

Becerra Patiño, B.A. (202x). Analysis of Polar Coordinates in Football Goalkeepers: Gender Differences. Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte vol. x (x) pp. xx Pendiente de publicación / In press.

## ORIGINAL

# ANALYSIS OF POLAR COORDINATES IN FOOTBALL GOALKEEPERS: GENDER DIFFERENCES

## ANÁLISIS DE COORDENADAS POLARES EN LOS PORTEROS DE FÚTBOL: DIFERENCIAS DE GÉNERO

**Becerra Patiño, B.A.**

Magister en Deporte y Actividad Física, Universidad Pedagógica Nacional, sede Bogotá, D.C., Facultad de Educación Física, Licenciatura en Deporte. Bogotá, D.C. (Colombia)  
[babecerrap@pedagogica.edu.co](mailto:babecerrap@pedagogica.edu.co)

**Spanish-English translator:** Viviana Katherine Quiroga Morales, Mg. Neuropsicología en el ámbito educativo, [vikaquimo@gmail.com](mailto:vikaquimo@gmail.com)

**Código UNESCO / UNESCO code:** 580000 Pedagogía / pedagogy.

**Clasificación del Consejo Europa / Council of Europe classification:** 17. Otras: Evaluación de la competencia / Competition assessment.

**Recibido** 26 de noviembre de 2020 **Received** November 26, 2020

**Aceptado** 12 de septiembre de 2021 **Accepted** September 12, 2021

### ABSTRACT

The principal objective of this study was to determine the activity profile and the physical requirements (total distance traveled, speed) and tactics (displacement by heat map) in the competition in the goalkeepers of university soccer in Bogotá over 64 games, implementing GPS devices. The treatment of statistical data was carried out using the R program in different phases; descriptive analysis, an analysis of variance, and a descriptive spatial analysis for the polar coordinates. The results showed that there are significant differences between the distance traveled in each of the speed categories and between the distance traveled by men and women with analysis of variance (category 1: 0.016; category 2: 0.0088). Finally, the activity profiles of goalkeepers should consider locomotion categories that establish speed ranges specific to their positioning needs.

**KEYWORDS:** sports competitive, soccer, comparative analysis, evaluation.

## RESUMEN

El objetivo del presente estudio fue determinar el perfil de actividad y los requerimientos físicos (distancia total recorrida, velocidad) y tácticos (desplazamiento por mapa de calor) en la competencia en los porteros/as de fútbol universitario en Bogotá a lo largo 64 partidos, implementando dispositivos GPS. El tratamiento de los datos estadísticos se realizó mediante el programa R en distintas fases; análisis descriptivo, un análisis de varianza y un análisis descriptivo espacial para las coordenadas polares. Los resultados mostraron que existen diferencias significativas entre la distancia recorrida en cada una de las categorías de velocidad y entre la distancia recorrida por hombres y mujeres con análisis de varianza (categoría 1: 0.016; categoría 2: 0.0088). Finalmente, los perfiles de actividad de los porteros deben considerar unas categorías de locomoción que establezcan rangos de velocidad específicos a las necesidades de su posicionamiento.

**PALABRAS CLAVE:** competencia deportiva, fútbol, análisis comparativo, evaluación.

## INTRUDUCTION

It should be noted that there have been multiple studies that have been responsible for analyzing the physical profile of the soccer goalkeeper in competition, and that have managed to describe in a general way their competitive needs in response to kinematic variables (Reilly and Bowen, 1984; Bloomfield, Polman and O'Donoghue, 2006; Di Salvo, Benito, Calderón, Di Salvo and Pigozzi, 2008; Condolo, Lupo, Cipriani and Tessitore, 2011; Becerra-Patiño, 2021a) and other studies have been directed to evaluate polar coordinates in handball (Vázquez-Diz, Morillo-Baro, Reigal, Morales-Sánchez and Hernández-Mendo, 2019) and the goalkeeper-player relationship in situations of offensive numerical inferiority in handball (Beiztegui-Casado, Oliver-Coronado and Sosa-González, 2019), as well as polar coordinate analysis for the estimation of relations in motor interaction in soccer (Castellano and Hernández-Mendo, 2003) and study of tactical aspects and analysis of decision making in beach handball through the study of polar coordinates (Vázquez-Diz, 2020), however, have not been found studies, aimed at establishing the relations of physical-tactical variables, in response to gender differences.

The adaptation of the goalkeeper to his role and functionality in group and collective dynamics produce a high variability for the goalkeeper in his individuality to contribute to group tasks and objectives (Liu, Gómez, & Lago-Peñas, 2015; West, 2018). Goalkeeper positioning is an area of overspecialization in the different subspecializations that occur in the alternating reality of matches and training (Álvarez, 2012; Rebelo-Gonçalves, Coelho-e-Silva, Severino, Tessitore, & Figueiredo, 2015; Liu et al., 2015), all this, because there is a factor that influences the manifestation of technical-tactical (López-Gajardo, González-Ponce, Pulido, García-Calvo and Leo, 2020) and

conditional performance, product of the level of the team (Casal, Losada, Maneiro and Arda, 2017). Being a soccer goalkeeper, means adapting through its specific technical fundamentals and particular, intermittent, variable and unpredictable tactical actions (Becerra-Patiño, 2021b; De Baranda, Llopis and Ortega, 2005; De Baranda, Ortega, & Palao, 2008), seeking interrelation with physiological processes (Nikolaidis, Ziv, Arnon, & Lidor, 2015) and the manifestation of strength as an expression of technique to develop an effective sport gesture (González-De los Reyes, Fernández-Ortega, & Garavito-Peña, 2019).

Therefore, the basis of the soccer goalkeeper's preparation must be competition (Pérez, López, Rodríguez and Sánchez, 2016; Coelho, Pimenta, Veneroso, Morandi, Pacheco, Pereira, Coelho and García, 2013) at the end, the unique and differential game in which he socializes and experiences must always be associated with the way in which the athlete intervenes even in his offensive and defensive phase (De Baranda, Ortega, Llopis, Novo and Rodríguez, 2005; Pérez et al., 2016). GPS global positioning systems have been used to determine the activity profile, devices that have a sampling frequency (1 Hz, 10 Hz, 18 Hz) (Nikolaidis, Clemente, Van der Linden, Rosemann, & Knechtle, 2018) and that allow monitoring speed ranges in an effective, and efficient way (Di Salvo et al., 2008; Castellano and Casamichana, 2014), this sampling frequency reveals the quality of the reference data, mainly in those short and explosive actions that demanding changes of direction and speed (Witte and Wilson, 2004), just as in other situations carried out because of the small sided-games methodology, in which the goalkeeper is linked in collective dynamics (Dellal, Chamari, Pintus, Girard, Cotte and Keller, 2008).

The influence of the goalkeeper on the physical and tactical demand not only responds to individual processes (Köklü, Sert, Alemdaroglu, & Arslan, 2015; Lamas, Drezner, Otranto, & Barrera, 2018), but, at the same time, the intensity of the actions decreases by 15%, especially in sprints when the goalkeeper is linked to the dynamics of small sided-games (Casamichana, Castellano, González-Morán, García-Cueto, & García-López, 2011). The physical, technical and tactical actions of the soccer goalkeeper are associated with his participatory range and possible alternatives and continuous adaptations of the goalkeeper in competition (Lapresa, Chivite, Aranda, Anguera, & Barbero, 2018) and the perfectly of his functions, influenced by the training methodology used in his training process (Becerra-Patiño, 2019; Hulka, Weisser, & Belka, 2016; Knoop, Fernández-Fernández, & Ferrauti, 2013).

The consideration about the analysis of polar coordinates is necessary, given that the athlete does not always reproduce the same pattern of performance and intervention (Hernández and Anguera, 2014) and this is due to the fact that he must constantly coexist with the change in the game zones, performance variables related to his training-competition process (Rojas-Inda, 2018), in which the trajectory of the ball, translation speed of the object, preceded technical action, position and tactical intention of the opponents, carried out from the position of the player expressed in x-y coordinates in one time, serving as a reference for collective sports such as soccer (Reche-Soto, Cardona, Díaz, Gómez-Carmona and Pino-Ortega, 2029). Finally, the use of heat mapping as a

form of search and situational analysis of the polar coordinates in which the athlete intervened in the game, responding to gender differences, provides relevant information, seeking to find relationships of influence and non-permanence taking into consideration the speed reached at each point, graphically representing these zones of influence and those strips in which the goalkeeper did not participate, as a way of approaching the relationship that has the physical demand, with the routes that usually develops the goalkeeper in competition, in attention to gender differences.

## OBJECTIVE

To determine the physical demand (total distance traveled, speed, accelerations and decelerations) and tactical (heat mapping) of the college soccer goalkeepers in Bogotá, using GPS devices (FieldWiz) to characterize gender differences.

## MATERIALS AND METHODS

The selected sample comprises 1 goalkeeper (male) and 1 goalkeeper (female) of university soccer from four institutions that participate in the men's and women's tournament and that meet the selection criteria, among which the following stand out: obtaining the first 4 places in the different university tournaments played in Bogotá and having a player in this position who trains at least 3 times a week, experience of at least 2 years playing in this position, not having suffered any injury to upper or lower limbs in the last 6 months and not suffering from any health affectation. Initially, a meeting was held with the coordinators of the university institutions, the coaches and the goalkeepers, in order to inform them about the objectives of the study, methodology, benefits and possible risks. Subsequently, the goalkeepers voluntarily agreed to participate, signing the informed consent, respecting the declaration of Helsinki. Likewise, the study was carried out under the approval of the SUE ethics committee. The variables to be evaluated were: total distance covered, distance covered in the different areas of the field according to heat mapping, distance covered at different intensities according to the characterization of the locomotion categories proposed by Castagna, D'Ottavio and Abt. (2003) (category 1) and Di Salvo et al., (2008) (category 2), while the general independent variables were temperature, time, weather conditions, game model of the teams, level of competition, etc. The instrument used was a FieldWiz GPS device used to analyze and quantify sports performance, capable of receiving, storing and processing information and then providing statistics collected at the end of the monitoring of each match. The use of GPS "FieldWiz" devices with a GPS sampling frequency (10 Hz) of high precision (Willmont, 2016) and 9-axis accelerometer and 45 gr.

The present study used the investigative method of match analysis based on the implementation of GPS devices to analyze the university soccer competition in Bogota. The indicators analyzed were: heat map, total distance covered, distance covered in different zones, distance covered at different intensities according to the locomotion categories proposed by Castagna et al. (2003) and

Di Salvo et al. (2008). All these data are stored in the FieldWiz virtual platform and then issued in a report, to be unified in Excel and finally processed.

### **Statistical analysis**

The type of statistical processing was carried out by means of the evaluation and association of the variables, for which the first step was directed to the descriptive analysis with the various categories of locomotion to know the distribution of speed, another analysis of variance with two indicators (gender and speed), The second was an analysis of variance with two indicators (gender and speed), calculated in a Euclidean way seeking to determine the separation of two points in a space through the consideration of the distance traveled between the data provided by the GPS device, and the last moment that analyzed the heat map, using spatial descriptive analysis on the influence of the data on the measured variables carried out with groupings of 1 meter x 1 meter.

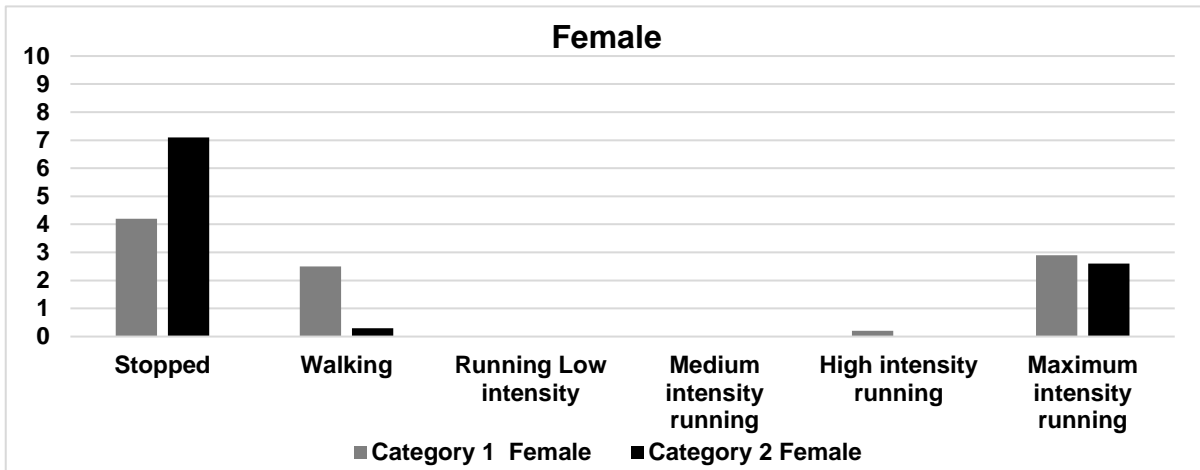
The colors reflect the level of intensity and participation that the athletes had in each of the categories, being the actions of greater participation those shown with dark colors and the areas of little or no participation in light colors. The more intense the color, the more time the goalkeeper spent in this specific area of the field. There, each of the images shows a division by time (1 VS 2 time), where on the left side are the actions of the goalkeepers and on the right side the actions of the goalkeeper in the first and second half.

**The analysis of the locomotion categories is interrelated with the intervention zones by means of polar coordinates as follows:**

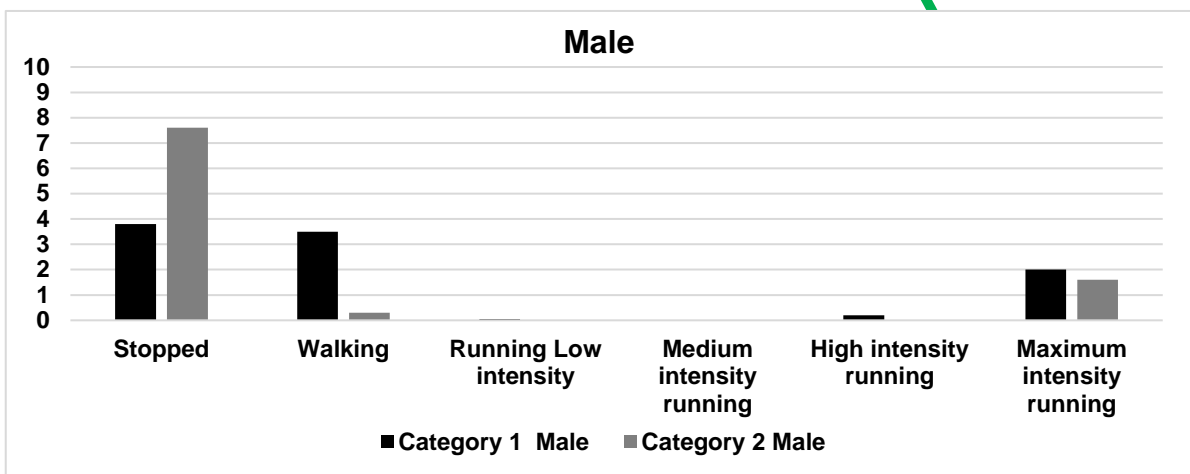
- Zones of maximum participation in black color
- Zones of moderate participation in dark gray color.
- Medium participation zones in opaque gray.
- Zones of minimum participation or at least once in light gray color
- Zones of null participation in gray color of the template.

### **RESULTS**

The results of the present study are expressed in a descriptive manner, and for this purpose a series of graphs are used to respond to the objectives set forth. The data were captured using GPS instruments (FieldWiz). Figures 1 and 2 show the results obtained by the goalkeepers and doormen in the differences in the total distance traveled at different intensities according to the analysis of the locomotion categories according to Castagna et al. (2003) (category 1) and Di Salvo et al. (2008) (category 2).

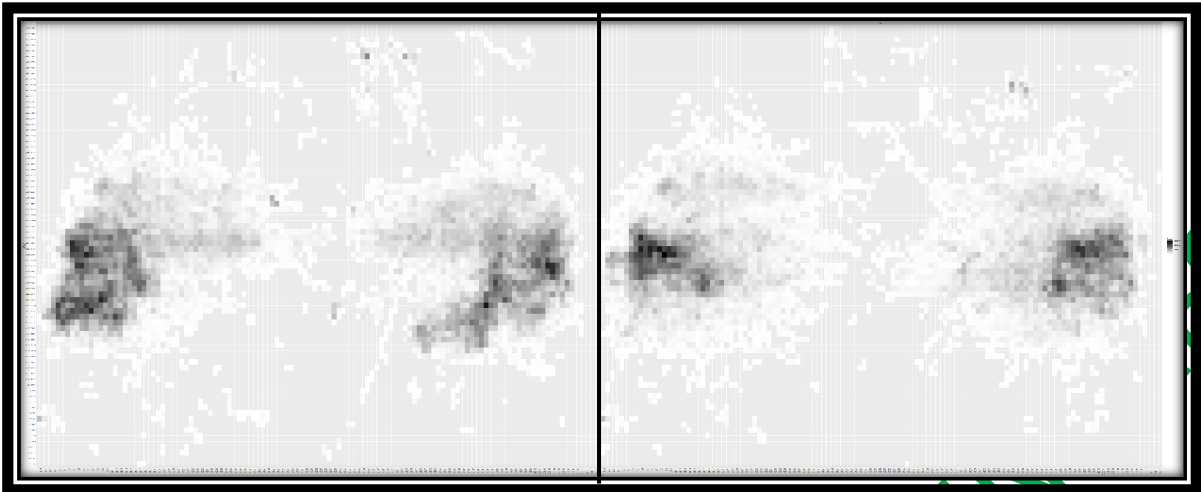


**Figure 1.** Differences in total distance traveled at different intensities according to locomotion categories for goalkeepers.

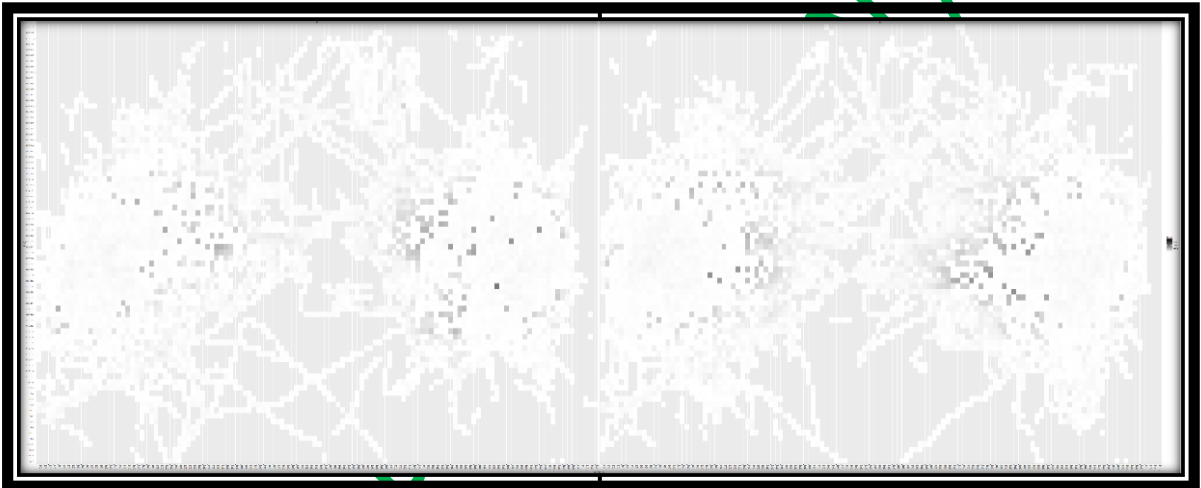


**Figure 2.** Differences in total distance traveled at different intensities according to locomotion categories for goalkeepers.

There are statistically significant differences in the following locomotion categories, with an advantage for goalkeepers, values reflected in the average difference and the degree of significance (p-value): total distance 0.50; (2.20 E -06), 3-4 km/h 0.08; (0.006), 4-5 km/h 0.16; (0), 5-6 km/h 0.10 (0), 6-7 km/h 0.01; (0.01), 12 km/h 0.06; (5.20E -06) and 15 km/h 0.02; (4.47E -05). The analysis of the coordinates to evaluate the displacements in the soccer goalkeeper reveals that the stationary category (0-0.4 km/h) according to Castagna et al, (2003) (Figure 3) (Figure 3) reflects a high intensity within the penalty area, interspersing movements and zones of influence towards the sides, where the goalkeeper has a much more extensive spectrum of action in depth and amplitude in relation to the goalkeeper; this is correlated in that the distance traveled at this intensity is greater in women than in men, which may be due to the variability of actions that they execute in frontal and lateral displacements, while the goalkeeper centralizes his pattern of intervention in a central area.

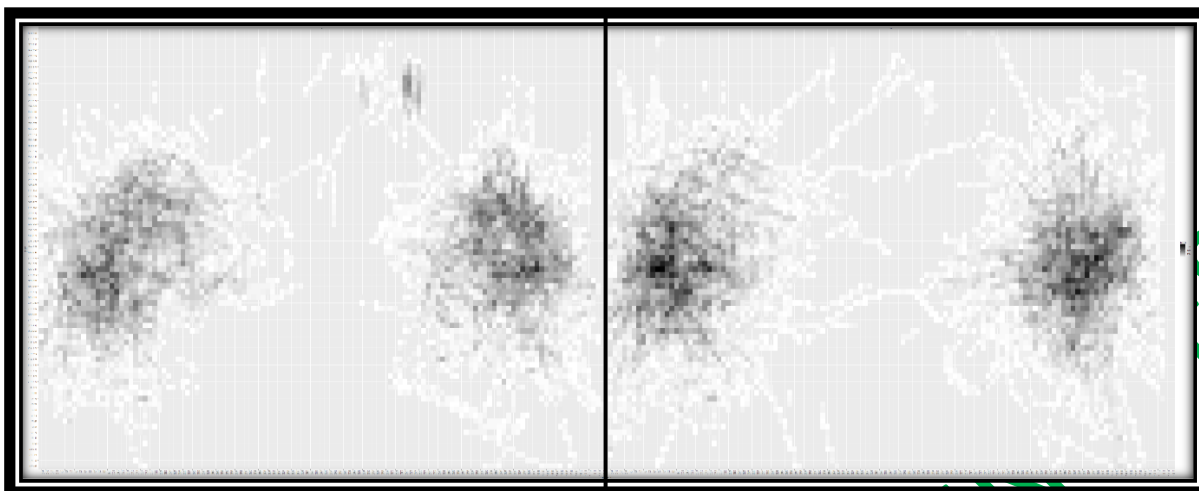


**Figure 3.** Analysis of heat mapping coordinates, category, category 1 "Standing" (0-0.4 km/h) according to Castagna et al., (2003) for goalkeepers and goalposts in the first and second half.



**Figure 4.** Analysis of heat mapping coordinates, category "Walking" (0.5-3 km/h) according to Castagna et al., (2003) for goalkeepers and goalkeepers in first and second half.

In the category "walking" speed ranging between (0.5-3 km/h) (Castagna et al., 2003) (figure 4) men have a higher prevalence and variability of displacements in this intensity range, while women reflect a higher degree of performance in the first half compared to the second part, and that may be due to factors such as cumulative fatigue in the final stages of the game, since the athlete while moving must mobilize depending on the fluctuation generated by the participatory dilemmas of the competition, alternating, modifying and altering the mental wear experienced by the physical and cognitive fatigue level.



**Figure 5.** Analysis of heat mapping coordinates, category 2 "Walking" (0.3-7.2 km/h) according to Di Salvo et al., 2008 for goalkeepers and goalposts in first and second half.



**Figure 6.** Analysis of heat mapping coordinates, category 2 "Low intensity" (7.3-14.4 km/h) according to Di Salvo et al., 2008 for goalkeepers and goalposts in the first and second half.

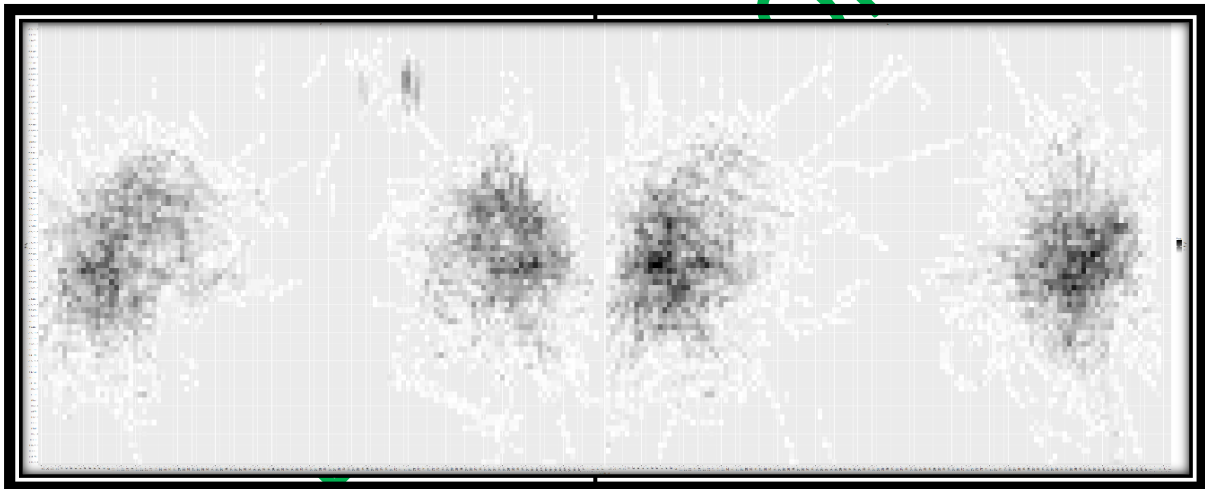
The displacements revealed in Figure 5, show a spectrum that is too extensive in the speed ranges (0.3-7.2 km/h) Di Salvo et al, (2008) and that do not allow establishing correlations of qualitative order, since this type of actions group a series of actions that the goalkeeper can perform, from being stopped, final movement of a deceleration, as the initial moment of an acceleration, quick movements to cut diagonal, frontal or lateral balls, clearances, bails, closing angles, enlarging and enlarging to ask for the ball, situations against the foot, etc., In this sense, it is reflected how men have a greater influence in this type of movements, being more intense in the central area, while women tend to perform lateral movements with predominance towards the right side of the field, both in the first and second half.

In low intensity running, which groups speeds ranging from 7.3 to 14.4 km/h (Di Salvo et al., 2008) shows that this type of executions are not common in competition, obeying the principles of individualization and specificity of the competition by the goalkeeper (Figure 6).



On the other hand, the high intensity displacements and in which the athletes reach speeds that fluctuate between (13.1-18 km/h) show how goalkeepers are able to continuously co-adapt to the multiplicity of coordinative-conditional and flexible technical-tactical patterns (see figure 7). All this, in order to give correct solutions to the variations of the game in response to the context, to each situation and to the alterations that occur in the megasystem of the competition, having to consider the trajectory, displacement and speed of the ball, as well as other conditioning factors linked to the teammate/opponent relationship, developing interceptions, angle closures, jumps, short cadences to take off or cut crosses or low balls in which their ability to anticipate will be fundamental. In short, the soccer goalkeeper is a highly co-adaptive being.

The actions that integrate movements ranging from 14.5 km/h to 19.9 km/h (Di Salvo et al., 2008) show that these types of movements are the least executed in the competition without differentiation of gender and that according to the analysis of the various categories taking as a reference the two studies cited above, are sporadic actions that respond to the unwavering nature of the game.



**Figure 7.** Analysis of heat mapping coordinates, category 1 "high intensity running" (13.1-18 km/h) according to Castagna et al., (2003) for goalkeepers and goalkeeper in the first and second half.

## DISCUSSION

The great popularity and diversification of soccer over time, has led to a pressing need to decipher and discover some elements related to the understanding of the physical demands of the soccer player within the competition (Reilly and Bowen, 1984; Bloomfield et al., 2006; Di Salvo et al., 2008; Condelo et al., 2011), many of these findings have been linked to the evaluation of kinematic variables at various levels of competition (Barbero-Álvarez, Barbero Álvarez, & Granda, 2007; Barbero-Álvarez, Barbero-Álvarez, Barbero-Álvarez, Gómez, & Castagna, 2009; Barbero-Álvarez, Coutts, Granda, Barbero-Álvarez, & Castagna, 2009). In this line, many studies have been aimed at determining the physical demand and categorization of movements in different contexts and levels of competition with GPS devices with a sampling frequency of (1 Hz) (Barbero-Álvarez et al., 2009; Coutts and Duffield, 2010), (10 Hz) (Beato, Bartolini, Ghia and Zamparo, 2016).

The study of distance and its subsequent segmentation into velocity ranges to determine the intensity at which athletes work is an important means of assessing physical performance in soccer players (Sporis, Jukic, Ostojic, & Milanovic, 2009). However, have not been found studies that evaluate and determine the positional physical demand for the soccer goalkeeper, discovering those differences that may arise in response to gender. On the other hand, the categorization of actions at high intensity depends on the ranges that are established to assess the displacements according to the desired intensity, in this same way it was found that the total average of actions at high intensity was 92, of which 52 were performed forward and 40 backward (Padulo, Haddad, Ardigò, Chamari and Pizzolato, 2015) and which are correlated with only 2% of the total compendium of movements in the competition (Di Salvo et al., 2008).

These data reveal that in actions at high intensity comprising speed movements above 13 km/h and 15 km/h correspondingly go down ( $0.30\pm 0.14$  and  $0.12\pm 0.05$  km) in men and ( $0.16\pm 0.10$  and  $0.06\pm 0.05$ ) for women and that the number of sprints above 13 km/h and 15km/h was ( $27.96\pm 12.87$  and  $16.04\pm 6.72$ ) and ( $15.78\pm 8.75$  and  $7.78\pm 5.96$ ) for men and women, for a total of 44 actions for the male gender and 24 for the female gender, demonstrating that in the actions at high intensity the goalkeeper only executes 54% of the actions executed by the goalkeeper, factors that may be due to the level of competition, promotion of high-level female leagues and with programs adapted to the needs and adaptations of the female gender to the continuum of the game (Becerra-Patiño, 2021b; Becerra-Patiño, 2021d).

Goalkeepers travel on average ( $4.58\pm 0.81$  km) and ( $3.26\pm 0.70$ ), of which in a speed range of (0-3 km/h) comprising the first two categories of locomotion proposed by Castagna et al., (2003) are covered (1.41 km) and (1.2 km) representing 30.7% and 36.7% of the total distance covered for men and women respectively, unlike the 4000 meters covered by goalkeepers (Reilly and Bowen, 1984), as well as values that differ from the study found in female goalkeepers of Bogota pre-juvenile female soccer in formative categories (2850 meters) (Becerra, 2018).

The actions of the soccer goalkeeper are associated with their participatory range and possible alternatives and continuous adaptations of the goalkeeper in the competition and the completeness of their functions (Boone, Vaeyens, Vanden-Bossche and Bourgois, 2012; Ziv and Lidor, 2011).

In this sense, when analyzing the locomotion categories that comprise the dimensions of (standing, walking and running at low intensity) of (0-8 km/h), it can be evidenced that in this intensity range (3.86 km) is covered for men and (2.27 km) for women representing 84% and 83% consequently, insignificant differences that denote that although the goalkeeper (men) covers greater distance, the displacements do not vary much without gender discrimination and that are related to the values that have been obtained in other studies (Reilly and Bowen, 1984).

The reference of the matches suggests that the variables are not linearly related; however, in the study developed by Condolo et al, (2011) a high gap was found in the third match between what was performed in the first and second half related to the total distance covered, and in which the descriptive analysis found a high frequency of occurrence for many of the movements contemplated, mainly the categories of resting and walking ( $28\pm 2\%$ ) and  $35.2\pm 1.2\%$ ) correspondingly, this differentiation in the contrast of the data obtained reflects that the soccer goalkeeper intervenes randomly in dependence of the actions that condition the game (Liu et al., 2015) and that are conditioned by each player (Boone et al., 2012; Ziv and Lidor, 2011).

## CONCLUSIONS

The activity profiles of goalkeepers should consider locomotion categories that establish speed ranges specific to the needs of their positioning. The analysis of the data obtained on kinematic dimensions such as distance traveled, speed and tactics with the heat map, are a first step to characterize the demands required by the soccer goalkeeper, in attention to the requirements of the competition and in correspondence to gender differences.

The exhaustive study of the polar coordinates represents a first approach to be able to correlate the distance traveled in the zones of influence and permanence within the competition, in order to interconnect the amount and type of displacements that are most executed at different intensities with the orientation and direction of these actions, thus facilitating a better training planning.

This study is aimed at analyzing, evaluating and determining the profile of tactical activity in soccer goalkeepers in Bogota, premise by which this research aims to serve as a turning point to generate more studies on this demarcation of the game.

## REFERENCES

- Álvarez, J. (2012). Actividad competitiva del portero de fútbol: análisis objetivo y orientaciones para el entrenamiento específico. *Futbolpf: Revista de preparación física en fútbol*, 69-83.
- Becerra, B. (2018). Demanda física posicional en jugadoras de fútbol femenino bogotanas (14-17 años), a través del análisis de la distancia, la velocidad y la frecuencia cardíaca. *Kinesis*, 68, 20-28.
- Becerra-Patiño, B.A. (2019). Fútbol: el portero dentro de una realidad sistémica: una revisión. *MLS Psychology Research*, 2(1): 81-98. doi: 10.33000/mlspr. v2i1.88
- Becerra-Patiño, B.A. (2021). Demanda física del portero de fútbol: necesidades y diferencias en respuesta al género. *Rev. Digit. Act. Fis.Deport.* 7(1):e1526. <http://doi.org/10.31910/rdafd.v7.n1.2021.1526>
- Becerra-Patiño, B. (2021b). *Fútbol como modelo sinérgico: complejidad del juego-jugador*. Armenia: Kinesis.

- Becerra-Patiño, B. (2021c). *Hacia una aproximación en la comprensión del fútbol femenino: un proceso de R-evolución*. Vigo: McSports.
- Becerra-Patiño, B. (2021d). *El ser dimensional al interior del modelo de juego: la jugadora de fútbol femenino*. Vigo: McSports.
- Beiztegui-Casado, C.; Oliver-Coronado, J. y Sosa-González, P.I. (2019) Portero-jugador en situaciones de inferioridad numérica ofensiva en balonmano: ¿penalización o ventaja? Goalkeeper-Field Player in Situations of Offensive Numerical Inferiority in Handball: Penalty or Advantage? *Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte* vol. 19 (74) pp. 293-307 [Http://cdeporte.rediris.es/revista/revista74/artportero1019.htm](http://cdeporte.rediris.es/revista/revista74/artportero1019.htm) DOI: <http://doi.org/10.15366/rimcafd2019.74.008>
- Barbero-Álvarez, J., Barbero-Álvarez, V., Gómez, M. y Castagna, C. (2009). Análisis cinemático del perfil de actividad en jugadoras infantiles de fútbol mediante tecnología GPS. *Kronos*, 8(14), 35-42.
- Barbero-Álvarez, J. Barbero Álvarez, V. y Granda, J. (2007). Perfil de actividad durante el juego en futbolistas infantiles. *Apunts Educación Física y deporte*, 33-41.
- Barbero-Álvarez, J. C., Coutts, A., Granda, J., Barbero-Álvarez, V. y Castagna, C. (2009). The validity and reliability of a global positioning satellite system device to assess speed and repeated sprint ability (RSA) in athletes. *Journal of Sci Med Sport*, 13(2), 232-235.
- Beato, M., Bartolini, D., Ghia, G. y Zamparo, P. (2016). Accuracy of a 10 Hz GPS unit in measuring shuttle velocity performed at different speeds and distances (5–20 M). *Journal of Human Kinetics*, 54, 15-22. doi: 10.1515/hukin-2016-0031
- Bloomfield, J., Polman, R. y O'Donoghue, P. (2006). Physical demands of different positions in FA Premier League soccer. *Journal of Sports and Medicine*, 6(1), 63-70.
- Boone, J., Vaeyens, R., Steyaert, A., Vanden Bossche, L. y Bourgois, J. (2012). Physical fitness of elite Belgian soccer players by player position. *J Strength Cond Res* 26(8), 2051–2057.
- Casal, C.A.; Losada, J.L.; Maneiro, R. y Ardá, T. (2017) Influencia táctica del resultado parcial en los saques de esquina en fútbol / Influence of Match Status on Corner Kick in Elite Soccer. *Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte* vol. 17 (68) pp. 715-728 [Http://cdeporte.rediris.es/revista/revista68/artinfluencia851.htm](http://cdeporte.rediris.es/revista/revista68/artinfluencia851.htm) DOI: <https://doi.org/10.15366/rimcafd2017.68.009>
- Casamichana, D., Castellano, J., González-Morán, A., García-Cueto, H. y García-López, J. (2011). Demanda fisiológica en juegos reducidos de fútbol con diferente orientación del espacio. *Revista Internacional de Ciencias del Deporte*, 23(7), 141-154.
- Castagna, C., D'Ottavio, S. y Abt, G. (2003). Activity profile of young soccer players during actual match play. *J Strength Cond Res*, 17(4), 775–780.
- Castellano, J. y Hernández, M. (2003). El análisis de coordenadas polares para la estimación de relaciones en la interacción motriz en fútbol. *Psicothema*, 15(4), 569-574.

- Castellano, J. y Casamichana, D. (2014). Deporte con dispositivos de posicionamiento global (GPS): Aplicaciones y limitaciones. *Revista de Psicología del Deporte*, 23(2), 355-364.
- Coelho, D., Pimenta, E., Veneroso, C., Morandi, R., Pacheco, D., Pereira, E., Coelho, L. y García, E. (2013). Assessment of acute physiological demand for soccer. *Brazilian Journal of Kinanthropometry and Human Performance*, 15(6), 667-676.
- Condello, G., Lupo, C., Cipriani, A. y Tessitore, A. (2011). Activity profile of a no-professional goalkeeper during oficial matches. *Research in sport and physical activity*, 2, 94-95.
- Coutts, A. J. y Duffield, R. (2010). Validity and reliability of GPS devices for measuring movement demands of team sports. *J Sci Med Sport*, 13(1), 133-135. doi: 10.1016/j.jsams.2008.09.015.
- Dellal, A., Chamari, K., Pintus, A., Girard, O., Cotte, T. y Keller, D. (2008). Heart rate responses during small-sided games and short intermittent running training in elite soccer players: a comparative study. *J Strength Cond Res*, 22(5), 1449-1457.
- De Baranda, P., Llopis, L. y Ortega, E. (2005). *Metodología global para el entrenamiento del portero de fútbol*. Sevilla: Wanceulen.
- De Baranda, P., Ortega, E., Llopis, L., Novo, J. y Rodríguez, D. (2005). Análisis de las acciones defensivas del portero de fútbol 7. *Apunts de Educació Física y Deportes*, 80, 45-52.
- De Baranda, P.S., Ortega, E. y Palao, J.M. (2008). Analysis of goalkeepers' defence in the World Cup in Korea and Japan in 2002. *European Journal of Sport Science*, 8(3), 127-134.
- Di Salvo, V., Benito, P. J., Calderón, M., Di Salvo, M. y Pigozzi, F. (2008). Activity profile of elite goalkeepers during football match-play. *J Sports Med Phys Fitness*, 48, 443-446.
- González-De Los Reyes, Y.; Fernández-Ortega, J. y Garavito-Peña, F. (2019) Características de fuerza y velocidad de ejecución en mujeres jóvenes futbolistas. Characteristics of Strength and Speed of Execution in Young Women Soccer Players. *Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte* vol. 19 (73) pp. 167-179  
<http://redeporte.rediris.es/revista/revista73/artcaracteristicas1009.htm>  
DOI: <http://doi.org/10.15366/rimcafd2019.73.012>
- Hernández, A. y Anguera, M. A. (2014). Estructura del comportamiento en deportes sociomotores: Fútbol. *Revista de Psicología Social*, 16(1), 71-93. doi: 10.1174 / 021347401317351215
- Hulka, K., Weisser, R. y Belka, J. (2016). Effect of the pitch size and presence of goalkeepers on the work load of players during small-sided soccer games. *Journal of Human Kinetics*, 51, 175-181. doi: 10.1515/hukin-2015-0180.
- Knoop, M., Fernández-Fernández, J. y Ferrauti, A. (2013). Evaluation of a specific reaction and action speed test for the soccer goalkeeper. *J Strength Cond Res*, 27(8), 2141-2148.
- Köklü, Y., Sert, Ö., Alemdaroglu, U. y Arslan, Y. (2015). Comparison of the physiological responses and time-motion characteristics of young soccer players in small-sided games: The effect of goalkeeper. *J Strength Cond Res*, 29(4), 964-971.

- Lamas, L., Drezner, R., Otranto, G. y Barrera, J. (2018). Analytic method for evaluating players' decisions in team sports: Applications to the soccer goalkeeper. *PLoS ONE*, 13(2), e0191431. doi: 10.1371/journal.pone.0191431.
- Lapresa, D., Chivite, J., Aranda, J., Anguera, M. y Barbero, J. (2018). Análisis de la eficacia del portero de fútbol cadete (14 – 16 años). *Apunts. Educación Física y Deportes*, 131, 60-79. doi: 10.5672/apunts.2014-0983.es.(2018/1).131.05.
- Liu, H., Gómez, M. A. y Lago-Peñas, C. (2015). Match performance profiles of goalkeepers of elite football teams. *International Journal of Sports Science & Coaching*, 10(4), 669-682.
- López-Gajardo, M.A.; González-Ponce, I.; Pulido, J.J.; García-Calvo, T.; Leo, F.M. (2020) Analysis of the Technical-Tactical Actions by Goalkeeper on Football in Competition. *Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte* vol. 20 (80) pp. 577-594  
[Http://cdeporte.rediris.es/revista/revista80/artanalisis1194.htm](http://cdeporte.rediris.es/revista/revista80/artanalisis1194.htm) DOI: <https://doi.org/10.15366/rimcafd2020.80.008>
- Nikolaidis, P., Ziv, G., Arnon, M. y Lidor, L. (2015). Physical and physiological attributes of soccer goalkeepers - Should we rely only on means and standard deviations? *J. Hum. Sport Exerc*, 10(2), 602-614.
- Nikolaidis, P. T., Clemente, F.M., Van der Linden, C. M. I., Rosemann, T. y Knechtle, B. (2018). Validity and Reliability of 10-Hz Global Positioning System to Assess In-line Movement and Change of Direction. *Front. Physiol.* 9:228. doi: 10.3389/fphys.2018.00228.
- Padulo, J., Haddad, M., Ardigò, L. P., Chamari, K. y Pizzolato, F. (2015). High frequency performance analysis of professional soccer goalkeepers: A pilot study. *J Sports Med Phys Fitness*, 55(6), 557-562.
- Pérez, S., López, S., Rodríguez, A. y Sánchez, A. (2016). Estudio de las acciones técnicas del portero de fútbol profesional a lo largo de una temporada: implicaciones para el entrenamiento. *Revista digital de Educación Física*, 7(42), 22-37.
- Rebelo-Gonçalves, R., Coelho-e-Silva, M.J., Severino, V., Tessitore, A. y Figueiredo, A. (2015). Anthropometric and physiological profiling of youth soccer goalkeepers. *Int J Sports Physiol Perform*, 10, 224–231.
- Reche-Soto, P., Cardona, D.; Díaz, A.; Gómez-Carmona, C.D.; Pino-Ortega, J. (2019). Tactical Demands of Small-Sided Games in Football: Influence of Tracking Technology. *Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte* vol. 19 (76) pp. 729-744  
[Http://cdeporte.rediris.es/revista/revista76/artanalisis1071.htm](http://cdeporte.rediris.es/revista/revista76/artanalisis1071.htm)  
DOI: 10.15366/rimcafd2019.76.011
- Reilly, T. y Bowen, T. (1984). Exertional cost of changes in directional modes of Running. *Perc Motor Skills*, 55, 267-271.
- Rojas-Inda, S. (2018) Análisis de carga interna y externa de futbolistas jóvenes en juegos reducidos / Analysis of Internal and External Load in Small Games in Young Football Players. *Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte* vol. 18 (71) pp. 463-477  
[Http://cdeporte.rediris.es/revista/revista71/artanalisis959.htm](http://cdeporte.rediris.es/revista/revista71/artanalisis959.htm) DOI: <http://dx.doi.org/10.15366/rimcafd2018.71.004>

- Sporis, G., Jukic, I., Ostojic, S.M. y Milanovic, D. (2009). Fitness profiling in soccer: physical and physiologic characteristics of elite players. *J Strength Cond Res* 23(7), 1947–1953.
- Vázquez-Diz, J. A.; Morillo-Baro, J. P.; Reigal, R. E.; Morales- Sánchez, V.; Hernández-Mendo, A. (2019). Estudio de las acciones del portero en balonmano playa a través del análisis de coordenadas polares: diferencias por género. *Cuadernos de Psicología del Deporte*, 19(3), 139-155.
- Vázquez-Diz, J. (2020). Estudio de aspectos tácticos y análisis de la toma de decisión en balonmano playa mediante análisis de coordenadas polares. (Tesis Doctoral), Departamento de Psicología Social, Universidad de Málaga.  
[https://riuma.uma.es/xmlui/bitstream/handle/10630/19735/TFD\\_VAZQUEZ\\_DIZ\\_Juan\\_Antonio.pdf?sequence=1](https://riuma.uma.es/xmlui/bitstream/handle/10630/19735/TFD_VAZQUEZ_DIZ_Juan_Antonio.pdf?sequence=1)
- West, J. (2018). A review of the key demands for a football goalkeeper. *International Journal of Sports Science & Coaching*, 0(0), 1-8. doi: 10.1177/1747954118787493.
- Willmont, A. (2016). FieldWiz GPS pilot Research report. Sport and Exercise Science Consultancy Unit.
- Witte, T. H. y Wilson, A. M. (2004). Accuracy of non-differential GPS for the determination of speed over ground. *Journal of biomechanics*, 37(12), 1891- 1898.
- Ziv, G. y Lidor, R. (2011). Physical characteristics, physiological attributes, and On-Field performances of soccer goalkeepers. *International Journal of Sports Physiology and Performance*, 6, 509-524.

**Número de citas totales / Total references:** 51 (100%)

**Número de citas propias de la revista /Journal's own references:** 6 (11,7%)