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## ORIGINAL

### GOALBALL: COMPARISON BETWEEN MALE AND FEMALE TEAMS IN THE 2016 PARALYMPIC GAMES

### GOALBALL: COMPARACIÓN ENTRE EQUIPOS MASCULINOS Y FEMENINOS EN LOS JUEGOS PARALÍMPICOS 2016

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#### ABSTRACT

The present research aimed to determine and compare behaviour patterns, in goalball, performed by male and female teams. Using the observational methodology, the sub-phases of the attack were studied control, preparation and throw, during eight matches played during the Paralympic games Rio de Janeiro 2016. Regarding the control and preparation sub-phases, the polar coordinate analysis indicated that in female matches there is more continuity and less time is spent in the preparation of attacks. Regarding the throws, in female category activate the goal emergence those that: are carried out without changing position, those that use a traditional technique and those that have a flat ball trajectory. However, throws that activate the goal emergence in male category are those that can be carried out after changing position, those using rotation technique and those that search for straight and bounce ball trajectories. These findings could be precious information in the preparation of training and competition.

**KEY WORDS:** goalball, performance analysis, match analysis, performance indicators, offensive principles.

## RESUMEN

La presente investigación tuvo como objetivos conocer y comparar patrones de conducta ofensivos en goalball, realizados por equipos masculinos y femeninos. Empleando la metodología observacional, se estudiaron las subfases del ataque control, preparación y lanzamiento, durante ocho partidos disputados en los juegos paraolímpicos Rio de Janeiro 2016. Respecto a las subfases control y preparación, el análisis de coordenadas polares indicó que en los partidos femeninos hay más continuidad y se invierte menos tiempo en la elaboración de los ataques. Respecto a los lanzamientos, en la categoría femenina activaron la aparición de gol los realizados sin cambiar de posición, los que utilizaron la técnica tradicional y aquellos con trayectoria del balón plana. En la categoría masculina, los realizados tras cambiar de posición, los que utilizaron la técnica de rotación y aquellos con trayectorias rectas y en bote. Estos hallazgos suponen una valiosa información para la preparación de entrenamientos y partidos.

**PALABRAS CLAVE:** goalball, análisis de rendimiento, análisis de partido, indicadores de rendimiento, principios ofensivos.

## 1 INTRODUCTION

Goalball is a sport designed for the blind and visually impaired, where two teams compete in a three-on-three situation (Morato et al., 2012). Toronto 1976 was the setting of the first goalball match to be played competitively in a Paralympic Games. It is now considered one of the main sports for athletes with visual impairment, played by men and women from all over the world. Goalball is a cooperation-opposition sport in separated space, as players from one team cannot invade the space assigned to the rival team, and alternative participation, given that ball possession is alternated. The objective is to score by throwing a ball that emits sound at the rival goal. All players play with their eyes covered to guarantee equality of conditions, in a way that players estimate the speed and trajectory of the ball by the sound it emits. Furthermore, players find their place on the court thanks to the tactile markers that delimit the playing space and the goalposts (Furtado et al., 2016).

Two very different phases of play take place in the game: the attack phase, when the ball is in possession, and the defence phase, when the ball is not in possession. Each of the phases involves specific technical and tactical behaviours which beg detailed study (Morato et al., 2012). Specifically, three sub-phases can be distinguished in the defence phase: 1) defensive balance, which makes reference to the return to defensive positions once the shot has been made; 2) reading of the ball trajectory, where the defending team moves as a block towards the origin of the opponent's throw; and 3) blocking of the ball, which involves behaviours made by the defending team to intercept the

trajectory of the ball and stop it entering its goal (Morato et al., 2012; Morato et al., 2018). Likewise, three sub-phases can also be differentiated in the attack phase: 1) control of the ball, which gives rise to the attack phase and begins following the blocking of a throw or after indication from the referees; 2) the attack preparation, which can be more or less elaborated and refers to the movements made by the players around the pitch to make it difficult for the defending team to identify the origin of the ball; and 3) throwing, which can be carried out via the use of different techniques and ball trajectories (Morato et al., 2012; Morato et al., 2017).

Over the last two decades research has been carried out on different aspects of this sport. Some studies have analysed the anthropometric and morphological characteristics of high level players (Molik et al., 2015; Romanov et al., 2017). Other investigations have tackled the physical capacities of players in different ways: applying physical tests (Goulart-Siqueira et al., 2018), monitoring player movements according to position (Monezi et al., 2019) and measuring the reaction time of players in defensive actions (Silva et al., 2010). There has also been research into the effects of training on psychological abilities, such as the use of mental images in practice and competition (Eddy & Mellalieu, 2003) and the effects of self-dialogue before throwing penalties (Stamou et al., 2007). In relation to the technical, tactical and strategic aspects of the game, the element that has received most attention on the part of researchers is the throw (Link & Weber, 2016; Muñoz-Jiménez et al., in press). Specifically, there has been analysis of each of the phases that comprise it (Bowerman et al., 2011), the relationship between the speed of the ball and the probability of scoring a goal (Morato et al., 2018; Weber & Link, 2016) and the effectiveness obtained according to technique employed and ball trajectory (Link & Weber, 2018).

One aspect that has not been subject to study by researchers, however, is the process or dynamics of the game, that is, the behaviours employed in the different attacking sub-phases prior to the throw (Link & Weber, 2018). This problem is not exclusive to goalball. The majority of studies in the sphere of team sports look for performance indicators via the study of actions once they have been carried out: total number of throws or success percentage (Prieto et al., 2015). One of the main problems highlighted when studying the dynamics of the game is the difficulty in analysing the complex interactions that occur between teammates and opponents (Prieto et al., 2015). Knowing the type of existing relationship, if there is one, between the behaviours carried out in the control and preparation sub-phases, and the realisation of specific types of finishing, would contribute to a better understanding of the game; in the same way that comparing the dynamics of the game that occur in the female category with those that occur in the male category would. That is why this study involves the analysis and comparison of behavioural patterns shown by male and female teams in the three attack subphases: ball control, attack preparation and throwing. This knowledge would help coaches with strategic preparation for competitions and with optimising training programmes.

## 2 MATERIAL AND METHODS

The observational methodology has been used to achieve the research purposes, since it allows the registration of the behaviours that are spontaneously performed during the competition. According to Anguera (2003), the application of the observational methodology requires the fulfillment of the following requirements: habitual behaviour, natural context, absence of a standard instrument (so it was necessary to build an ad hoc observation instrument) and perceptibility. Due to its ecological validity, it allows the study of the interactions that occur between teammates and opponents, the observational methodology has been used in the study of various team sports, such as soccer (Castañer et al., 2016), volleyball (Muñoz-Llerena et al., 2020), handball (Flores-Rodríguez and Ramírez-Macías, in press) and, also, goalball (Morato et al., 2017). The observation carried out was non-participatory and an observational Specific/Nomometric/Multidimensional (S/N/M) design was used (Anguera et al., 2011). Its justification is as follows: it is follow-up due to the fact that several matches were analysed; idiographic because players who were part of the same team or national team were examined; and finally, it is multidimensional because several levels of response detailed in the observation instrument are studied.

### 2.1 PARTICIPANTS

Eight matches were analysed, four of them male and the other four female, played in the Paralympic Games held in Rio de Janeiro 2016. The selection of the matches was conducted randomly. This study was developed following the ethical standards established in the Declaration of Helsinki and, according to the provisions of the Belmont Report (1978). It was not necessary to obtain informed consent or the review of any ethics committee because: (a) the study involved the observation of individuals in a public setting (sports venue); (b) the individuals and groups observed did not have a reasonable expectation of privacy (the matches were broadcast worldwide); and (c) the study did not involve any intervention by the researchers nor direct interaction with the individuals under study.

### 2.2 OBSERVATION INSTRUMENT

An ad hoc observation instrument was designed (table 1) which allowed the registration of the most relevant behaviours related to the proposed research purposes. The instrument combined the field format with a system of comprehensive and mutually exclusive categories. This combination allows us to take advantage from theoretical consistence provided by the categories system and the flexibility offered by the field format when collecting the diversity of behaviours performed by players while they compete (Anguera et al., 2011).

The instrument was constructed in three phases (Anguera, 2003). 1) An initial version was constructed from the theoretical review performed, in which the work by Morato et al. (2017) was particularly useful. 2) Subsequently, three matches not included in the sample with similar characteristics to those involved

in the study were recorded. As no new behaviours in any criterion were detected, the level of caution was deemed achieved. 3) The instrument was submitted to the judgement of five experts, university professors with goalball experience. The experts completed an assessment template in which they were asked to state whether or not they agreed with each criterion and category. All the criterion and categories defined in the observation instrument obtained an agreement equal to or greater than 80%. Observation units began when one of the teams obtained the ball possession, and they finished once it was lost, after having performed a throw or arbitral decision.

**Table 1 – Observational instrument**

Criterion	Categories
Gender	Male (MAL)/ Female (FEM)
Preceding situation	Link with the previous game sequence to indicate how the team conquered the ball possession. Block out (BLO)/Goal against (GAG)/ Received ball from the main referee (REF)
Offensive Strategy	The strategy the attacking team uses for the throw. Regular (REG): player throws the ball from the same or surrounding sector in which (s)he defended or received a pass /Fluctuation (FLU): player defends the ball or receives a pass and before throwing changes the sector beyond the neighbouring sectors/Set piece (SET): organized and practiced move, other than FLU
Attack length	Time the team uses to perform the attack. Short attack (SHO): up to 4 seconds after defense/ Standard attack (STA): between 4 and 7 after defense/ Extended attack (EXT): more than 7 seconds after defense
Thrower	Identification of the player performing the attack. Left wing(LWI)/ Central(CEN)/ Right Wing (RWI)
Technique	Technique used in the throw. Traditional (TRA): Player performs a movement that is similar to bowling/Rotation (ROT): before releasing the ball, the player performs a 360-degree rotation around his longitudinal axis/Between legs (LGE): Player throws the ball between his/her legs
Ball Type	Throw ball feature. Bounce (BOU): The player throws the ball on the ground at a step angle, causing it to bounce several times on its way to goal/ Flat (FLA): Otherwise. The player throws the ball in a sharp angle.
Angle	Trajectory of the ball. Straight(STR): angel between the trajectory of the ball and the goal line is between 75 and 90 degrees/ Diagonal (DIA): the trajectory of the ball and the goal line draw another type of angle
Throw target	The place where the ball reaches. Space between right wing and post (PRW)/ Gaps between central defender and right wing (RWC)/ Gaps between central defender and left wing (LWC)/ Space between left wing and post (PLW)/the ball goes out near the midfield line (OUT)
Outcome	Result of the interaction between the offensive dimension of one team and the defensive dimension of the other. Goal (GOA): The referee decided on goal for the attacking team /Infraction (INF) an infraction occurs/ (MIS) Miss shot



## 2.3 REGISTRATION AND ANALYSIS AND INSTRUMENTS

Two observers took part in the research, graduates in physical activity and sports sciences, with previous experience in the use of observational methodology in the analysis of other collective sports. The observers carried out a training process that consisted of three phases (Muñoz et al., 2018): the first was theoretical and lasted six sessions. Through the viewing of videos, the essential concepts of the game were explained and, also, each of the criteria and categories of the observation instrument; in the second one, the observers were trained in the use of the registration instrument; and finally, in the third phase, the observers recorded different matches that were not included in the sample. The training process was completed when intra- and inter-observer levels above 0.80 were obtained on Cohen's Kappa statistic for all of the observation instrument criteria.

The Dartfish 5.5 software programme was used to register and encode the matches. The quality analysis of the observational data obtained was carried out by calculating the Cohen's Kappa concordance index, for each of the criteria at both at the intra-observer and inter-observer level, with the GSEQ 5-1 software programme (Bakeman & Quera, 1995). Once this step was completed, the generalizability analysis was conducted using the EduG version 6.1 software (Cronbach, Gleser, Nanda & Rajaratnam, 1972) with the objectives of: assessing the goodness of the categories, determining the reliability of the observers and establishing the number of matches to be analysed in order to generalise the outcomes accurately. Subsequently, the sequential analysis was calculated again using the SDIS-GSEQ 4.0 programme. This analysis is required to be able to apply the polar coordinate technique. The calculation of the polar coordinates was carried out with the HOISAN 1.2 programme (Hernández-Mendo, López, Castellano, Morales & Pastrana, 2012) and allowed us to discover the significant behaviour patterns. Finally, the Snowflake 0.2 software was used for the graphical representation of the polar coordinate maps.

## 2.4 DATA QUALITY

Once the eight matches within the study sample were registered, the intra-observer and interobserver agreements were analysed, obtaining Cohen Kappa (Cohen, 1960) indices higher than 0.96 in all criteria and in both reliability tests (intra and inter). According to Landis & Koch scale (1977), the level of agreement shown can be considered almost perfect.

To estimate the homogeneity of the categories, a two-facet cross-sectional design was observed (observers/categories = O/C), obtaining relative and absolute generalisation coefficients worth 0.00. When the generalisation coefficients are equal to zero, it can be assumed that the homogeneity of the categories is optimal. Consequently, the categories are adequate and meet the requirement of being exhaustive and mutually exclusive (Blanco-Villaseñor et al., 2014).

To determine intraobserver reliability, a two-facet design was used (category/observer = C/O). With this design structure, the analysis of the generalisation coefficients indicated an excellent level of generalisation reliability (0.99). The same design structure was raised to determine interobserver reliability, obtaining an excellent level of reliability (0.944). Finally, once all the matches were registered, a two-facet design (categories/matches = C/P) was used to discover the generalisability indexes. The estimate of variance components has been carried out randomly with an infinite trajectory for categories and matches. Its analysis shows that a high variability is associated with the categories facet (97.5%), being null for the matches facet and the rest of the variability being left for the categories/matches interaction facet (2.5%). By globally analysing the indexes of generalisability according to this design structure, it can be determined that from the observation of 4 matches, excellent results would be achieved, since a relative G coefficient of 0.99481 and an absolute G coefficient of 0.99 would be obtained. These values indicate that with the observation of 4 male matches and four female matches a high degree of generalisation is obtained.

## 2.5 POLAR COORDINATE ANALYSIS

The polar coordinate technique allowed us to determine which behaviour patterns emerge during the matches, having been previously used in different studies focused on collective sports (Castañer et al., 2016). This technique studies the correlation between various behaviours by assigning them different roles. On the one hand, the behaviour considered to be generating, "forward" (prospective perspective) and "backward" (retrospective perspective) of relationships plays the role of focal behaviour, while the others behaviours involved assume the role of conditioned behaviours (Tarragó et al., 2017). By means of the calculation of the zsum statistic (Sackett, 1980), the strength of the correlation is found. This is indicated by the length of the vector, and the nature of the vector, which can be activation or inhibition depending on the quadrant where it is located. When the relations remain located in quadrant I, relations of mutual activation between the focal behaviour and the conditioned ones can be appreciated; quite the opposite occurs when the relationship is represented in quadrant III, because in this case, we can talk about a relationship of mutual inhibition between both behaviours. On the other hand, when the relationship is represented in quadrant IV, it means that the focal behaviour activates the conditioned one, while it inhibits the focal behaviour; inverse relationships to those obtained when the association is located in quadrant II, which indicates that the focal behaviour inhibits the conditioned one, while this one activates the focal behaviour (Anguera et al., 2011).

## 3 RESULTS

Figures 1, 2, 3, 4 and 5 show the behaviour patterns found in each of the attack subphases studied. Two polar coordinate maps with their respective data appear in each figure. The one on the left shows the significant relationships found in the female competition and the one on the right, those of the male competition. Now, we will comment on the significant relationships ( $> 1.96$ ) of

mutual activation between the behaviour and the conditioned ones, that is, those represented in quadrant I.

Figure 1 studies the control and preparation subphases of the attack, especially, the significant associations between the focal behaviours, the female (FEM) and male (MAL) teams, and the conditioned behaviours, and between the criteria of the observation instrument: preceding situation, offensive strategy and attack length. It can be observed that the female teams (left column) showed a relationship of mutual activation with SHO behaviours (less than 4 seconds invested in the preparation of the team), REG (the thrower performs the throw from her position), BLO (possession begins after blocking a rival throw) and EXT (the time spent preparing the attack is greater than 7 seconds). On the other hand, the male teams (right column) showed a mutual activation relationship with REF (the attack begins after an interruption), FLU (the player performs the throw from a remote area to the position he occupies) and STA (attack preparation lasts from 4 to 7 seconds).

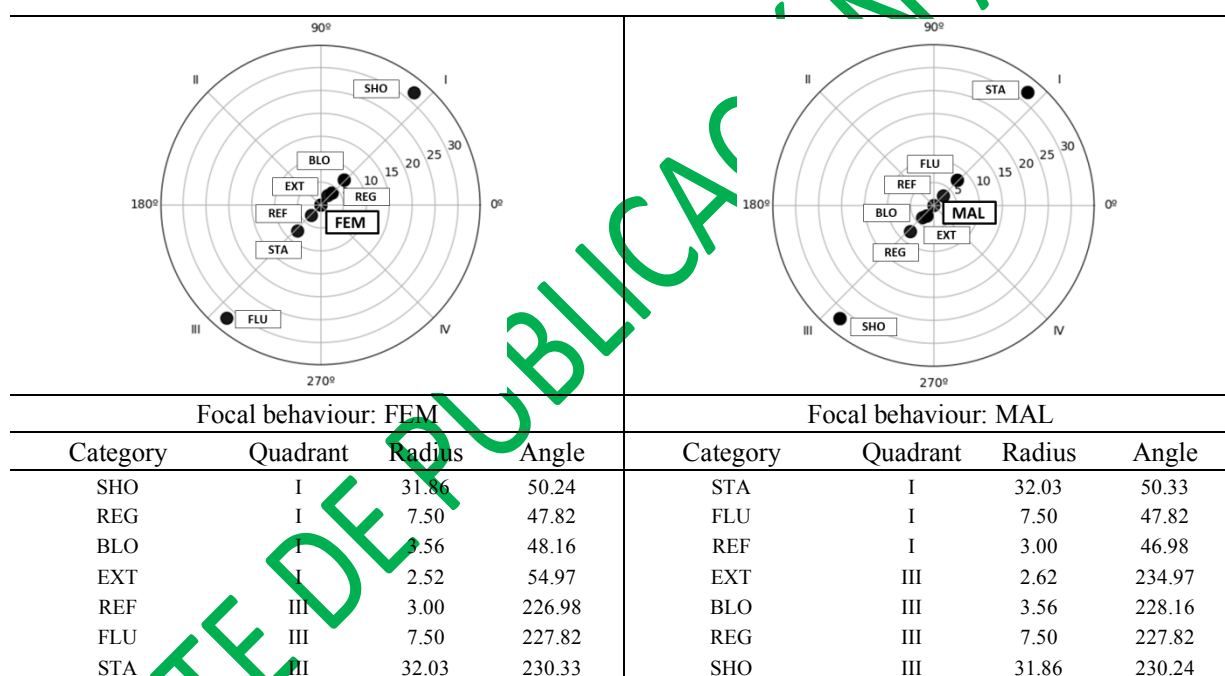


Figure 1. Control and preparation subphases

In figures 2, 3 and 4, the throw subphase is studied according to the position of the player who performs it, so that, in figure 2, the throws from the left wing will act as focal behaviour, in table 4 those of the centre and in 5 those of the right wing. As conditioned behaviours, those belonging to the criteria acted as such: technique, ball type, angle and throw target.

In figure 2, when the female left wings (FEM\_LWI) acted as focal behaviour, a mutual activation was observed with the conditioned behaviours: TRA (traditional technique), FLA (flat throws) RWC (location of the throw between the right wing and the centre of the rival team) and PLW (location of the throw between the post and the left wing). Whereas, for the left wings of the male teams (MAL\_RWI), mutual activation was found with: PRW (location between



the post and the right wing), STR (straight throws), BOU (bounce throws) and ROT (rotation throws).

Moreover, figure 3 studied the completions made by the centres which acted as focal behaviour. The female teams (FEM\_CEN) had a mutual activation association with: TRA, FLA, RWC and PLW, while the male teams' centres (MAL\_CEN) expressed the same relationship with: ROT, BOU, STR and PRW.

Likewise, figure 4 shows that the completions made by the players occupying the right-wing position acted as focal behaviour. For the female teams (FEM\_RWI), a mutual activation relationship was found with TRA, FLA, DIA, RWC and LWC, while the male teams (MAL\_RWI) showed mutual activation with ROT, BOU, STR and PRW.

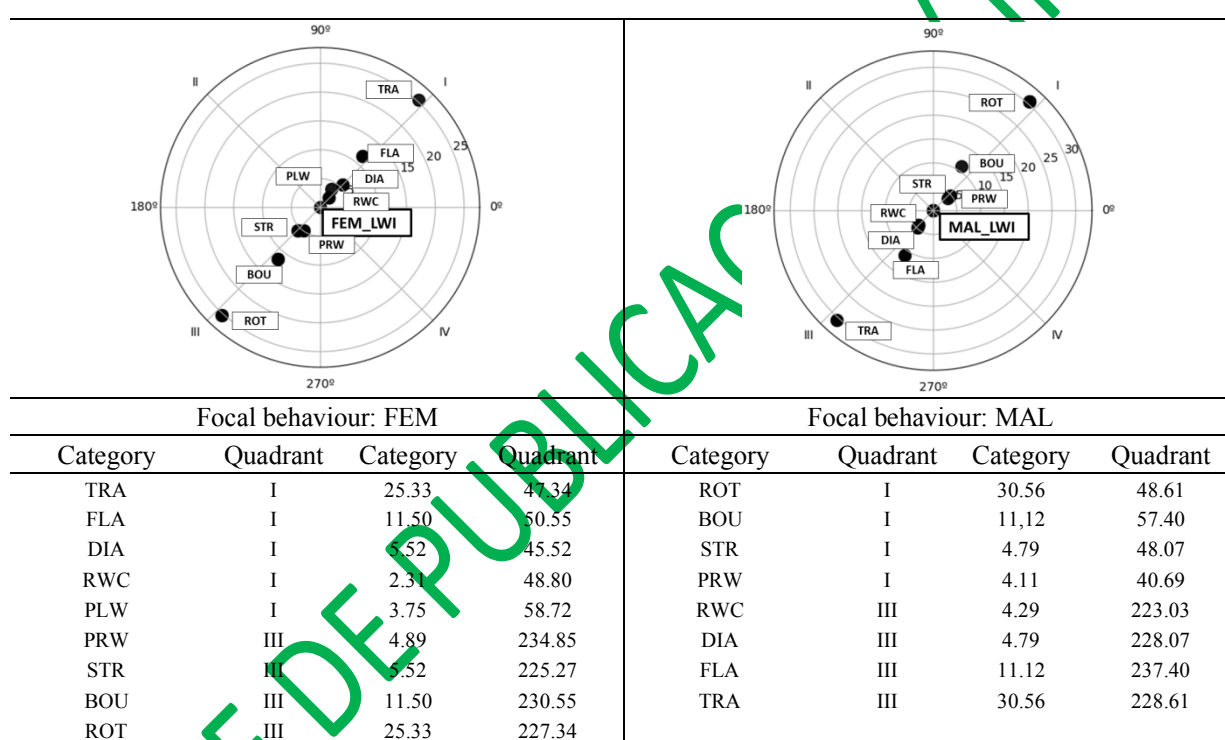


Figure 2. Throws performed by left wing

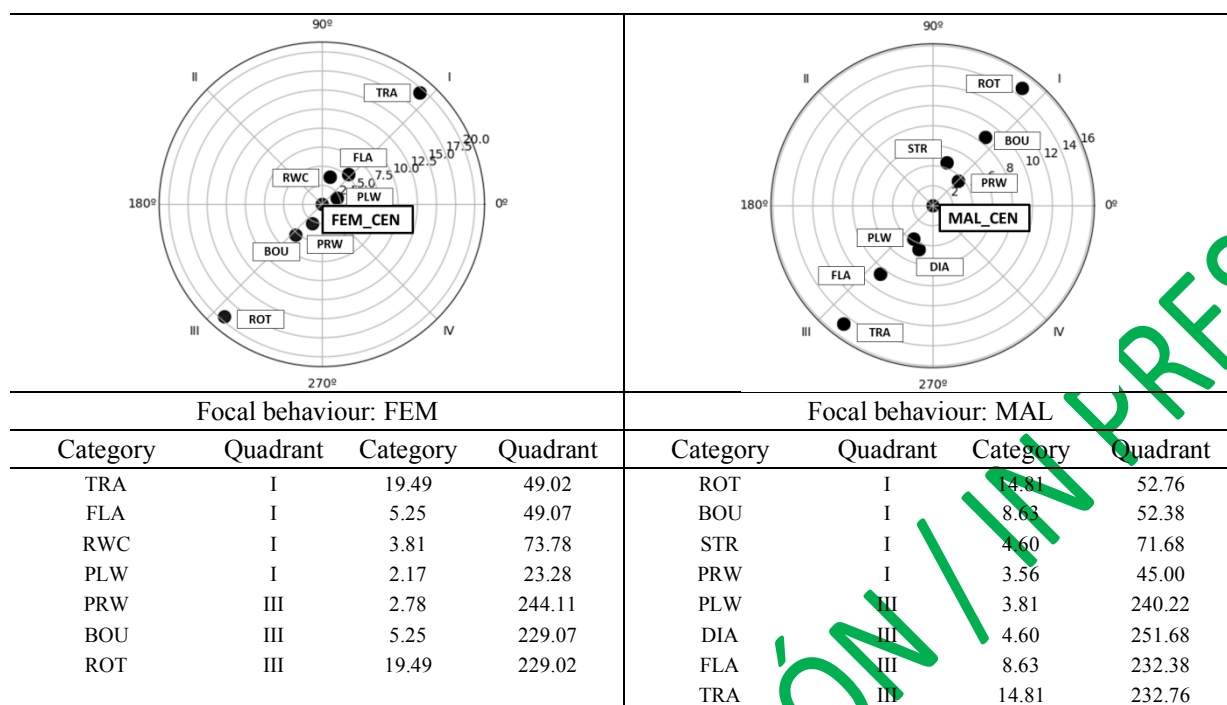


Figure 3. Throws performed by left centre

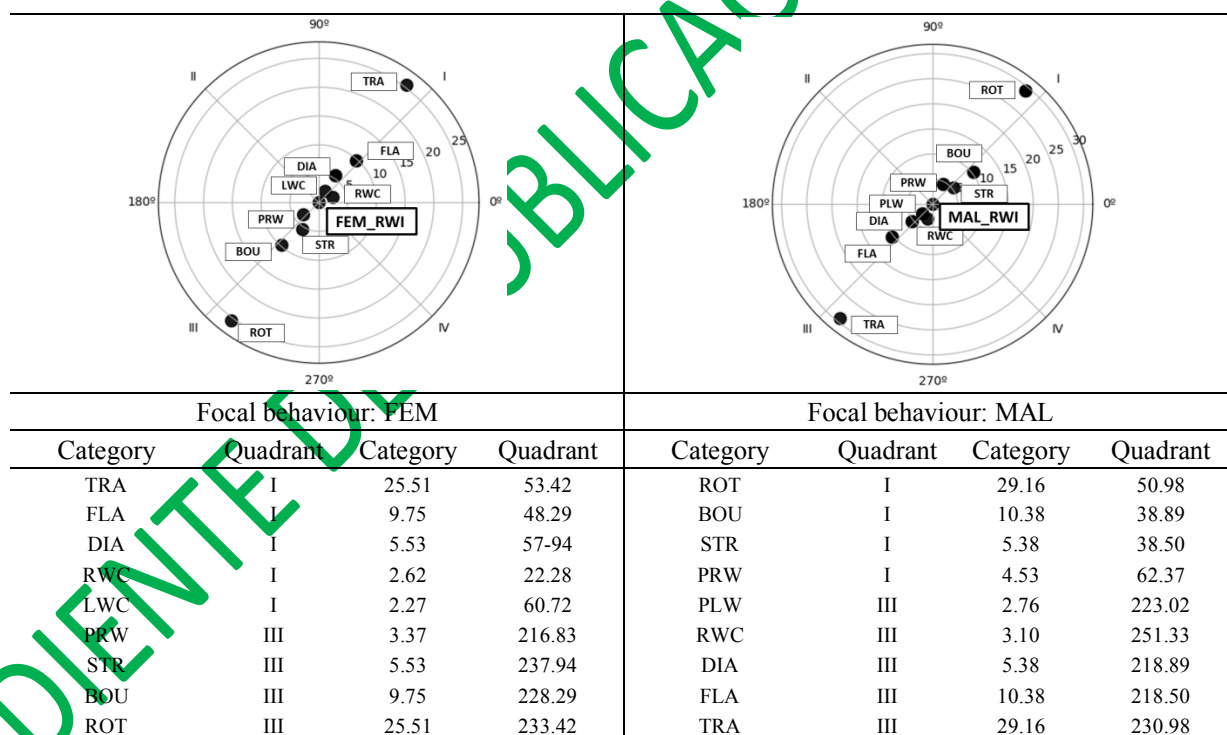


Figure 4. Throws performed by right wing

In figure 5, the goal behaviour (GOA) acted as focal behaviour and some of the criteria of the observation instrument that reported on the preparation and throw subphases acted as conditioned behaviours. These criteria included: preceding situation, offensive strategy and attack length, technique, ball type, angle and throw target. In the female category (GOA\_FEM), mutual activation was observed with TRA, SHO, DIA, FLA, EXT and REG. While in the male category

(GOA\_MAL), the relationship of mutual activity occurred with ROT, STA, BOU, CEN and STR.

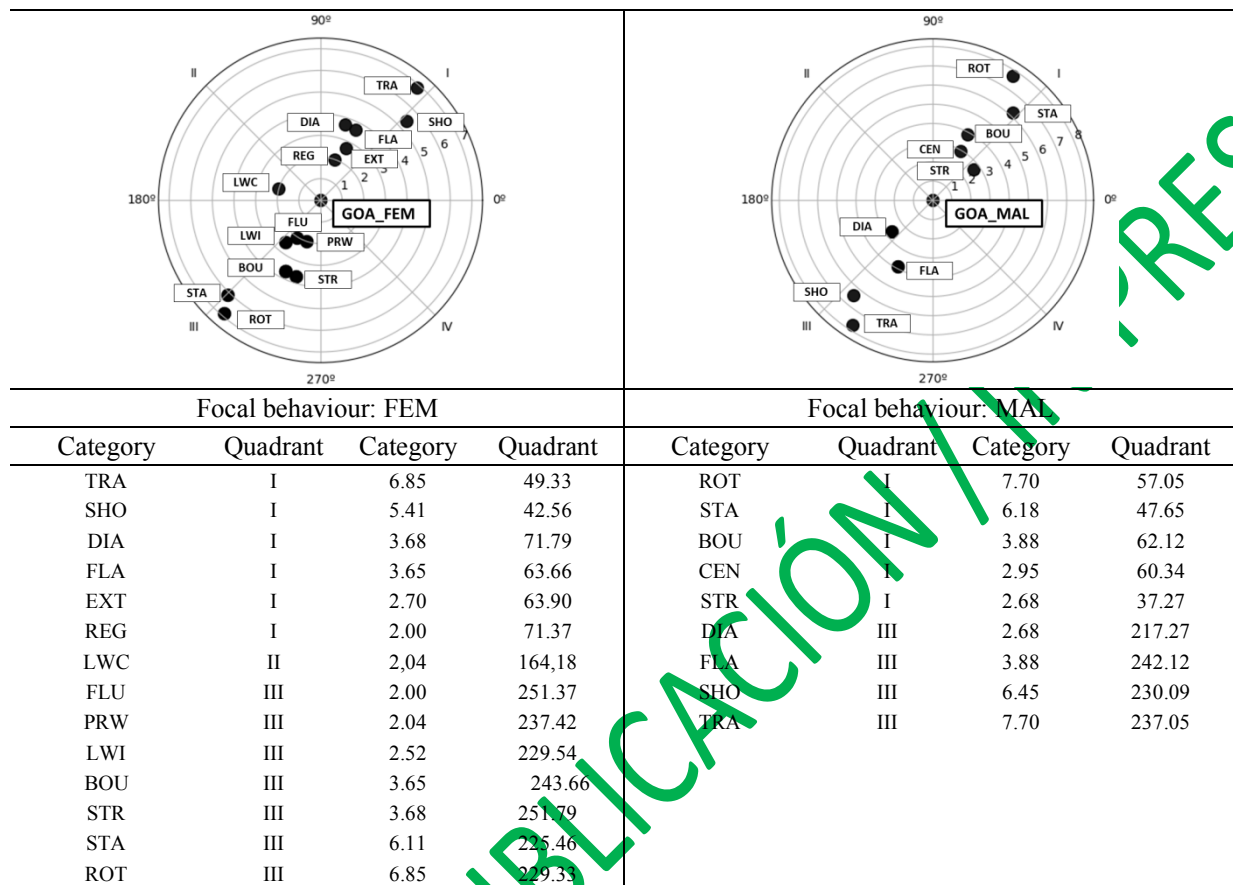


Figure 5. Throws that activate the appearance of a goal

#### 4 DISCUSSION

This study has involved the analysis and comparison of patterns of behaviour shown by male and female teams in the three attack sub-phases: ball control, attack preparation and throwing. To do so, eight matches were analysed: four male and four female, played in the Rio de Janeiro 2016 Paralympics. The application of the polar coordinate technique revealed differences between the patterns of behaviour expressed by the male teams and those expressed by the female teams in each of the sub-phases studied. The findings obtained are along the lines of those indicated by Morato et al. (2012), in that each offensive sub-phase demands the carrying out of different behaviours, in order to create the attack and, at the same time, generate imbalances in the rival team.

Firstly, regarding the ball control sub-phase, in the female competition it has been observed that attack activations commence following the blocking of a rival throw, whereas for the male competition attacks started following an interruption of play. These results are coherent with the findings indicated by Muñoz-Jiménez et al. (in press), who have stated that for the male category there is a greater probability of the result of the throw being incorrect (for example, the ball leaves the playing area).

Secondly, the preparation sub-phase has also shown differences. The female teams invested under four seconds in this sub-phase, possibly to avoid the rival team forming its defensive system, whereas the male teams showed a tendency to employ between four and seven seconds in their attack preparations. Taking into account how attacks are started and the time employed in their preparation, it could be said that in the case of the female matches there is more continuity in the game than in the case of the male matches. Furthermore, the greater time employed in attack preparation in the male category allowed players to collaborate via an exchange of positions prior to shooting. This behaviour, which did not occur in the female category, has the objective of avoiding the defending team identifying the place from where the throw is going to take place (Morato et al., 2018). In this regard, it appears that the male teams carried out more elaborated attacks.

Thirdly, regarding shooting, the results found indicate that the male teams activated the technique of rotation and bounce throws, whereas the female teams activated the traditional technique and flat throws. These results are coherent with the findings indicated by Muñoz-Jiménez et al. (in press) and partially, only in relation to the male category, with the findings of Weber & Link (2016). Rotation and bounce throws allow for greater ball speeds (Bowerman et al., 2011; Monezi et al., 2018 y Weber & Link, 2016), which make defensive actions extremely difficult. Regardless, the high technical and physical demands for carrying out this type of shot could explain why some players use them, and others do not.

On the location of shots, Link & Weber (2018) indicated that for the male category the zones between defenders were associated with greater success. However, in our study we have not found any location more successful than others for the male teams. This is also true for the female category. Perhaps, in order to be successful with throws, it is important to vary locations, and exploit the weaknesses of opponents, who are not always in the same place. According to the findings, and coinciding with Morato et al. (2018), ball speed, independently of location, could be related to throw success. This may explain why in the male category there was activation between the scoring of a goal and two types of throw: those employing the rotation technique and straight throws. On the one hand, as mentioned above, throws with rotation transfer more speed to the ball and, on the other hand, straight throws, with the ball travelling a shorter distance, offer defenders less time to identify the throw and act. In contrast, in the female category, the tendency identified of diagonal throws did not result in a goal. Along the lines of the previous argument, with diagonal throws the ball travels further and, therefore, gives defenders more time to stop them.

The results found in this study provide information on the dynamics of the game, in particular those relating to the behaviours employed in the three attacking sub-phases. This information could help coaches with preparation for competitions and in training design. Regarding competitions, from an offensive point of view, coaches could include those strategies that have proved more successful in their match plan and leave out those that have not. In contrast,

from a defensive perspective, coaches can use this information to compensate for the general behavioural tendencies found. As regards training programme design, the findings may help in the achievement of two objectives: 1) optimising dominating behaviours, affording them greater variability: using them against different defensive systems, from different positions or varying the time employed in their use. 2) improving non-dominant behaviours: those used in the competition but which are not effective or, simply those that are not used because they do not form part of the behavioural repertoire of the player or team (for example, determined shot techniques or position exchanges in the preparation sub-phase). In this sense, it would be important to detect the existence of strength or coordination deficits that limit the execution of certain types of throws and the speed transferred to the ball. If these limitations existed, it would be recommendable to tackle them through specific training programmes.

Lastly, as a study limitation, attention should be drawn to the fact that there has not been an analysis of the specific characteristics of the players, nor of the collective strategies of the teams that have been studied. These aspects may have had an influence on the behavioural patterns found. We believe it is necessary to continue exploring knowledge of the dynamics especially of the attacking game in more detail, due to the fact they are the least studied aspects of the game to date: aspects related to the beginning and preparation of attacks. It is also necessary to research the defensive game dynamics, paying attention to each of the sub-phases that comprise them.

## 5 CONCLUSIONS

The aim of this study was to discover the behavioural patterns expressed in the different sub-phases of attack, comparing male and female teams. The main conclusions that we can draw for the matches studied during the Rio de Janeiro 2016 Paralympics are the following:

-Female matches, in comparison with male matches, have a higher rhythm of play, there is more continuity in the game and less time is spent on attack preparation. Regarding throws that activate the appearance of a goal, it has been found that the players make them from their specific position, with a traditional technique and flat ball trajectory.

-Male matches, in comparison with female matches, have a slower game dynamic, as there are more interruptions and more time is spent on attack preparation. Regarding shots that activate the appearance of a goal, it has been found that the player who makes them normally changes position before doing so, uses the rotation technique and seeks straight, bouncing trajectories.

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