Differences in the external and internal load according to the player's position

Diferencias en la carga externa e interna en función de la posición de juego

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Abstract

Background/Objectives: the load analysis in football has consolidated as an essential factor for optimising performance and reducing the injury risk in players at different competitive levels. External and internal loads in football present significant changes according to the player position, and these differences must be considered in the training plan and periodization of the load during the season and in injury prevention. The study aimed to evaluate and compare external, internal, and neuromuscular load in senior football players in Portugal across different players' positions.
Methods: Wimu Pro™ (Hudl, Nebraska, United States) and Garmin Heart Rate bands (Garmin International Inc., Kansas, USA) were used to quantify and evaluate the external and internal load of the players. A total of 121 athletes were assessed which were divided into 5 player positions.
Results: significant differences were observed between players' positions across several external and neuromuscular load variables (p >0.001). Considering the distance, midfields reported higher mean values (118.20±12.41) compared to the other positions. Considering the Player Load, significant differences were reported among the different positions (p <0.001; ε^2 = 0.285) and Total Impacts/min (p <0.001; ε^2 = 0.312). Regarding the internal load (heart rate), a significant difference was observed for the variable Avg. HR (bpm) (p = 0.024; ε^2 = 0.062) when comparing GK with all the other positions. In the same line, the GKs were those who reflected the lowest values according to the Avg. HR.
Conclusions: the inclusion of kinematics, neuromuscular, and cardiac variables allows the coaching staff a higher comprehension of the sports performance and facilitates the decision-making of the performance manager.

Keywords

Performance; player position; football; load.

Resumen

Antecedentes y objetivos: el análisis de la carga en el fútbol se ha consolidado como un factor esencial para optimizar el rendimiento y reducir el riesgo de lesiones en los jugadores de diferentes niveles competitivos. Las cargas externas e internas en el fútbol presentan cambios significativos según la posición del jugador, y estas diferencias deben tenerse en cuenta a la hora de planificar el entrenamiento, así como en la periodización y el control de la carga durante la temporada y en la prevención de lesiones. El objetivo del estudio fue evaluar y comparar la carga externa, interna y neuromuscular en futbolistas sénior de Portugal en función de sus distintas posiciones.
Métodos: se utilizaron Wimu Pro™ (Hudl, Nebraska, Estados Unidos) y pulseras de frecuencia cardíaca Garmin (Garmin International Inc., Kansas, EE. UU.) para cuantificar y evaluar la carga externa e interna de los jugadores. Se cuantificó un total de 121 deportistas, que se dividieron en 5 posiciones de juego.
Resultados: se observaron diferencias significativas entre las posiciones de los jugadores en varias variables de carga externa y neuromuscular (p >0,001). Considerando la distancia, los mediocampistas reportaron valores medios más altos (118,20±12,41) en comparación con las otras posiciones. Considerando la carga del jugador, se reportaron diferencias significativas entre las diferentes posiciones (p <0,001; ε^2 = 0,285) e impactos totales/min (p <0,001; ε^2 = 0,312). Respecto a la carga interna (Frecuencia Cardíaca), se observó una diferencia significativa para la variable FC promedio (lpm) (p = 0,024; ε^2 = 0,062) al comparar GK con todas las demás posiciones. En la misma línea, los GK fueron los que reflejaron los valores más bajos según la FC promedio.
Conclusiones: la inclusión de variables cinemáticas, neuromusculares y cardíacas permite al cuerpo técnico comprender mejor el rendimiento deportivo y facilita la toma de decisiones del responsable de rendimiento.

Palabras clave

Rendimiento; posición de juego; fútbol, carga.

Introduction

The load analysis in football has consolidated as an essential factor for optimising performance and reducing the injury risk in players at different competitive levels. In recent years, research has increased significantly due to the introduction of technology for monitoring training and match loads. For this purpose, the Global Positioning System (GPS) (Saberisani et al., 2025; Tierney et al., 2016), accelerometers (Espada et al., 2023; Santos et al., 2024), and various strategies and tools for quantifying the Rate of Perceived Exertion (RPE) (Tan et al., 2025) or for evaluating the subjective load of the tasks (Gamonales et al., 2022) have been used to assess the players' external and internal loads. These tools have facilitated the understanding of how the players responded physiologically to the physical demands during the game (Pillitteri et al., 2024), giving the coaching staff important information to make a good training plan (Modena & Schena, 2024).

The External Load (EL) is understood as the physical work developed by the players, and it is measured with variables such as distance covered, number of accelerations and decelerations, sprints, High Speed Running (HSR) and changes of direction (Tereso et al., 2026). The EL has been analysed in various sports modalities, such as football (Santos et al., 2024), basketball (Gamonales et al., 2023b; López-Sierra et al., 2026), and tennis (Penalva-Salmerón et al., 2026). These studies concluded that players' EL varies with position as an independent variable (Font et al., 2021; Reina et al., 2020). Therefore, it is necessary to develop an individualised approach to obtain better physical fitness of the player and reduce the risk of injury (Ibáñez et al., 2022). On the other hand, the Internal Load (IL) reflects the physiological response of the players (Bourdon et al., 2017; Coutts et al., 2009). To evaluate these variables, different strategies, including Rate of Perceived Exertion (RPE), training monotony, strain, and impulse, heart rate (HR), hormonal and biochemical markers, and training diaries and questionnaires (Macedo et al., 2024). In order to develop a correct training program and periodisation of the loads, it is necessary to understand each sport's demands and select the best method for monitoring EL and IL, because different responses can vary for each player even when they are experiencing the same external workload (McGuigan, 2017).

In the Portuguese context, the training and match monitoring have increased and acquired great importance due to the league's growth (Cavaca et al., 2025; Coutinho et al., 2024; Oliveira et al., 2025). The literature focused on the importance of understanding the positional variances for optimising sports performance (Sarmento et al., 2024). In this line, Miguel et al. (2022), detected significant differences between playing positions in EL variables ($p < 0.001$). Central defenders covered the highest distance during the matches, and forwards developed the highest number of intensity decelerations. According to this line, Sarmento et al. (2024) found that central and external midfielders, and external defenders cover greater total and high-speed distance than forwards or central defenders. External midfielders presented the highest percentage of the maximum HR (Sarmento et al., 2024). These results can be explained because midfielders usually develop fast transitions during defensive and offensive phases (Filter et al., 2023). In contrast, the studies developed by Ingebrigtsen et al. (2015) and Modric et al. (2019), detected that forwards and central defenders covered less distance during the matches. These results are related to their roles in the pitch, due to the role of forwards being to lead attacks and create goal opportunities, predominantly high-intensity actions (Vigh-Larsen et al., 2018). In contrast, central defenders are focused on maintaining a compact defensive structure with a positional game (Sarmento et al., 2024).

Overall, the recent literature concludes that the EL and IL in football present significant variances according to the player position (Altundağ, Soylu, et al., 2025), and these differences must be considered in the training plan and periodization of the load during the season and the injury prevention (Georgiadis et al., 2024). Understanding the differences by position may provide valuable information for coaches and strength and conditioning professionals, allowing researchers to tailor the training process to the specificities and constraints of each competitive level. Also, this information will help the training staff prevent injury through load management.

The present study aimed to assess and compare IL and EL indicators among senior football players in Portugal, considering the player's position as an independent variable. This evaluation will provide relevant information related to the physical demands throughout the players' positions in the Portuguese

football environment. Therefore, as summary, the research question established was how the external and internal load varies according to the player's position in senior football?

Method

Design

This study adopted an observational and cross-sectional design, using a comparative strategy (Ibáñez & Feu, 2026; O'Donoghue, 2010). This research aimed to assess and compare internal and external load demands across different football players' positions. Also, the variables were not manipulated, and there was no intervention during the data collection. This methodological approach is similar to that used in previous studies focused on performance analyses (Gamonales et al., 2023; Ibáñez et al., 2023; Tereso et al., 2026).

Participants

A total of 121 athletes were included in the study. The participants were selected from five different categories from the Portuguese leagues (1st Division, 2nd Division, 3rd Division, 4th Division, and Regional Division). For the analysis, these categories were removed, as the main aim was to analyse the EL and IL of the players considering the game position. Table 1 shows the main characteristics of the sample divided by the game position established.

Table 1. Characteristics of the sample.

	Game position	Hight (cm)	Body Mass Index	Weight (kg)	Age (years)
N	Goalkeeper	5	5	5	5
	Central defender	27	27	27	27
	Wingers	30	30	30	30
	Midfielders	29	29	29	29
	Forwards	30	30	30	30
Mean	Goalkeeper	185	22.8	77.6	26.2
	Central defender	187	22.7	79.6	22.2
	Wingers	178	23.0	72.5	23.1
	Midfielders	178	22.7	72.0	24.9
	Forwards	181	22.2	72.7	24.5
SD	Goalkeeper	2.51	0.313	2.19	6.22
	Central defender	5.26	1.18	5.86	2.60
	Wingers	5.37	1.25	5.54	3.38
	Midfielders	5.63	1.24	5.89	6.06
	Forwards	6.13	0.978	5.93	4.25

All the participants included in the study were evaluated considering the following inclusion criteria, in order to be able to analyse and compare the results in a correct way. Therefore, the inclusion criteria established were a) the players must be included in the match for a minimum of 45 minutes; b) they must play a minimum of 4 matches; c) the players must not be injured or in the process of recovering. In this line, from the total of 145 players involved in the initial sample, considering the five categories, 24 were removed for not meeting these criteria. A total of six goalkeepers were removed due to they did not play a minimum of 4 matches; 10 field players were removed because they did not play a minimum of 45 minutes; and finally, eight players were not included due to they were injured or in the process of recovering. In this line, only 5 goalkeepers were included because they were the total number of subjects who met the inclusion criteria proposed.

An a priori statistical power analysis was carried out using the GPower 3.1 software. The analysis assumed a significance level of $p = 0.05$, a statistical power of 0.85, and a moderate/large effect size. Therefore, the minimum of 115 players was the minimum sample size required to ensure adequate power to detect statistically significant differences.

Instrument

In the present study, different tools and instruments were used to obtain and analyse the variables. The EL was collected throughout the use of an inertial device, WIMU PRO™ (RealTrack Systems, Almeria,

Spain). This device collects information about different variables such as speed, distance covered, acceleration, deceleration, or impacts at a frequency of 1000 Hz. The device was in the interscapular line (vertebral T2-T4 level). To obtain the variables related to the IL, a GARMIN HR band (Garmin Ltd., Olathe, Kansas, USA) was used. All the results were obtained at a frequency of 4Hz and sent to the inertial measurement unit. This band was located between the abdomen and the chest. Finally, all the data and results were extracted using SPRO software (v.990, RealTrack Systems, Almería, Spain) (Gómez-Carmona et al., 2020; Pino-Ortega et al., 2022).

Variables

During the study, the following variables were recorded to quantify and evaluate the IL and EL of the player. These variables were recorded during the matches. Therefore, the dependent variables selected were classified as follows: Demographic and Anthropometric Characteristics (Age, Height (cm) and Body Mass (Kg)); Kinematics EL (Distance(m)/min, Explosive distance (m)/min, Acceleration/min (n), Deceleration/min (n), High Speed Running (HSR) Abs (m)/min, Max. speed (km/h), Avg. speed (km/h)); Neuromuscular EL (Player load/min and Total impacts/min); and, Objective IL (HR peak (bpm, Avg. HR (bpm), Avg. HR 1st H (bpm) and Avg. HR 2nd H (bpm). On the other hand, to compare the variables, the player position was selected as an independent variable: GoalKeepers (GK), Central Defender (CD), MidFielders (MF), Wingers (Wg) and Forward (Fw).

In order to make the analysis and interpretation of the results easier, all the variables measured were normalised to the minute. To do this, the results of the variables were divided by the minutes played by each subject.

Statistical analysis

First of all, a descriptive analysis was performed for all analysed variables, including mean and standard deviation. Also, the database was revised to remove outliers and incomplete values.

Afterwards, a Shapiro-Wilk test was performed to analyse the data distribution, considering $p > 0.05$ as a normal distribution (Mohd Razali, 2011). All analysed data variables were non-normally distributed. A Kruskal–Wallis test was used to verify differences between groups. When significant differences were identified, multiple post hoc comparisons were conducted using Dunn's test with Bonferroni correction. Finally, the Effect Size (ES) was calculated using the epsilon squared value (ε^2) (Tomczak & Tomczak, 2014) and interpreted as follows: 0.01 = small effect; 0.06 = moderate effect; 0.14 = large effect, taking the proposal of Cohen's (Cohen, 2013).

All statistical analyses were performed using the SPSS software v. 29.0 (IBM, Chicago, IL, USA), and the significance level was set at $p \leq 0.05$ to reject the null hypothesis (Ho, 2013).

Results

Table 2 presents the data regarding comparisons between the player's position considering Demographic and Anthropometric Characteristics, Kinematics EL, Neuromuscular EL, and Objective IL variables. In the category of Demographic and Anthropometric Characteristics, there are statistically significant differences regarding the variables Height (p <0.001, ε^2 = 0.289) and Body Mass (p <0.001, ε^2 = 0.197), with GK athletes and CD showing the highest mean values for both variables.

In the category of Kinematics EL, only the variable Dec/min did not show statistically significant differences. Regarding Distance (m/min) (p <0.001; ε^2 = 0,383), the MF showed higher mean values (118.20±12.41) than all other positions, while GK had lower mean values (51.91±5.81). Significant differences were found in Explosive Distance (m/min) (p <0.001; ε^2 = 0.312) when comparing GK with the other positions. The lowest mean values were observed in GK (3.42 ± 0.73), and the highest mean values were observed in Fw (12.72 ± 1.76). For the variable Acc/min (p = 0.05; ε^2 = 0.045), significant differences were observed when comparing GK with de CD. GK athletes presented the highest mean values (34.99 ± 0.61), and CD presented the lowest mean values (30.83 ± 6.49). Significant differences were observed for the variable HSR Abs (m/min) (p < 0.001; ε^2 = 0.302) when comparing GK and Fw with all other positions. Regarding the Kinematics EL variables, GK showed the lowest values in Max. Speed

(km/h) (24.83 ± 1.61), and Avg. Speed (km/h) (3.99 ± 0.41). In contrast, MF obtained the highest values in Avg. Speed (km/h) (7.20 ± 0.37), and Wg in Max. Speed (30.19 ± 2.00).

In the Neuromuscular EL category, statistically significant differences were observed among the groups for all variables: PL/min (p <0.001; ε^2 = 0.285) and Total Impacts/min (p <0.001; ε^2 = 0.312). According to the PL, the lowest mean values were observed in GK (0.58 ± 0.10), and the highest mean values were observed in MF (1.75 ± 0.29). For the variable Total Impacts/min, MF (204.05 ± 29.67) exhibited the highest mean values and showed statistically significant differences compared to athletes from the other positions. In contrast, the GK were the players with the lowest number of impacts per minute (96.77 ± 13.60).

Finally, in the Objective IL category, statistically significant differences were observed for the variables Avg. HR (bpm) (p = 0.024; ε^2 = 0.062), Avg. HR 1st H (bpm) (p = 0.016; ε^2 = 0.070), and Avg. HR 2nd H (bpm) (p = 0.05; ε^2 = 0.042) when comparing GK with all the other positions. In the same line, the GKs were those who reflected the lowest values according to the Avg. HR.

Table 2. Comparisons between groups (playing positions) regarding the variables Demographic, Anthropometrics, Kinematics EL, Neuromuscular EL, and Objectives IL.

Variables		GoalKeepers		Central Defender		Wingers		MidFielder		Forward		p	H	ε^2	Post-hoc (Bonferroni)
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD				
Demographic and Anthropometric Characteristics	Age	26.20	6.22	22.19	2.60	23.07	3.38	24.93	6.07	24.50	4.25	0.315	4.74	0.006	
	Height (cm)	184.60	2.51	187.15	5.26	177.50	5.37	178.10	5.63	180.57	6.13	<0.001**	38.73	0.289	MF-CD (p=0.000) Wg-CD (p=0.000) Fw-CD (p=0.003)
	Body Mass (Kg)	77.60	2.19	79.56	5.86	72.45	5.54	71.96	5.89	72.65	5.93	<0.001**	26.81	0.197	MF-CD (p=0.000) Fw-CD (p=0.001) Wg-CD (p=0.001)
Kinematics EL	Distance (m)/min	51.91	5.81	100.43	6.55	107.18	12.36	118.20	12.41	111.45	10.91	<0.001**	48.37	0.383	GK-Fw (p=0.001) GK- MF (p=0.000) CD- Fw (p=0.002) CD- MF (p=0.000) Wg-MF (p=0.004)
	Explosive dist (m)/min	3.42	0.73	10.01	1.65	11.67	1.55	11,27	2,04	12.72	1.76	<0.001**	40.14	0.312	GK-Fw (p=0.006) GK-Wg (p=0.002) GK-Fw (p=0.000) CD-Fw (p=0.000)
	Acc/min (n)	34.99	0.61	30.83	6.49	34.66	8.17	33.01	7.06	32.75	8.89	0.05	9.21	0.045	
	Dec/min (n)	35.33	0.68	31.01	6.60	34.75	8.23	33.11	7.10	33.00	8.10	0.081	8.30	0.037	
	HSR Abs (m)/min	0.29	0.21	5.52	2.07	8.01	2.19	5.87	2.82	9.09	3.25	<0.001**	38.98	0.302	GK-CD (p=0.011) GK-Fw (p=0.001) GK-Wg (p=0.000)
	Max. speed (km/h)	24.83	1.61	29.79	1.89	30.19	2.00	27.92	2.05	29.33	1.75	<0.001**	29.42	0.219	GK-Fw (p=0.011) GK-CD (p=0.002) GK-Wg (p=0.000) MF-CD (p=0.028) MF-Wg (p=0.001)
	Avg. speed (km/h)	3.99	0.41	6.34	0.26	6.57	0.41	7.20	0.37	6.94	0.50	<0.001**	61.01	0.492	GK-Wg (p=0.049) GK-MF (p=0.000) GK-MF (p=0.000) CD-Fw (p=0.000) CD-MF (p=0.000) Wg-MF (p=0.000)
Neuromuscular EL	PL/min	0.58	0.10	1.33	0.28	1.56	0.25	1.75	0.29	1.63	0.23	<0.001**	37.11	0.285	GK-Wg (p=0.006) GK-Fw (p=0.001) GK-MF (p=0.000) CD-Fw (p=0.002) CD-Mf (p=0.000)
	Total impacts/min	96.77	13.60	173.38	23.96	182.05	27.22	204.05	29.67	170.58	15.84	<0.001**	40.23	0.312	GR-CD (p=0.033) GR-Wg (p=0.0055) GR-MF (p=0.000) Fw-MF (p=0.000) DC-MF (p=0.001) Wg-MF (p=0.026)
Objective IL	HR peak (bpm)	185.20	7.85	187.56	13.71	188.80	11.44	191.21	9.23	188.57	7.40	0.586	2.83	-0.010	
	Avg. HR (bpm)	145.00	2.74	161.22	16.22	160.42	11.87	162.89	29.59	162.83	9.90	0.024*	11.19	0.062	GK-Wg (p=0.037) GK-CD (p=0.019) GK-Fw (p=0.012) GK-MF (p=0.008)

	Avg. HR 1st H (bpm)	143.60	4.28	163.56	16.39	163.52	13.71	166.77	11.27	165.89	8.12	0.016*	12.14	0.070	GK-CD (p=0.013) GK-Wg (p=0.012) GK-Fw (p=0.015) GK-MF (p=0.009)
	Avg. HR 2nd H (bpm)	146.00	3.94	161.00	10.55	157.93	15.99	161.59	12.21	161.34	11.10	0.05	8.81	0.042	

EL: External Load; IL: Internal Load; Acc: Accelerations; Dec: Decelerations; HSR: High Speed Running; PL: Player Load; HR: Heart Rate; SD: Standard Deviation; *$p < 0.05$; **$p < 0.01$; ε^2: epsilon squared.

Discussion

The present study aimed to assess and compare IL and EL indicators among senior football players in Portugal, considering the player's position as an independent variable. This evaluation will provide relevant information related to the physical demands throughout the players' positions in the Portuguese football environment. The results confirm that playing position has a decisive influence on the physical and physiological demands of the game, which will affect the sports performance of the players. These findings are related to previous research highlighting the highly positional nature of physical performance in professional football (Modena & Schena, 2024; Slimani & Nikolaidis, 2017). Therefore, it is important to develop a program to evaluate and analyse the training and match load of the players during the season, in order to prevent overloading and the risk of injury.

Considering the anthropometric differences observed between positions are consistent with the traditional morphological profile in football. Goalkeepers and Central Defenders were significantly taller and heavier than the other players, which is consistent with studies highlighting the biomechanical advantage of these characteristics for actions such as aerial play, spatial coverage and protecting the penalty area (Toro-Román et al., 2023; Vega et al., 2020). Conversely, wingers and midfielders had lower values for height and body mass, a pattern associated with the need for agility, acceleration and frequent changes of direction (Villaseca-Vicuña et al., 2021). These anthropometric differences not only reflect natural selection processes for talent selection, but also functional adaptations derived from the specific demands of each player's position.

In terms of EL, midfielders were the players who covered the greatest distance per minute and achieved the highest average speeds. This finding is consistent with evidence describing the midfielder as the position with the greatest continuous involvement in the game, in both the attacking and defensive phases, which demands constant movement and high aerobic capacity (Altundağ, Yıldız, et al., 2025; Clemente et al., 2022). Explosive distance and HSR were higher among wingers and forwards, which is consistent with their tactical role focused on breakaway moves, running off the ball and rapid transitions (Modena et al., 2021; Palucci Vieira et al., 2019). These actions require a combination of maximum speed, acceleration and anaerobic power, which explains the higher values recorded for these positions. In this line, the study developed by Miguel et al. (2022) identified significant differences in the EL variables considering the playing positions, information that differs from the results of the present study, due to they identified that central defenders covered the highest distance during the matches. On the other hand, forwards developed the highest number of intensity decelerations. This information also differs from our results, because the forwards did not reflect the highest number of decelerations, obtaining lower values than the goalkeepers and wingers. However, they obtained very similar results to those positions. According to this, Sarmento et al. (2024), identified that midfielders, and defenders cover greater high-speed distance than forwards or central defenders, results which differ from the finding of the present study.

Goalkeepers showed the lowest values across all kinematic variables, which is consistent with studies describing their activity as predominantly static, involving short, explosive movements but little involvement in sustained running (Vladovic et al., 2023). Midfielders, for their part, showed intermediate values, with lower total distance and speed than attacking players, but with specific demands relating to short bursts of acceleration, one-on-one duels and marking high-speed movements (Pillitteri et al., 2023). Goalkeepers reported the lowest values, which is consistent with the literature describing their activity as highly intermittent and characterized by a predominance of technical actions over locomotor demands (Hernández-Beltrán et al., 2024; Tienza-Valverde et al., 2023).

The maximum speed achieved was significantly higher among wingers and forwards, which is consistent with research highlighting the importance of peak speed in decisive actions such as counterattacks, finishing and attacking duels (Morgans et al., 2025). Midfielders, although they recorded lower maximum speeds, compensated with a higher average speed, reflecting a more continuous pattern of activity that was less reliant on isolated bursts of speed.

In terms of neuromuscular load, midfielders and forwards reported the highest values considering PL and impacts per minute (1.75 ± 0.29 and 204.05 ± 29.67; and 1.63 ± 0.23 and 170.58 ± 15.84, respectively), because this position combines high intensity actions, predominantly a high number of changes of direction, contact and challenges (Alanen et al., 2023). Wingers also exhibited high neuromuscular loads, likely associated with repeated accelerations and duels on the flanks (Izquierdo et al., 2023). Forwards showed intermediate values, whilst midfielders exhibited lower loads, consistent with a more controlled movement pattern that is less reliant on repeated high-intensity actions. Differences across playing positions suggest that training and testing protocols in football could be enhanced to better match individual and position-specific needs.

The results from the IL showed significant differences between GK and the other positions, indicating that GK had the lowest values. With the aim of improving the physical fitness and technical factors of the goalkeepers, it is necessary to develop small-sided games with different constraints (Babic et al., 2018). On the contrary, no significant differences were detected between field positions. This pattern is consistent with studies indicating that heart rate is less sensitive to positional differences than external load metrics, as it depends more on relative effort than on the type of movement (Mäkiniemi et al., 2023; Panduro et al., 2022). The similarity between outfield positions suggests that, although locomotor demands differ, the overall physiological stress during the match tends to be comparable between attacking and defensive roles. However, goalkeepers obtained significantly lower values, which is to be expected given their reduced involvement in sustained actions and their predominantly technical profile (Kisilewicz et al., 2026).

Overall, the findings of this study reinforce the necessity of correct planning of training load and the importance of individualization in the fitness preparation. The inclusion of kinematics, neuromuscular, and cardiac variables allow the coaching staff a higher comprehension of sports performance and facilitates the decision-making of the performance manager.

Limitations

This study has certain limitations that should be borne in mind when interpreting the results. Firstly, an observational, cross-sectional design was adopted, which prevents the establishment of causal relationships between the variables analysed. Secondly, data collection took place over a short period (two weeks and a limited number of matches), which may not fully reflect the variability in performance throughout the entire season.

Furthermore, although the sample size is substantial, the distribution across playing positions is somewhat unbalanced (for example, a smaller number of goalkeepers), which could affect the comparability between groups. Moreover, contextual variables such as the match result, the opponent's standard or environmental conditions were not taken into account.

Strengths and future recommendations

One of the study's key strengths is the combined use of advanced technologies, which enabled a comprehensive analysis of external, internal and neuromuscular load under real competition conditions. Furthermore, the position-specific analysis provides highly relevant practical information for individualized training in football.

In the same line, the inclusion of multiple variables normalized per minute allows comparison of the performance of each player's position. As future research lines, it could be interesting to analyse a full season and evaluate the load changes over time. Also, to increase the information on contextual variables, match results, venue, match location, and opponent's level can be considered to develop a more

ecological analysis. Considering the analysis carried out of the IL, future studies can include more subjective variables such as rate of perceived exertion, wellness and biomarkers, such as lactate. These data could also support a separate correlational study examining the relationship between external and internal load.

Practical applications

From an applied perspective, these findings have direct implications for training design. Midfielders require training stimuli that combine aerobic endurance with a high density of neuromuscular actions. Wingers and forwards need training focused on maximum speed, acceleration and anaerobic power. Central defenders require specific strength work, one-on-one situations and short bursts of acceleration. Goalkeepers should focus on explosive movements, short positional shifts, and specific technical demands to improve their mobility and agility. Also, they have to focus on developing their technical abilities in low-visibility situations, with barriers or defenders near the goal.

Conclusions

The results of the study show that playing position has a significant influence on the physical, neuromuscular and physiological demands in senior football. Midfielders recorded higher values for distance covered and average speed, reflecting a high aerobic component, whilst wingers and forwards reported high-intensity actions such as sprints and explosive distance. In contrast, goalkeepers showed the lowest values for most of the variables analysed.

In terms of neuromuscular load, midfielders and forwards experienced greater demands due to a combination of changes of direction, impacts and high-intensity actions. However, IL, measured using the HR of the players, showed less discriminatory power between on-field positions, excluding goalkeepers, who reported the lowest values

These findings reinforce the importance of tailoring training planning to the specific position, integrating EL and IL variables to optimize performance and reduce the risk of injury.

Author Contributions

Conceptualisation, D.T. and R.P.; methodology, D.T. and R.P.; formal analysis, D.T. and R.P.; investigation, D.T. and R.P.; writing—original draft preparation, D.T., R.P. V.H.-B., J.M.G. and S.I..; writing—review and editing, D.T., V.H.-B., J.M.G. and R.P.; visualisation, D.T., V.H.-B., J.M.G. and R.P.; supervision, R.P., J.M.G and S.I.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of the University of Extremadura (Registration number 67/2017; 19th April 2017).

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The data are available upon request by contacting the corresponding author.

Conflicts of Interest

The authors declare no conflicts of interest.

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