaya, Aki & Ergun, 2009), and even one that focused on assessing static balance during the execution of motor skills that affect sport performance in goalball (Bednarczuk et al., 2017). Another study analysed the relationship between maximum strength, muscle power, anthropometric measurements and body composition, and the throw in goalball (De Campos et al., 2020). Furthermore, there are manuscripts that describe the experiences of athletes with visual impairment related to the use of mental imagery in training and competition (Eddy & Mellalieu, 2003), as well as studies focused on determining defence reaction time and performance (Da Silva, Pereira, Depra & Gorla, 2010). Other studies addressed elite players' anthropometric measurements (Molik et al., 2015; Scherer et al., 2012), requirement profiles for goalball coaches (Abdolmaleki, Mirzazadeh, Allahyari & Ramezani, 2015) and school teaching guidelines (Laughlin & Happel, 2016). There is also one study that developed different specific methods to analyse the ball sound (Gulick & Malone, 2011).

Besides, there exist studies that analysed the different throwing techniques (Bowerman, Davis, Ford & Nichols, 2011), identified the most effective throws (Link & Weber, 2018), or examined defensive and offensive systems in goalball (Amorím, Botelho, Sampaio, Molina & Corredeira, 2010; Tosim, Junior, Leitão & Simões, 2008; Tosim, Massolli & Beltrao, 2008). One study evaluated an observational system to analyse goalball applying the Systematic Observational Methodology with the help of expert observers (Morato et al., 2017), and another one developed goalball performance analysis software (Weber & Link, 2016). Therefore, it can be noted that, compared to other sport modalities for people with disability, research is scarce and addresses varied topics, meaning that this is an emerging field of knowledge that is starting to generate scientific interest (Muñoz-Jiménez, Gamonales, León & Ibáñez, 2018).

Sport performance analysis in one of the most relevant research lines within Training Sciences and it is growing as a consequence of the important progress achieved in the statistical methods applied (Da Silva, Duarte, Esteves, Travassos & Vilar, 2016). This growth is also due to the increasing interest from

clubs, athletes, media and coaches in knowing about players' performance and, therefore, in being able to explain it (Gómez-Ruano, 2017). This methodology includes all research that analyses competition or training (Hughes & Bartlett, 2002) with the purpose to learn how to predict and prescribe players and teams' performance based on the competition characteristics. Observation is the most widely used method to study and analyse team sports through game analysis (Wright, Atkins, Jones & Todd, 2013).

Game analysis through observational methodology can be defined as an objective means of recording sport performance, so that key elements can be quantified in a valid and consistent manner (Nevill, Atkinson & Hughes, 2008). These studies use recording and coding tools that allow for observation of preceding and concurrent behaviours to the scoring action (goal or basket), meeting the quality, reliability, validity and accuracy criteria (Jiménez-Salas & Hernández-Mendo, 2016). To that purpose, observation procedures designed and validated by experts are needed (Wieserma, 2001). Systematic observation allows us to gain knowledge on the game (Ardá, Maneiro, Rial, Losada & Casal, 2014) and to extract relevant information on the specific context under study (Lames & McGarry, 2007). Specific offensive or defensive variables are described (Fellingham & Vehrs, 2009), allowing coaches to improve training tasks and even competitive performance (Gómez-Ruano, Ibáñez, Parejo & Furley, 2017). Therefore, performance indicators are a selection or combination of movement variables that aim to define some or all performance aspects of a specific sport context through technical-tactical factors (Gómez-Ruano, 2017).

After conducting a literature review on goalball, specific sport for the visually impaired, and given the lack of studies on performance analysis of this modality, it seemed necessary to gain knowledge on this topic, with the aim to determine game-related performance indicators. Consequently, the aims of the present study were: i) to analyse elite goalball in 2009 through the definition and description of *Context variables (Gender, Competition stage, Team and Moment of throw), Offensive variables (Attacking player, Starting area, Ending area, Throwing technique, Type of throw and Throw outcome), Defensive variables (Defensive system, Defending player, Individual defending position, Collective defending technique, Area where the defensive action occurs and Outcome)* and the variable *action effectiveness*; and ii) to determine whether there are differences in the game actions between men and women. In summary, to gain technical-tactical knowledge on goalball game processes.

2. METHODS

2.1. Design

This research belongs to the category of *quantitative empirical studies* (Montero & León, 2007), and the observational methodology was applied with the purpose to analyse elite goalball.

2.2. Sample

The sample was composed of all throws performed during the European Goalball Championships, held in Munich (Germany) in 2009. Nineteen teams from 15 countries participated, 8 in the men's and 11 in the women's competition. All the playing actions of the 71 matches were recorded, a total of 10,648, and 16 variables were recorded in each of them (Table 1).

Table 1. Action distribution in men's and women's competitions

Gender	Actions	Percentage	Total matches	Total teams
Men	4,731	44.4	32	8
Women	5,917	55.6	39	11
Total	10,648	100	71	19

2.3. Variables

The variables analysed in this research were the ones used in recently conducted observational studies in goalball (Muñoz-Jiménez et al., 2018). These variables were: *Context variables (V1C.Gender, V2C.Competition stage, V3C.Team* and *V4C.Moment of throw), Offensive variables (V1O.Attacking player, V2O.Starting area, V3O.Ending area, V4O.Throwing technique, V5O.Type of throw* and *V6O.Throw outcome), Defensive variables (V1D.Defensive system, V2D.Defending player, V3D.Individual defending position, V4D.Collective defending technique (body segment), V5D.Area where the defensive action occurs* and *V6D.Outcome)* and the variable *action effectiveness (V1E).* Figure 1 shows the division into tactical areas suggested in this study, in particular for variables *V2O*, *V3O* and *V5D,* which corresponds to the tactical division used by goalball players and coaches. The numbering refers to whether it is an offensive or defensive action.
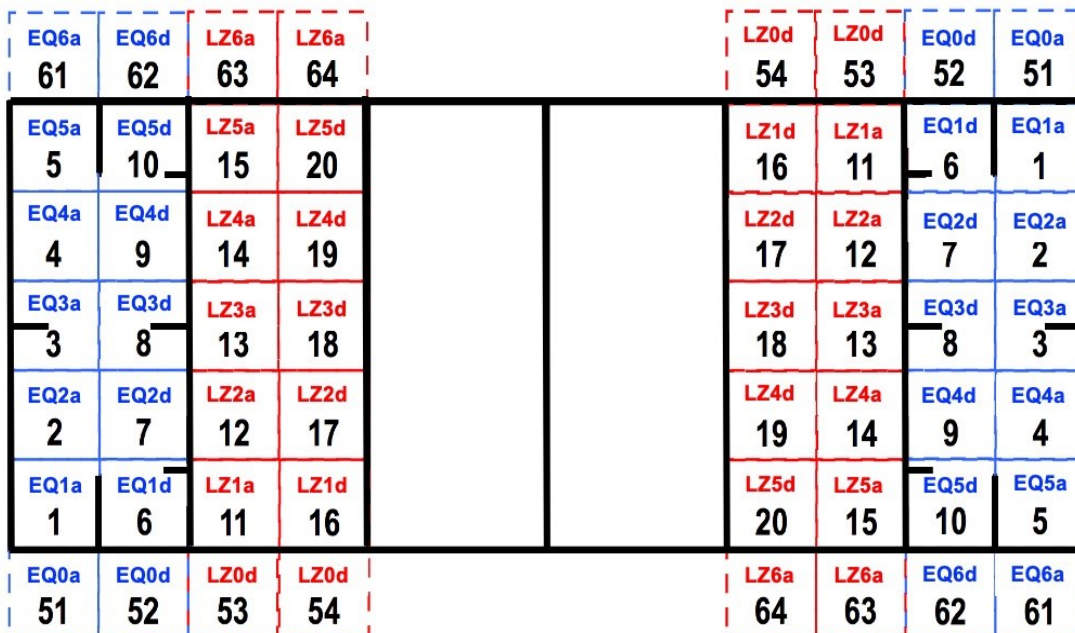

Figure 1. Field diagram to define V2O, V3O and V5D.

2.4. Procedure

Context variables, offensive variables, defensive variables and effectiveness variables were used to analyse elite goalball and to establish gender-based differences. To do so, it was necessary to implement a theoretical and practical training process for coders similar to those existing in the scientific literature involving sports for people with disability (Gamonales, Muñoz-Jiménez, León & Ibáñez, 2018; Muñoz-Jiménez et al., 2018), with the aim to confirm the validity and reliability of the data used in the study.

The five coders of the present study underwent a training process divided into three phases: theoretical training, practical training and individual training. After the theoretical and practical training, reliability was calculated through *Multirater Kappa Free* test, which yielded a Kappa coefficient of 0.85 for the observation instrument (Muñoz-Jiménez et al., 2018). Furthermore, the five following inclusion criteria were established by the researchers in order for the selected observers to be included in the sample of coders: 1) to show interest in the study; 2) to hold a university degree related to Physical Activity and Sport; 3) to have received specific training on physical activity for the disabled; 4) to have practised goalball in an inclusive or educational environment; and 5) to commit to observing, recording and coding the assigned matches. After the training, the coders individually recorded all the playing actions of the championship (*n*=10,648), allowing for collection of the necessary data for the corresponding statistical analysis.

2.5. Statistical Analysis

A descriptive analysis based on frequencies and percentages was conducted in order to gain knowledge on elite goalball. Furthermore, *Chi-squared* (χ^2) test and *Cramer's Phi (φc)* coefficient were applied to identify the differences between men's and women's competitions (Newell, Aitchison & Grant, 2014). The strength of association revealed by *Cramer's φc* was interpreted according to Crewson's (2006) proposal. The degree of association between the dependent variables *(Context variables, Offensive variables* and *Offensive variables)* and the independent variable *(Gender)* was interpreted by means of the *Corrected Typified Residues (ASR)* of the contingency tables, allowing for accurate interpretation of the meaning of the relationships between variables (Field, 2009).

3. RESULTS

The throws performed during the 71 competition matches (*n*=10,648) were recorded, 153.87 ± 15.9 actions per match on average. The mean number of actions per match was 152.68 in men's competition and 154.82 in women's competition. The evolution of the number of throws per match is represented in Figure 2.

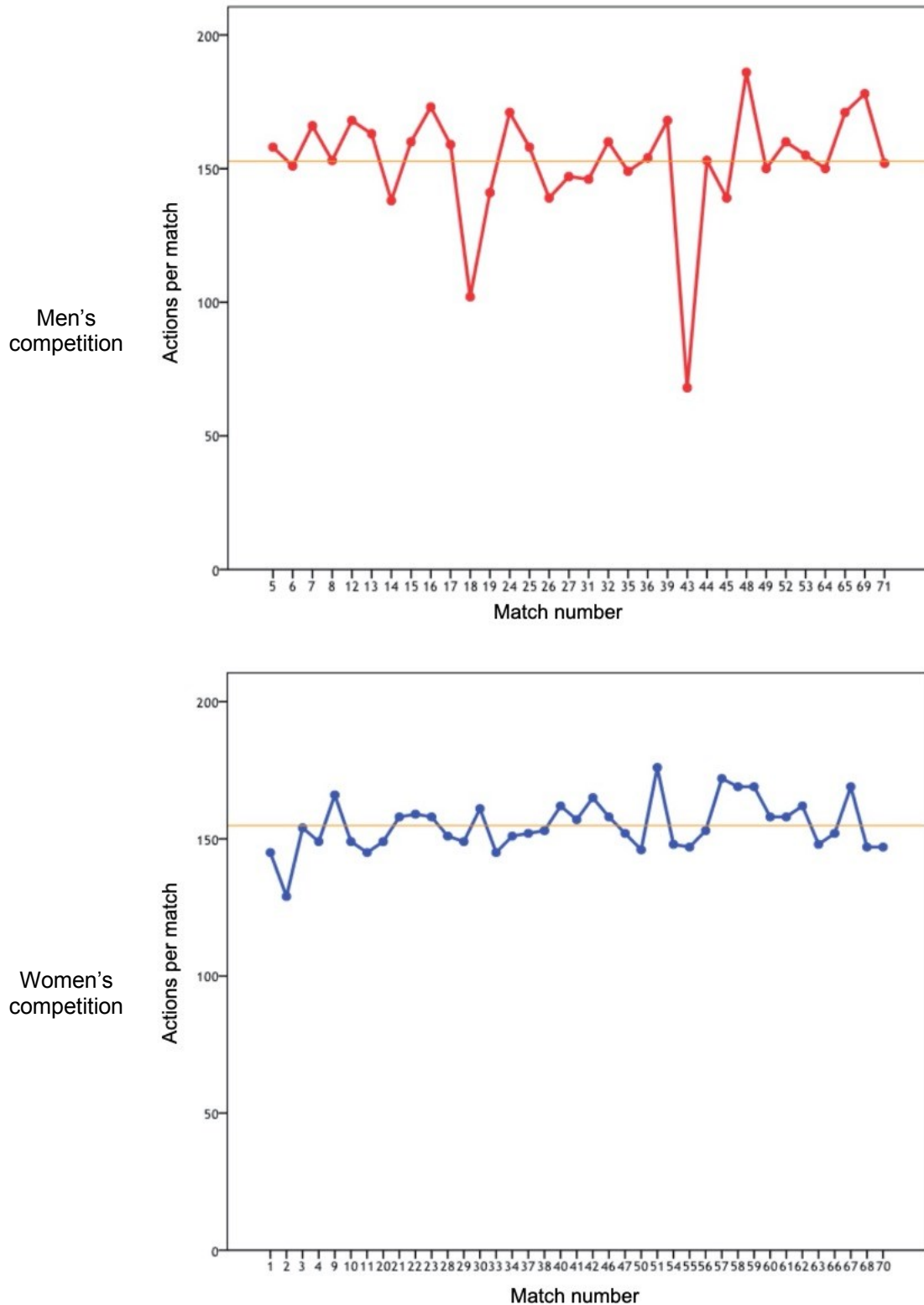**Figure 2.** Evolution of the number of throws per match

The number of throws was significantly lower in two men's competition matches. This was due to a goalball playing rule, which states that a match will be declared finished when a goal difference of 10 is reached. Furthermore, the results allow for identification of differences between genders in the variables used to analyse playing actions (Table 2).

Table 2. Relationship between variable V1C.Gender and the study dependent variables.

Variables	χ^2	df	Sig.		φc	Sig.	Degree of association
V2C.Competition stage	1,471.7	5	**0.00**	*	0.372	0.00	Moderate
V3C.Team	6,205.1	14	**0.00**	*	0.763	0.00	High
V4C.Moment of throw	39.379	3	**0.00**	*	0.061	0.00	Small
V1O.Attacking player	7.884	2	**0.01**	*	0.027	0.01	Small
V2O.Starting area	286.65	25	**0.00**	*	0.164	0.00	Low
V3O.Ending area	765.52	27	**0.00**	*	0.268	0.00	Low
V4O.Throwing technique	1,774.8	6	**0.00**	*	0.408	0.00	Moderate
V5O.Type of throw	95.248	3	**0.00**	*	0.095	0.00	Small
V6O.Throw outcome	57.516	4	**0.00**	*	0.073	0.00	Small
V1D.Defensive system	519.69	6	**0.00**	*	0.221	0.00	Low
V2D.Defending player	70.587	3	**0.00**	*	0.081	0.00	Small
V3D.Individual defending position	694.19	4	**0.00**	*	0.255	0.00	Low
V4D.Collective defending technique	78.931	4	**0.00**	*	0.086	0.00	Small
V5D.Area where the defensive action occurs	220.29	10	**0.00**	*	0.144	0.00	Low
V6D.Outcome	81.019	11	**0.00**	*	0.087	0.00	Small
V1E.Effectiveness	58.754	2	**0.00**	*	0.074	0.00	Small

* *p*<0.05   Degree of association according to Crewson (2006)

The results revealed relationships between variable *V1C.Gender* and the rest of variables proposed in this study. According to Crewson (2006), the degree of association was small for variables *V4C*, *V1O*, *V5O*, *V6O*, *V2D*, *V4D* and *V6D* and low for variables *V2O*, *V3O*, *V1D*, *V3D* and *V5D*. Moderate association was detected for variables *V2C* and *V4O*. Lastly, variable *V3C* showed a high degree of association. Descriptive results and ASR are presented in order to interpret these differences.

Context Variables

Table 3 contains the rest of descriptive results and ASR for the context variables.

Table 3. Descriptive results and ASR for the context variables

| Variables | VC1.Gender | | | | | |
| | Male | | | Female | | |
	n	%	ASR	n	%	ASR
V2C.Competition stage						
Group stage	4,096	86.6	**26.9**	3,755	63.4	**-26.9**
Quarter-finals	0	0	**-23.1**	630	10.6	**23.1**
5th-11th places	0	0	**-28.7**	938	15.9	**28.7**
Semi-finals	315	6.7	**3.3**	305	5.2	**-3.3**
3rd-4th places	174	3.7	**3.7**	144	2.4	**-3.7**
Final	146	3.1	**2.0**	145	2.5	**-2.0**
V4C.Moment of throw						
1st half	2,481	52.1	**2.9**	2,935	49.6	**-2.9**
2nd half	2,250	47.6	**-2.2**	2,941	49.7	**2.2**
1st overtime	0	0	**-5.6**	39	0.6	**5.6**
2nd overtime	0	0	-1.3	2	0.1	1.3

ASR=|1.96|

V3C was related to the number of throws completed by every national team. Therefore, since it changed depending on the team, it was removed from the study.

Offensive Variables

Table 4 contains the descriptive results and ASR for the offensive variables of this goalball study.

Table 4. Descriptive results and ASR for the offensive variables

| Variables | VC1.Gender | | | | | |
| | Male | | | Female | | |
	n	%	ASR	n	%	ASR
V1O.Attacking player						
Left wing	2,042	43.2	1.3	2,482	41.9	-1.3
Centre	754	15.9	1,9	865	14.6	-1,9
Right wing	1,935	40.9	**-2.6**	2,572	43.4	**2.6**
V2O.Starting area						
EQ1a	1,178	24.9	**5.0**	1,232	20.8	**-5.0**
EQ2a	806	17.0	**2.8**	891	15.1	**-2.8**
EQ3a	354	7.5	**-6.1**	647	10.9	**6.1**
EQ4a	665	14.1	**4.9**	646	10.9	**-4.9**
EQ5a	1,211	25.6	**3.2**	1,355	22.9	**-3.2**
EQ1d	50	1.1	**-3.6**	114	1.9	**3.6**
EQ2d	68	1.4	**-5.0**	171	2.9	**5.0**
EQ3d	55	1.2	**-9.3**	246	4.2	**9.3**
EQ4d	51	1.1	**-3.3**	111	1.9	**3.3**
EQ5d	58	1.2	-1.6	95	1.6	1.6
LZ1a	8	0.2	0.2	9	0.2	-0.2
LZ2a	2	0.0	**-3.3**	20	0.3	**3.3**
LZ3a	1	0.0	**-3.6**	19	0.3	**3.6**

LZ4a	2	0.0	**-3.3**	20	0.3	**3.3**
LZ5a	3	0.1	-0.7	6	0.1	0.7
LZ1d	-	-	-0.9	1	0.0	0.9
LZ2d	-	-	-0.9	1	0.0	0.9
LZ3d	3	0.1	1.2	1	0.0	-1.2
LZ4d	1	0.0	0.2	1	0.0	-0.2
LZ5d	1	0.0	-0.4	2	0.0	0.4
EQ0a	38	0.8	**-4.5**	108	1.8	**4.5**
EQ0d	1	0.0	1.1	-	-	-1.1
LZ0a	-	-	-	-	-	-
LZ0d	-	-	-	-	-	-
EQ6a	173	3.7	0.3	211	3.6	-0.3
EQ6d	2	0.1	-1.6	8	0.1	1.6
LZ6a	-	-	-0.9	1	0.0	0.9
LZ6d	-	-	-0.9	1	0.0	0.9

V3O. Ending area

EQ1a	12	0.3	-0.2	16	0.3	0.2
EQ2a	4	0.1	0.3	4	0.1	-0.3
EQ3a	2	0.0	-0.5	4	0.1	0.5
EQ4a	1	0.0	-1.8	7	0.1	1.8
EQ5a	7	0.1	**-2.7**	26	0.4	**2.7**
EQ1d	62	1.3	**2.5**	48	0.8	**-2.5**
EQ2d	189	4.0	**10.0**	61	1.0	**-10.0**
EQ3d	51	1.1	**2.1**	41	0.7	**-2.1**
EQ4d	151	3.2	**7.8**	63	1.1	**-7.8**
EQ5d	211	4.5	**8.8**	95	1.6	**-8.8**
LZ1a	471	10.0	**-11.7**	1,062	17.9	**11.7**
LZ2a	542	11.5	**-4.9**	869	14.7	**4.9**
LZ3a	162	3.4	**-9.4**	458	7.7	**9.4**
LZ4a	403	8.5	**-5.0**	680	11.5	**5.0**
LZ5a	545	11.5	**-3.9**	831	14.0	**3.9**
LZ1d	506	10.7	**9.3**	341	5.8	**-9.3**
LZ2d	399	8.4	**8.3**	266	4.5	**-8.3**
LZ3d	165	3.5	1.2	181	3.1	-1.2
LZ4d	307	6.5	**4.0**	278	4.7	**-4.0**
LZ5d	394	8.3	**4.6**	356	6.0	**-4.6**
EQ0a	-	-	-0.9	1	0.0	0.9
EQ0d	-	-	-0.9	1	0.0	0.9
LZ0a	-	-	**-4.3**	23	0.4	**4.3**
LZ0d	10	0.2	-0.1	13	0.2	0.1
EQ6a	18	0.4	-1.3	33	0.6	1.3
EQ6d	7	0.1	-0.3	10	0.2	0.3
LZ6a	48	1.0	**-4.5**	126	2.1	**4.5**
LZ6d	64	1.4	**5.5**	23	0.4	**-5.5**

V4O.Throwing technique

Straight	2,428	51.3	**-39.3**	5,101	86.2	**39.3**
Rotation	2,257	47.7	**41.8**	668	11.3	**-41.8**
Low	15	0.3	**-3.8**	54	0.9	**3.8**
High	12	0.3	**-2.6**	35	0.6	**2.6**
Backwards	1	0.0	**-5.1**	36	0.6	**5.1**
Other	7	0.1	**2.0**	2	0.0	**-2.0**

Third throw	11	0.2	-1.1	21	0.4	1.1
V5O.Type of throw						
Rolling	3,083	65.2	**-9.4**	4,355	73.6	**9.4**
Spin bounce	1,628	34.4	**9.5**	1,536	26.0	**-9.5**
Other	9	0.2	1.5	5	0.1	1.5
Third throw	11	0.2	-1.8	21	0.4	-1.8
V6O.Throw outcome						
Correct	3,888	82.2	**-6.3**	5,126	86.6	**6.3**
Incorrect—High ball	101	2.1	**3.2**	79	1.3	**-3.2**
Incorrect—Long ball	26	0.5	**3.8**	8	0.1	**-3.8**
Incorrect—Out	705	14.9	**5.3**	678	11.5	**-5.3**
Incorrect—Third throw	11	0.2	-1.8	26	0.4	1.8

ASR=|1.96|

Defensive Variables

Table 5 contains the descriptive results and ASR for the defensive variables.

Table 5. Descriptive results and ASR for the defensive variables

Variables	VC1.Gender					
	Male			Female		
	n	*%*	*ASR*	*n*	*%*	*ASR*
V1D.Defensive system						
One-two	1,030	21.8	**-6.0**	1,586	26.8	**6.0**
One/two right wing/s, one forward	1,732	36.6	**18.7**	1,200	20.3	**-18.7**
One/two left wing/s, five forward	708	15.0	**-14.2**	1,554	26.2	**14.2**
Three lines	418	8.8	**-7.2**	785	13.3	**7.2**
Wings forward–centre backward	1	0.0	1.1	-	-	-1.1
One single player (penalty throw)	2	0.0	0.2	2	0.0	-0.2
No defence (incorrect)	840	17.8	**6.2**	791	13.4	**-6.2**
V2D.Defending player						
Left wing	1,153	24.4	**3.8**	1,260	21.3	**-3.8**
Centre	1,675	35.4	**-5.9**	2,426	41	**5.9**
Right wing	1,060	22.4	**-2.3**	1,440	24.3	**2.3**
No defence (incorrect)	843	17.8	**6.3**	791	13.4	**-6.3**
V3D.Individual defending position						
Low straight-leg defence	803	17.0	**21.9**	250	4.2	**-21.9**
Low defence on hand and knees	3,072	64.9	**-15.3**	4,631	78.3	**15.3**
Very low defence	-	-	-	-	-	-
Standing defence	13	0.3	**-12.2**	224	3.8	**12.2**
Other defending technique	-	-	**-4.2**	22	0.4	**4.2**
No defence	843	17.8	**6.4**	790	13.4	**-6.4**
V4D.Collective defending technique (body segment)						
Legs	957	20.2	**2.4**	1,090	18.4	**-2.4**
Arms	650	13.7	**-4.4**	997	16.8	**4.4**
Trunk	2,197	46.4	**-4.1**	2,984	50.4	**4.1**
No contact	87	1.8	**4.1**	55	0.9	**-4.1**
No defence	840	17.8	**6.2**	791	13.4	**-6.2**
V5D. Area where the action occurs						

	n	%	ASR	n	%	ASR
EQ1a	157	3.3	**-8.3**	412	7.0	**8.3**
EQ2a	65	1.4	**-8.7**	251	4.2	**8.7**
EQ3a	26	0.5	0.9	25	0.4	-0.9
EQ4a	158	3.3	-1.6	232	3.9	1.6
EQ5a	236	5.0	-0.8	316	5.3	0.8
EQ1d	447	9.4	**4.5**	418	7.1	**-4.5**
EQ2d	775	16.4	**-2.7**	1,089	18.4	**2.7**
EQ3d	818	17.3	-1.8	1,101	18.6	1.8
EQ4d	797	16.8	**3.2**	864	14.6	**-3.2**
EQ5d	406	8.6	**3.0**	416	7.0	**-3.0**
Incorrect	846	17.9	**6.4**	793	13.4	**-6.4**
V6D. Outcome						
No goal. Block	1,657	35.0	-1.4	2,150	36.3	1.4
No goal. Block out	620	13.1	**-2.3**	867	14.7	**2.3**
No goal. After clearance	1,276	27.0	**-4.1**	1,812	30.6	**4.1**
No goal. After high ball	46	1.0	**2.2**	35	0.6	**-2.2**
No goal. Ball over	20	0.4	0.9	19	0.3	-0.9
No goal. Other	5	0.1	1.0	3	0.1	-1.0
Goal. No ball contact	84	1.8	**4.2**	51	0.9	**-4.2**
Goal. After clearance	76	1.6	0.6	87	1.5	-0.6
Goal. After high ball	94	2.0	1.5	95	1.6	-1.5
Goal. Under the body	11	0.2	1.7	6	0.1	-1.7
Goal. Other	2	0.0	0.8	1	0.0	-0.8
No defence	840	17.8	**6.2**	791	13.4	**-6.2**

ASR=|1.96|

Action effectiveness variable

The *action effectiveness variable* was the last variable registered by the coders. It refers to the general defensive and offensive effectiveness. The descriptive results and ASR are shown in Table 6.

Table 6. Descriptive results and ASR for the action effectiveness variable

Variables	VC1.Gender					
	Male			Female		
	n	*%*	*ASR*	*n*	*%*	*ASR*
V1E.Action effectiveness						
No goal	3,624	76.6	**-7.7**	4,886	82.6	**7.7**
Goal	267	5.6	**3.8**	240	4.1	**-3.8**
No defence	840	17.8	**6.2**	791	13.4	**-6.2**

ASR=|1.96|

Figure 3 shows a summary of the results obtained for the analysed variables, with the aim to have an overview of the technical-tactical actions in men's and women's competition goalball.

Figure 3. Differences in goalball between genders.
E.V.: Effectiveness variable

4. DISCUSSION

The aims of the present research were to analyse elite goalball and to determine the differences in playing actions between men's and women's competitions through the definition and description of all variables. Differences

were observed in all the variables proposed in the study: context, offensive, defensive and effectiveness variables. Men's and women's goalball competitions presented differences as regards playing performance.

There are studies in the scientific literature involving goalball (Amorím et al., 2010; Tosim, Junior et al., 2008; Tosim, Massolli et al., 2008), as well as specifically addressing the throw (Bowerman et al., 2011; Link & Weber, 2018). These manuscripts brought to light the importance of the throw in goalball. It is an essential technical-tactical action, which can be performed from anywhere on the court before the 6-m line, starting from a standing position (Amorím et al., 2010). Women and men mostly used the side areas of the court to throw, while most defensive actions occurred in the central part of the opposing team's area (Morato et al., 2017). Nevertheless, the limited number of studies addressing performance and gender in goalball makes it necessary to confirm the findings of the present research with future studies in goalball or even in other sport contexts with people with or without disabilities, where similar methodologies are applied. The results of the descriptive and inferential analyses with the purpose to determine the differences between genders allowed for acquirement of relevant information for coaches. This information can be helpful to design more appropriate training sessions, and to establish which strategies and tactics to apply in men's and women's competitions. Furthermore, according to the results, goalball seems to be a sport with limited variety of technical-tactical actions.

With regard to *Context variables*, differences between men and women were detected in the variables *Competition stage*, *Team* and *Moment of throw*, proving once more the difference between male and female players.

The results revealed that the competition structure affects the number of throws performed by players in every *Competition stage*. Consequently, the number of throws per *Team* changed depending on their ranking in the competition. The male teams who reached the final performed a larger number of throws than the rest, since they played two more matches (semi-final and final). However, the number of throws per team was more balanced in the women's competition, due to the fact that the competition system allowed all teams to play a similar number of matches, regardless of their classification or not for the last rounds. In the case of goalball, as reported in previous studies, winning teams set a trend that the rest of teams tend to imitate (Hughes & Bartlett, 2002). Therefore, goalball coaches should design specific training tasks depending on gender and the specific competition requirements at every moment, as well as other key performance indicators such as static balance (Bednarczuk et al., 2017), dynamic balance or throwing and defending techniques. Moreover, it would be advisable to adapt training sessions to the applicable rules, since the sample of the present study was from 2009.

There were differences in the *Moment of throw* between genders. The highest number of throws in men's competition was registered in the *first half*, while it was registered in the *first overtime* in women's competition. These results are similar to other sport contexts where two different playing situations were also

observed, like handball (Gutiérrez-Aguilar, Fernández-Romero & Saavedra, 2012) or volleyball (Palao, Manzanares & Ortega, 2009).

The results revealed that the most relevant distinguishing factor between men's and women's competitions was related to the muscle power applied to defensive and offensive actions. Therefore, it would be advisable to prepare players to be able to maintain their muscle performance level at the key moments of the match. Furthermore, if female players used a smaller and lighter ball, the execution of technical and tactical actions would probably become more similar between genders, as it occurs in other team sports like volleyball (Palao et al., 2009) or handball (Gutiérrez-Aguilar et al., 2012).

Regarding the *Offensive variables*, differences between genders were observed in the variables *Attacking player, Starting area, Ending area, Throwing technique, Type of throw* and *Throw outcome*. The differences in the offensive variables between men and women are related to the technical-tactical actions performed by the team who has the ball, whose main aims are to keep possession and to advance to the opposing team's goal with the purpose to score (Amorím et al., 2010).

There were differences in the *Attacking player* between genders. In men's competition, there was no prevailing position as regards the throw, while in women's competition the probability of the *right wing* being involved in the attack was greater than the expected value. These data are in keeping with previous goalball studies (Morato et al., 2017; Link & Weber, 2018). Moreover, the game has recently evolved with regard to the throwing player as a consequence of a change in the rules. Therefore, goalball coaches must know players' performance in every position on the field, and they must know the opposing teams' playing systems in order to foster throwing from the different positions.

Differences were found in *Starting area* between men's and women's competitions. While men started the previous actions to throwing in area *EQ1a*, women did in area *EQ3d*. This reveals an evolution in the game compared to recent goalball studies (Morato et al., 2017; Link & Weber, 2018). Nowadays, the right and left side areas are the most frequently used ones in competition (Amorím et al., 2010). When throwing from these areas, the ball describes a diagonal trajectory, taking advantage of the maximum distance between throwing areas and trying to break the opposing team's defensive balance (Link & Weber, 2018). Match analysis is relevant for coaches (Gómez-Ruano, 2017), as it allows them to understand the game characteristics at every moment. Therefore, it would be advisable that goalball coaches used tasks with high variability in the starting area.

The results revealed differences between genders in the variable *Ending area*. Throws occurred in area *EQ2d* in men's competition, while actions ended in area *LZ1a* in women's competition. These findings seem logical if we take into account that goalball players play completely blindfold and move at high speed when throwing (Bowerman et al., 2011). This brings to light elite players' good spatial orientation in order to finish the throw in the desired place.

Consequently, choosing the ending area is important in a sport modality with a relatively simple tactical structure (Link & Weber, 2018). Coaches must identify and understand the importance of throwing action phases. Besides, knowledge on the playing phases will allow them to provide their players with appropriate instructions in order to make the best decisions during this action.

Differences between genders were detected in the variable *Throwing technique.* Men mostly performed the *rotation throw,* while the most frequently used technique by women was the *straight throw*. These data are similar to the existing scientific literature (Amorím et al., 2010; Link & Weber, 2018) and are associated with athletes' strength, depending on gender (Bowerman et al., 2011), and with the ball size and weight. This allows men to throw at higher speeds and to use the bounce more frequently, compared to women (Link & Weber, 2018). Coaches must, therefore, design specific tasks related to throwing technique, since it is one of the determining factors in achieving success in goalball.

Differences were also observed in the variable *Type of throw.* In men's competition, the most commonly applied technique was the *spin bounce throw*, while the *rolling throw* was the most frequent one in women's competition. Bounce-rotation throws were more successful than straight-flat ones (Link & Weber, 2018). The differences in the *Type of throw*, as well as in other aspects related to offensive actions, such as the displacement prior to throwing, are associated with the physical capacities of each gender (Da Cunha Furtado et al., 2016). Thus, men perform diagonal throws from the side areas taking advantage of the maximum distance between throwing areas to complete the action at higher speed, while women perform throws at lower ball speed, reducing the probability of the ball not being blocked by the defence (Link & Weber, 2018). Therefore, it is advisable to conduct strength and conditioning training to increase strength, and compensatory exercises to prevent injuries during throwing actions in goalball.

The results yielded differences in *Throw outcome* between genders. In particular, men presented higher probability of the throw outcome being *incorrect-out* (the ball goes out of the playing area after the throw), while women presented higher probability of the throw outcome being *correct*. These results bring to light that men take more risks when throwing than women. These findings may be affected by the rules of the competition analysed, from 2009. Nonetheless, there is no scientific evidence that the use by men of a specific technique or trajectory increases the risk of missing the throw (Link & Weber, 2018). Therefore, mastering different throwing techniques is highly recommended to male and female players.

Regarding the *Defensive variables*, differences between genders were observed in the variables *Defensive system, Defending player, Individual defending position, Collective defending technique, Area where the defensive action occurs and Outcome.*

Differences were found between men's and women's competitions in the *Defensive system* used by the defending team. Men used the system *one/two*

right wing/s, one forward (player 1 forward) more frequently. By contrast, women applied the system *one/two left wing/s, five forward* (player 5 forward) more often. These results show that teams select a defensive system with displacement depending on the area from which the attacking player throws. The data are in keeping with the findings by Amorím et al. (2010). Furthermore, these defensive movements have the purpose to cover the widest throwing angle possible. Despite players not presenting a clear trend to finish their throws on either side of the court, defences tend to choose a system that entails moving to the right side. To find out the reason for this, it would be necessary to conduct an in-depth study on the association between throwing error and the area from which the throw is performed in men's and women's competitions.

The results revealed differences between genders in the variable *Defending player.* In men's competition, the probability that no defender touched the ball (*incorrect defence*) was higher than the expected value, while in women's competition, the *centre player* showed higher probability than expected of blocking the ball. This is, the trend changed depending on the gender. These results are in keeping with the performance of defensive displacements that allow female players to react to throws covering a larger part of the goal, possibly because the ball is thrown at lower speed. Moreover, the results made it evident that men take more offensive risks as a consequence of their greater throwing power (Link & Weber, 2018). Thus, women's competition ball should be smaller and lighter to make the game faster and, therefore, more spectacular.

Regarding the *Individual defending position*, men showed higher probability of using the *low straight-leg defence*, while women presented higher probability of executing the *low defence on hands and knees*. The low defence allows for better orientation on the court, since players can touch the orientation lines, and also for quick body extension to the final defending position. According to Da Silva et al. (2010), there are no differences between genders in the individual defending position adopted in the orientation area in goalball. The *Individual defending position* depends on the player's starting position and on the defender's position within their team (Link & Weber, 2018). Therefore, in defence, players dive laterally, stretching their limbs to the maximum in order to cover the gaps between players with hands and legs, trying to prevent the ball from going through the empty spaces. The probability that a ball deflects off a defender's extremities is higher than in other sport modalities. Goalball coaches must improve specific training to work on the individual defending position and to minimise errors when blocking the ball.

Differences were identified in the variable *Collective defending technique*. In men's competition, the probability of *no defence* was higher than the expected value. By contrast, in women's competition *legs* and *arms* were mostly used in defence. This is again because, since men perform more powerful throws, shorter reaction time is required in each phase of the defensive movement to prevent a goal (Bowerman et al., 2011; Da Silva et al., 2010), increasing the number of defensive tactical mistakes. It is logical that women used *arms* and *legs* to defend, since blocking the ball with these body segments allows them to do it more safely. In their case, the ball travels at lower speed and,

consequently, there is longer time to react to the opposing team's actions. Goalball coaches must individualise defence training based on gender and work on reaction time to auditory stimuli.

The results also showed differences in the *Area where the defensive action occurs.* In particular, men threw the ball out more often, so there was higher probability than expected that no defensive action occurred. By contrast, women mostly defended in area *EQ2a.* The descriptive results showed that the majority of actions occurred in the centre-forward defensive area. This is logical, if we consider that the player that is most frequently involved in this type of action is the *centre*. This makes attacking players try to throw to *zones 2* and *4* of the opposing team, where there may be a gap between the *wing* and the *centre*, the probability of scoring a goal being higher. This happened both in men's and women's competitions. The data are similar to those reported in the scientific literature related to the analysis of performance indicators in goalball (Bowerman et al., 2011; Link & Weber, 2018; Molik et al., 2015).

Differences were also found in the action *Outcome*. In men's competition, the probability of the action outcome being *no defence* was higher than expected, while in women's competition the outcome *no goal after clearance* presented higher probability than expected. These data reveal how difficult it is to score a goal during normal game (excluding penalty throw). In men's competition, only 267 out of 4,731 throws ended in a goal. In women's competition, the number of goals was even lower (n=240), despite female players having performed a higher number of throws than men. This result shows that it was easier for the defence to block the ball in women's competition, mainly because of their lower throwing speed. This confirms the need for using a smaller and lighter ball in female competition, as it happens in other team sports, like volleyball (Palao et al., 2009) or handball (Gutiérrez-Aguilar et al., 2012). Moreover, the results proved the differences in physical capacities between male and female players with visual impairment, in line with the studies by Da Cunha Furtado et al. (2016) and Goulart-Siqueira et al. (2019). Men's greater strength is relevant in offensive actions, characterised by powerful movements, and in the defensive ones, where they cover a defensive area as large as possible. By contrast, female goalball players are tactically more organised and do not perform so powerful movements.

Lastly, differences between genders were found in the variable *Action effectiveness*. Throws in men's competition showed higher probability than expected of being missed (*no defence*), while female players missed less often but showed lower probability than expected of scoring a goal (*no goal*). These findings prove that, in general, elite goalball teams present low offensive effectiveness. This was confirmed as only 5.6% of the throws in men's competition and 4.1% in women's competition ended in a *goal*. In the scientific literature, studies addressing offensive effectiveness showed that visually impaired athletes achieved higher effectiveness in these actions than totally blind athletes (Molik et al., 2015). In future research, it would be interesting to deeper investigate about the relationship between throwing effectiveness and total blindness in elite goalball using the performance observation instrument validated for the present study.

Lastly, this type of research helps gain knowledge on effective playing patterns (Ardá et al., 2014) and identify relevant information related to the subject under study (Lames & McGarry, 2007), allowing coaches to improve their training tasks (Gómez-Ruano et al., 2017). Consequently, the major contribution of these results is that in goalball, as confirmed by Palao et al. (2009) for volleyball, it would be necessary to develop specific and original training methods considering the characteristics of men's and women's competitions, as well as adapted to the applicable rules, with the aim to make the sport more spectacular.

5. CONCLUSIONS

Goalball is a sport with limited variety of offensive and defensive technical actions. This is determined by players' lack of sight during competition, leading to a very repetitive game structure both in men's and women's competitions.

The differences in playing actions between men and women are related to Context variables (Competition stage, Team and Moment of throw), Offensive variables (Attacking player, Starting area, Ending area, Throwing technique, Type of throw and Throw outcome), Defensive variables (Defensive system, Defending player, Individual defending position, Collective defending technique, Area where the defensive action occurs and Outcome) and the variable action effectiveness.

Coaches should implement specific training sessions based on gender and prepare matches depending on the specific competition system.

It would be very useful to further investigate on throwing effectiveness from the different court areas, taking into account whether it is men's or women's competition. It would also be interesting to complement it with a study on the accuracy of players' displacements on court, with the aim to determine whether the tactical areas could be used more efficiently.

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842