2023, Retos, 48, 590-597

Profile of high-speed efforts considering the playing position of Chilean professional soccer players, recorded by a GPS device: A Pilot Study

Perfil de esfuerzos de alta velocidad considerando la posición de juego de futbolistas profesionales chilenos, registrados por un dispositivo GPS: un estudio piloto

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Abstract. This study analyze the number of sprints and distances traveled at high speed by Chilean professional soccer players considering the playing position with a GPS device. Methods: The data from high-speed efforts of 10 professional soccer players were recorded. The amount of effort in sprints (> 21 km·h−1) and the distances covered in zone 4 (> 21 km·h−1 and < 25 km·h−1) and in zone 5 (> 25 km·h−1) were analyzed, differentiating and grouping the players by playing position. A Global Positioning System (GPS) device was used to collect the data, and the results were recorded in the program cloud. Results: Statistically significant differences were noted between playing positions in zone 4 (p=0.03), zone 5 (p=0.01), and number of sprints (p=0.01), with the wide forwards presenting the greatest number of sprints and distance traveled at high speed compared to the other positions, whereas the central defenders show a tendency to travel less in zones 4 and 5 and have a lower number of sprints. Conclusion: The number of sprints and distances covered at high intensity (zones 4 and 5) are different and will be specific according to the characteristics of the playing position.
Keywords: Soccer; GPS; Sprints; Distance covered; High-speed efforts.

Resumen. Este estudio analiza el número de sprints y distancias recorridas a alta velocidad por futbolistas profesionales chilenos considerando la posición de juego con un dispositivo GPS. Método: Se registraron los datos de los esfuerzos de alta velocidad de 10 futbolistas profesionales. La cantidad de esfuerzo en sprints (> 21 km·h−1) y las distancias recorridas en la zona 4 (> 21 km·h−1 y < 25 km·h−1) y en la zona 5 (> 25 km·h−1) 1), diferenciando y agrupando a los jugadores por posición de juego. Se utilizó un dispositivo de Sistema de Posicionamiento Global (GPS) para recopilar los datos y los resultados se registraron en la nube del programa. Resultados: Se observaron diferencias estadísticamente significativas entre posiciones de juego en zona 4 (p=0,03), zona 5 (p=0,01) y número de sprints (p=0,01), siendo los delanteros anchos los que presentaron mayor número de sprints y distancia recorrida en altura. velocidad respecto al resto de posiciones, mientras que los centrales muestran una tendencia a desplazarse menos en las zonas 4 y 5 y tienen un menor número de sprints. Conclusión: El número de sprints y distancias recorridas a alta intensidad (zonas 4 y 5) son diferentes y serán específicos según las características de la posición de juego.
Palabras clave: Fútbol; GPS; carreras de velocidad; Distancia recorrida; Esfuerzos de alta velocidad.

Fecha recepción: 03-11-22. Fecha de aceptación: 27-02-23
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Introduction

For many years, the Federation Internationale de Football Association (FIFA) has allowed the use of electronic performance and tracking systems (EPTS) in official competitions to monitor and improve the performance of the soccer players and teams. These technological advances have encouraged the detailed study of training processes that used to be difficult to quantify, making it possible to identify the stimuli applied in training and matches in order to optimize athletic performance and avoid states of overtraining and injuries (Cardinale & Varley, 2017).

The training load is important to quantify so as to establish the characteristics of the stimulus applied during the training process, and it can divided into external and internal loads. The former consists of determining the application of stimuli to the athlete in training and/or match situations (Clemente et al., 2019). The latter, within the parameters quantified as an external load, indicate the distance traveled and speed (Strauss et al., 2019). These variables are measurable thanks to the incorporation of a GPS, which began its first applications on athletes in group games in 2006 (Aughey, 2011). The variables that comprise the internal load are heart rate (HR) and the subjective rating of perceived exertion (RPE) (Akubat et al., 2014). Their relation to the external load makes it possible to monitor the loads and optimize athletic performance (Enes et al., 2021; Medina et al.,2022).

GPS devices allow an accurate follow-up of the players on the field (Casamichana & Castellanos 2011b; Ehrmann et al., 2016), information that allows the coaching staff to identify possible trends that can expose the athlete to overloads and injuries (Oliveira et al., 2019). It also provides data to correctly schedule weekly training sessions according to the demands of each player and team (De Silva et al., 2018), and finally to optimize the players' athletic performance throughout the season (Terrier & Schutz, 2005).

Advances in technology during these years have improved the measuring capacity of the GPS system in terms of high-speed movements, which facilitates the data analysis of distance and time in athletes (Dwyer & Gabbett, 2012), variables that are essential to record because they are actions that characterize the sport and originate in specific actions of game play, such as evading an opponent or making a shot on goal (Sweeting et al., 2017); these are

considered determining factors of success in soccer (Modric et al., 2019). The distance traveled at high speed must be differentiated according to the player's position (Abbott et al., 2018; Di Mascio & Bradley, 2013), because it is considered a determining characteristic in high-level teams (Bradley et al., 2013; Sæterbakken et al., 2019), and it is also a variable that acts dependently on the outcome of the matches (Rampinini et al., 2007).

There is no consensus among researchers regarding the minimum speed threshold to determine a sprint (de Hoyo Lora & Rodríguez, 2017); however, some proposals, like Haugen and Buchheit (2016), define speed thresholds between 18 km/h−1 and 30 km/h−1, while in another proposal the threshold is identified as 24 km/h−1 (Dellal et al., 2010), and still other authors put it at 21 km/h−1 (Casamichana & Castellano, 2011b; Casamichana et al., 2012).

With respect to the speed zones, GPS devices can render adjustment formats between five and seven training zones and the speed can be identified between the ranges of 0 km/h−1 and 36 km/h−1 (Randers et al., 2014). The distance traveled is considered the variable of greatest scientific merit, and especially those at high speed, because these are the actions that bring about the greatest physical wear in soccer players (Abt & Lovell, 2009; Cardinale & Varley, 2017; Osgnach et al., 2010). Mohr et al. (2003) indicate that a soccer player runs on average 8.7% in high-speed races in zone 4 (speed between 18 km/h−1 and 30 km/h−1), and an average of 1.4% in zone 5 (< 30 km/h−1), considering the total run of soccer players during matches, and the study by Vigne et al. (2010) notes that the players run 8% in zone 4 (speed between 16 km/h−1 and 19 km/h−1) and 10% in zone 5 (< 20 km/h−1).

High-speed efforts are the most important actions for premier soccer players, because they are determining movements in decisive plays during matches (Mendiguchia et al., 2020), but also the actions that carry the greatest risk of hamstring injuries, accounting for one in three injured players (van den Tillaar et al., 2017), and also used as a fatigue marker (Carling et al., 2016).

A better knowledge of players' physical performance adaptations during the season is extremely useful for optimizing the training process, as it assists coaches in setting up specific targets, provides supporting data for the load adjustment and improves performance (West et al., 2021). To the best of author´s knowledge, there remains a paucity of studies that use GPS in Chile. Only, Hernández et al. (2018), conducted on 7-a-side soccer players with motor disabilities but, to the best of our information, no previous study has been focused on the analysis of using GPS on Chilean professional soccer players.

In light of the aforementioned considerations, the main purpose of this study was to examine the number of sprints and distances traveled at high speed in Chilean professional soccer players considering the position during four national championship matches.

Materials and Methods

Study Design

It is an investigation carried out using a longitudinal design of repeated measures that examined the high-speed efforts in professional soccer players, considering their playing position. This study recorded 4 official matches during 4 continuous weeks of the 2019-2020 regular season of the Chilean national professional soccer championship of First B division. The measurements of the high-speed efforts, were made through GPS devices (Catapult) which were distributed, individually, to each player and turned on before the warm-up, prior to the game. Each device was placed between the player's scapula. The data was collected after each game, in order to be analyzed with a statistical program. All tests were conducted on the soccer field. Players were instructed to avoid tampering the device once it was turned on.

Participants

A total of 10 professional soccer players who participate in the First B division of the Chilean National Professional Soccer Championship (ANFP) volunteered to participate in the present study. (Anthropometric measures provided in Table 1). Participants belonged to the same club that competed both on national and international level. The sample was comprised of 10 field players: 2 wide defenders (WD); 2 central defenders (CD); 2 central midfielders (CM); 2 wide forwards (WF) and 2 strikers (S) according to the criteria of Clemente et al.(2019). The requirements for the inclusion of the soccer players in the study were: a) belonging to the First B Club with a current contract, b) having no injuries that affect their performance, c) fulfilling all the planned evaluations, and d) being a field player and having played a minimum of 60 minutes in each official match during the months of February and March, 2020. All participants became familiar with the test exercises. Before participating in this project, which was approved by the scientific ethics committee of the Universidad Adventista de Chile (nº 2021-04), all participants were fully informed about the protocol and were asked to give their written consent in accordance with the Declaration of Helsinki.

Table 1.
Characteristics anthropometrics and years of experience.

	n	Mean ± SD
Age (years)	10	27,30 ± 4,50
Weight (kilogram)	10	75,19 ± 8,86
Height (centimeters)	10	177,11 ± 0,08
Years of experience	10	8,10 ± 3,78

Instruments

To establish the number of sprints per match, and the distances traveled at high speeds, a Catapult GPS, Playertek model (Melbourne, Australia) was used, which has hardware with the following characteristics: dimensions 84 mm x 42 mm x 21 mm; weight 42 grams; 7-hour bat-

tery life; signal 10 Hz; 400 Hz triaxial accelerometer and Polar® pulsometer including H1 model, and software with a Playertek Cloud. It is a certified EPTS for use in FIFA competitions (Catapult Sports), fulfilling the validation standards considering its Hertz capacity (Castellano et al., 2011a; Varley et al., 2012).

Testing Procedures

Data for the study was obtained during the beginning of the competitive season in summer, where four official matches took place, 2 on a synthetic field and 2 on natural grass. To carry out the measuring procedure, each player was assigned a specific vest and a pocket located between the scapulae contained a GPS device (Casamichana & Castellano, 2011b) that recorded the number of sprints made by the players in each match, considering a minimum threshold speed of >21 km·h−1 (Casamichana & Castellano, 2011a), and the distances traveled in zones 4 and 5, the first being recorded between speeds of 21 km·h−1 and 24 km·h−1(Casamichana & Castellano, 2011a), and the second > 24 km·h−1 (Castellano et al., 2011a).

After the matches, the data were reviewed in the Catapult cloud software and exported to an Excel spreadsheet, considering only the data for number of sprints, and the distance traveled at high speeds in absolute values from the two zones, that provided the overall difference between the playing positions of the soccer players (Sæterbakken et al., 2019). The GPS in its metric valuation includes the number of sprints, all the efforts between zones 4 and 5, and which must be maintained at least 1 second on this threshold of zone 4, and at a speed greater than >5 m·s−1 (Catapult sport) . It must be mentioned that we only considered the load from the match, excluding warm-up and cool-down.

Statistical Analysis

Descriptive statistics (mean ± SD) for the different variables were calculated. Whereas the normality of distribution of the data was examined with the Shapiro Wilk test (<30). The intraclass correlation coefficient (ICC) was used to establish the temporal consistency of the variables (zone 4, zone 5 and sprints) among the matches. Data were analyzed using a one-way Anova to verify if there were significant differences among the playing positions. Statistical significance was accepted at an alpha level of $p \leq 0.05$. The SPSS statistical package, version 23.0 was used (SPSS®, Inc., Chicago, IL, USA).

Results

Table 2 provides the results overall and by position for each match analyzed according to distance traveled in zone 4, zone 5 and the number of sprints. In order to visualize the mechanical efficiency and homogeneity in the efforts of the matches, the variable player load was used, which showed no significant differences between matches (p>0.05) nor in the overall results of distance traveled in zone 4 or total number of sprints (p>0.05). Zone 5 only showed differences among the matches analyzed (p=0.03). Following the criteria of Prieto et al. (1998), the reliability of the variables (zone 4, zone 5 and sprints) among the matches represented an excellent reliability for being over 0.75.

Table 2.
Means of distances traveled at high speed and numbers of efforts in sprints by match played.

Overall Results by match	Match 1	Match 2	Match 3	Match 4	*p*-value	ICC*
Player Load (u.e)	396±58.6	341±93	405±86.9	361±85.9	0.20	
Zone 4 (m)	445.7±168.25	340.8±193.81	457.8±153.45	379.4±129.75	0.054	0.83 [0.56–0.95]
Zone 5 (m)	189.90 ±154.63	127.20±107.36	132.80±71.59	128.50±84.00	0.030	0.92 [0.79–0.98]
Sprints (n)	19.2±8.75	15.2±8.01	17.9±5.30	15.2±6.89	0.142	0.86 [0.63–0.96]

ICC*: Intraclass correlation coefficient

Table 3.
Means and standard deviation of numbers of efforts in sprints and distance traveled at high speed by position.

Playing position	Zone 4 mean±SD [min-max]	Zone 5 mean±SD [min-max]	Sprints mean±SD [min-max]
Central defender (m)	256.63±137.01 [26–494]	53.13±48.32 [3–154]	10.25±5.52 [3–22]
Wide defender (m)	413.88±113.98 [318–664]	131.50±64.90 [49–255]	17.25±4.46 [13–24]
Central midfielders (m)	475±207.40 [164–722]	93.25±61.99 [26–231]	17.0±6.97 [6–25]
Striker (m)	347.13±124.48 [177–506]	137.37±33.18 [94–178]	14.25±5.31 [7–24]
Wide forwards (m)	537±70.14 [450–658]	307.75±102.03 [186–521]	25.62±4.75 [20–32]
p-value	0.003	< 0.001	<0.001

Table 3 provides the mean values and standard deviation of the meters traveled in zone 4, zone 5, and number of sprints of the 4 official matches played, considering the playing positions. The results show significant differences between positions for zone 4 ($F(4.39) = 5.02$; $p = 0.03$), zone 5 ($F(4.39) = 17.28$; $p < 0.001$) and number of sprints ($F(4.39) = 8.51$; $p < 0.001$).

Figure 1 shows the results of the post hoc Bonferroni test, finding that in zone 4 there were significant differences between the central defenders and central midfielders (DM = -218.38; $p = 0.03$) and wide forwards (DM = -280.38; $p = 0.003$). In zone 5 there were significant differences between central midfielders and wide forwards (DM = -254.63; $p < 0.001$), between wide defenders and wide forwards (DM = -176.25; $p < 0.001$), between central midfielders and wide forwards (DM = -214.50; p

< 0.001) and between wide for-wards and strikers (DM = 170.38; $p < 0.001$). In the number of sprints, there were significant differences between the central defenders and strikers (DM = -15.38; $p < 0.001$), between wide defenders and strikers (DM = -8.38; $p = 0.042$), central midfielders and strikers (DM = -8.63; $p = 0.03$) and between wide for-wards and strikers (DM = 11.38; $p = 0.002$) (Figure 2).

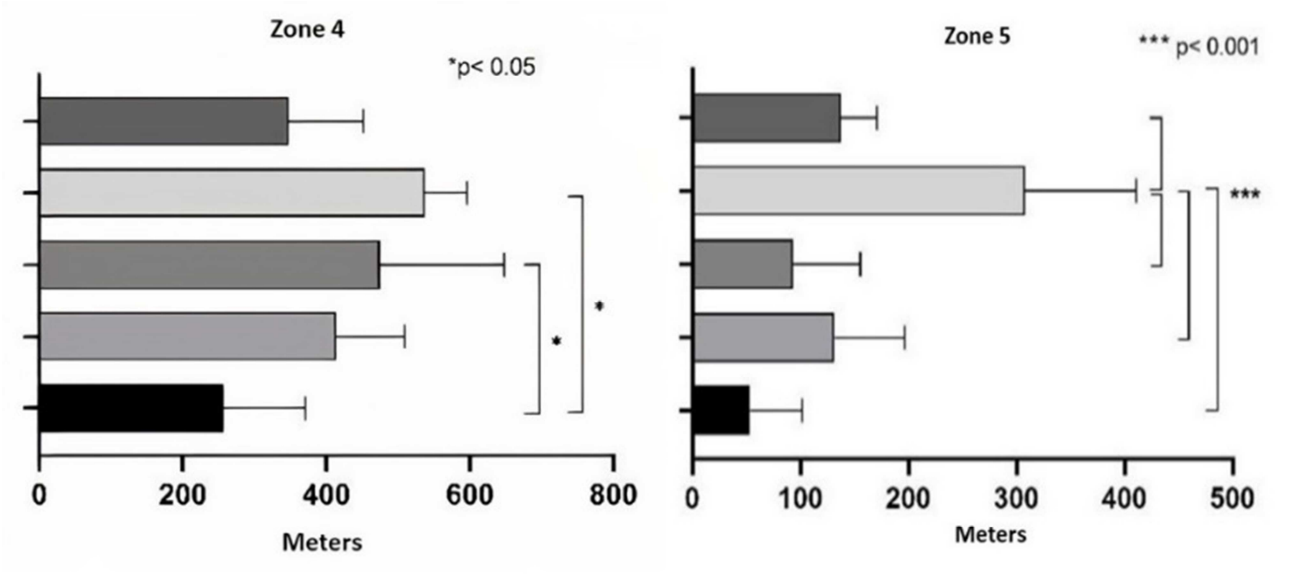

Figure 1. Results by player in four matches according to meters crossed by zone matches (4 and 5)

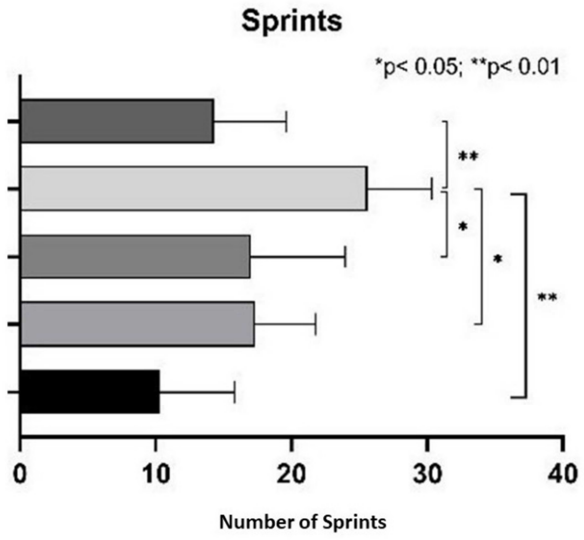

Figure 2. Differences of means by zone and sprints according to playing position

Discussion

This study aimed to analyze the number of sprints and distances traveled at high intensity (zones 4 and 5), considering the playing position of professional soccer players belonging to the Second Division of Chilean professional soccer. According to the analyses performed by zone (4 and 5), the study results show that in both zones there are statistically significant differences ($p<0.05$) in the distance traveled at high intensity.

In zone 4 (21 km·h−1 to 24 km·h−1), differences were observed between the central defenders compared to the central midfielders and strikers, results consistent with the study by Abbott et al. (2018) in 37 U-23 players in the English Premier League. In this way, Principe et al. (2021), analyzed 23 professional Brazilian soccer players, and concluded that midfielders have the longest travel (323.612 ±148.55 m s−1) compared to the defenses and forwards, on the other hand, Di Salvo et al. (2007) analyzed 20 players who participated in 10 Champions League matches (season 2002-2003 and 2003-2004), and concluded that the midfielders and wide defenders cover the most distance in this type of effort with 738 m and 652 m, respectively. Besides, Pettersen and Brenn (2019), reported that the external midfielders are those who cover more metters, with speed thresholds between > 19.8 km·h−1 and < 25.2 km·h−1, covering 1,442.2 ± 168.2 m, and those who cover the least distance are the central midfielders, covering 508.3 ± 182.0 m. Similar results were obtained in the study by Núñez-Sánchez et al. (2017), in speed ranges between 18 km h−1 to 21 km h−1, with the exception of the shortest distance traveled that corresponds to the central defenders.

Our results concur with two studies Miñano-Espin et al. (2017), who analyzed 149 Real Madrid matches in league, UEFA Cup and Champions League competitions (seasons 2001 to 2007), reporting that the external midfielders cover the greatest distances with 354 ± 88 m, and those with the least distance covered are the central defenders with 180 ± 65 m. On the other hand, Altavilla et al. (2017), in the range > 16 km·h−1 (lower thresh-old speed that our study), confirmed that the wide defenders and offensive midfielders cover greater distances at high speed, with a value of 1,815.7 m and 1876.13 m, respectively, and the central defenders cover less distance with 1,066.28 m. Baptista et al. (2018) analyzed 23 matches in

Norwegian league soccer, concluding that the wide defenders are the players with the greatest total distance covered at speeds > 19.8 km·h−1.

With respect to the results obtained in zone 5 (> 24 km·h−1), the present study showed significant differences ($p < 0.05$) between the wide forwards and the other positions, demonstrating that the wide forwards cover greater distances at high speed, similar result has been presented by Principe et al. (2021), in Brazilian soccer players who conclude that the forwards have the longest travel (166.56±110.72 m·s−1). From this perspective, the results of the study conducted with U-23 soccer players in the English Premier League Abbott et al. (2018) indicate that the wide defenders and external midfielders cover the greatest distances at very high speed, while the central defenders record the least.

These results are in agreement with the previous literature Andrzejewski et al. (2013), where they analyzed 147 soccer players in 10 official UEFA Europe League matches (2008-2009 and 2010-2011 seasons). Their result indicated that analyzing the distance traveled > 24 km·h−1, on aver-age they were of 237 ± 123 m and there were significant differences in the distance traveled between the defenders, midfielders and wide forwards compared to the central defenders and midfielders. Also, these results were specified by position where the forwards covered 345 ± 29 m, external midfielders 314 ± 123 m, wide 265 ± 121 m and central 186 ± 82 m. Similarly, Bradley et al. (2009), analyzed the English Premier League and concluded that the players travel at a speed > 25,1 km·h−1, covering an average distance of 251 m and Vigh-Larsen et al. (2018) in the Danish soccer league concluded that the players covered a total distance of 143 m, considering the same speed thresholds, values similar to the ranges in our study.

Pettersen and Brenn (2019) in U-17 players in the Norwegian league soccer, identified a high-speed threshold slightly greater than the one we presented in our study (> 25.2 km·h−1). Their results are similar to ours, where the external midfielders present the greatest distances covered, recording 224.4 ± 82.4 m, and the players with the least distance covered were the central defenders (85.1 ± 61.4 m). In the study by Núñez-Sánchez et al. (2017) who presents different ranges in this area (> 21 km·h−1), concludes that forwards are the players with the longest travel. Finally, Miñano-Espin et al. (2017), in their study with Real Madrid (seasons 2001 to 2007), concluded that at speeds > 24 km·h, the players with the greatest distance covered were the wide defenders (374 ± 144 m), and those with the least distance covered were the central defenders (161 ± 91 m). Our results concur with those studies, showing that wide defenders were the players who greatest distance covered.

On the other hand, in the results obtained for the variable number of sprints, the present study presented significant differences between the wide forwards and the other positions in the field (center back, full back, defensive midfielder and striker). These results agree with the study of Varley and Aughey (2013) on Australian elite soccer players, who indicate that the positions of central defenders and midfielders present the fewest number of sprints compared to the other positions. Martín-García et al. (2018) showed similar conclusions, stating that players who play on the flanks present a greater number of sprints. In the Norwegian soccer league, Baptista et al. (2018), in 23 official matches, concluded that the central defenders and central midfielders were the players who presented the fewest number of sprints. In the same way, Haugen et al. (2014) recorded between 17 and 81 high-intensity efforts per match (18 km/h to 31 km/h), concluding that in relation to the number of sprints and the meters covered in sprints, the wide defenders and external midfielder have the greatest number and distance covered. These results are confirmed by the study by Andrzejewski et al. (2013) on players who competed in the UEFA Europa League, concluding that the average number of sprints were 11.2 ± 5.3, and there were significant differences between midfielders and wide forwards compared to the central midfielders and defenders. Also, Di Salvo et al. (2007) concluded that the external midfielders were the ones with the greatest number of sprints (35.8 ± 13.4), and the central defenders presented the least amount (17.3 ± 8.7), considering a speed threshold > 25,1 km·h−1.

Practical applications

The reported results contribute valuable information for physical trainers and soccer coaches, making it possible to adequately plan the training loads associated with the number of sprints and distances traveled at high inten-sity (zone 4 and 5) in the competitive microcycle, from which it may be inferred that differentiated training is needed according to the efforts for each position, and thus the physical training conditions can be improved for players and the programming of workloads can be stabilized over time. In addition, there will be comparative parameters of the training load volume to guide planning for physical training of other Chilean and/or foreign professional soccer teams that do not have GPS devices for the planning and monitoring of the loads during the training period.

Limitations

This study had limitations, since the team's tactics, players' technical abilities, relevance of the match, score, the physical place of the match (at home or away), among others were not included, understanding the dynamics that the game raises in its development during the matches. Therefore, for future studies, the proposed variables should be analyzed, the sample size increased and other professional soccer teams included in the analyses.

We may conclude that the number of sprints and distances covered at high intensity (zones 4 and 5) are different and will be specific according to the characteristics of the playing position. The wide forwards present the great-

est number of sprints and distance traveled at high speed compared to the other positions, with these being statistically significant differences, whereas the central defenders show a tendency to have a smaller distance covered in zones 4 and 5, and a lower number of sprints.

Acknowledgments

We wish to thank the Club Deportes Valdivia, an institution belonging to Chilean professional soccer.

Conflicts of Interest

The authors declare no conflict of interest.

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