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Physical training and external load management for young athletes
Entrenamiento físico y gestión de la carga externa para jóvenes deportistas

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Abstract. Football today is more intense and demanding than ever before and these increasing physical demands have a direct impact on grassroots players, leading to ever greater interest in determining the external load variables using GPS in lower categories. The objective of this study is to observe and analyse the mean figures for the variables Distance(m), High Acc(m) and High Dec(m), HSR Abs(m), HMLD(m) and MAX. Speed (km·h-1) per player aged 15, 16 and 17 based on their position in a competitive match. We also aim to determine if U16 players are able to compete in a U17 and U18 category team. A total of 57 male players, between 15 and 17 years old, participated in the study, divided by team corresponding to their age, and members of farm teams of a professional football club in the Community of Madrid. The results obtained for the mentioned variables show that some players could play at a higher category, specifically U16 Centre-Backs and Forwards and U17 Wing-Backs, Midfielders and Wingers. However, it must be noted that these results may be influenced by factors such as biological age of the players, the minutes of play, the style of play, the rival in the match, the pitch conditions and weather.
Keywords: Grassroots Football, External Load, GPS, Distance(m), High Acc(m)/Dec(m), HSR Abs(m), HMLD(m), MAX Speed(km·h^{-1})

Resumen: El fútbol actual es más intenso y exigente que nunca, este aumento de la exigencia física repercute directamente en los jugadores de fútbol base, lo que hace que cada vez sea mayor el interés por determinar las variables de carga externa mediante GPS en categorías inferiores. El objetivo de este estudio fue observar y analizar las cifras medias de las variables Distancia(m), Alta Acc(m) y Alta Dec(m), HSR Abs(m), HMLD(m) y Velocidad MAX (km-h-1) por jugador de 15, 16 y 17 años en función de su posición en un partido de competición. También pretendemos determinar si los jugadores sub-16 son capaces de competir en un equipo de categoría sub-17 y sub-18. Participaron en el estudio un total de 57 jugadores varones, de entre 15 y 17 años, divididos por equipos en función de su edad, y pertenecientes a equipos de un club de fútbol profesional de la Comunidad de Madrid. Los resultados obtenidos para las variables mencionadas muestran que algunos jugadores podrían integrarse en una categoría superior, concretamente los Centrales y Delanteros Sub16 y los Laterales, Centrocampistas y extremos Sub17. No obstante, hay que tener en cuenta que estos resultados pueden estar influenciados por factores como la edad biológica de los jugadores, los minutos de juego, el estilo de juego, el rival en el partido, las condiciones del terreno de juego y la climatología.
Palabras clave: Fútbol Base, Carga Externa, GPS, Distancia(m), Alta Acc(m)/Dec(m), HSR Abs(m), HMLD(m), Velocidad MAX (km-h-1)

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Introduction

Football is a highly technical-tactical team sport where the outcome of a match can turn on a single play or action (Santos, Caldeira Ferreira, Figueiredo & Cunha Espada, 2021). There are also constant fluctuations in the intensity of play (Coutts, et. al., 2015, cited in Muñiz, Giráldez, González, Romero & Campos, 2020), with significant variations in the performance demands on cardiovascular, neuromuscular and metabolic systems (Casas, 2008, cited in Geria Reines, 2021). The result is a highly demanding sport which requires players to act both individually and as a group simultaneously.

The physical training of football players is fundamental given that football is physically more intense and demanding than ever before. Players are required to run longer distances at levels beyond the high intensity threshold (Santos et. al., 2021; Valencia, 2023). One consequence is that these increasing demands have a direct impact on the lower categories of the sport. However, in the interests of fair competition, players of grassroots football in clubs are separated by age into different categories. For example, at the national level of grassroots football in Spain, the Royal Football Federation of Madrid (*Real Federación de Fútbol de Madrid)* divides players into the following categories: *Prebenjamín* (6-7 years), *Benjamín* (8-9 years), *Alevín* (10-11 years), *Infantil* (12-13 years), *Cadete* (14-15 years) and *Juvenil* (U16, U17 y U18). Football 7 has been introduced in the Community of Madrid up to the first-year *Alevín* category to adapt the physical demands of the game to younger categories of players (Castro, Cuenca & Villanueva, 2022).

It is important to note that changes in the conditions and format of play will place different physical and physiological demands on farm team players (Santos, et. al., 2021). At the professional level, players generally run between 9.5 and 12.5 km per match, of which some 220 to 1900 metres are at high speed (>19.8 km·h^{-1}) and some 200 to 500 metres are at a sprint (>25 km·h^{-1}) (Torregrosa Calabuig, 2022). By comparison, young players, between 10 and 18 years of age, generally run 4.5 to 7 km per match, with approximately 10% to 30% at high speed (Torregrosa Calabuig, 2022). Similarly, it has been observed that football players under 15 years of age run 6 to 8 km in official matches, with some 11% at over 16.1 km·h^{-1} and approximately 5% above 19 km-h^{-1} (Castillo, Raya, Clemente & Yanci, 2020). These figures may of course vary depending on different variables such as the specific position of the player, level of competition and the formation of play

(Oliva, Gómez, Pino, Moreno & Rodríguez, 2022).

For a clearer understanding of these figures, it should be noted that in sports there is a factor known as 'external load', which refers to the objective physical effort involved in sports training and competitions and matches (Valencia-Peña, 2022, Hernandez et al,. 2022). External load considers a number of parameters, including distance covered, top speeds, the number of accelerations and decelerations. (Valencia Peña, 2022¸Diaz, et al,. 2023).

In monitoring these variables, the use of the Global Positioning System (GPS) has become a standard methodology in quantifying external loads, including movements in line, changes in direction, etc, reliably and objectively (Dios-Álvarez, Suárez, Bouzas, Alkain, González & Ayán, 2021) and in real time (Sánchez Abselam, 2023). The margin of error in GPS monitoring in less than 1% in measuring the distances included above (Bonilla, Urrutia, Bustamante & Romero, 2023).

Considering the above, the principal aim of this work is to evaluate the external load of players between the ages of 15 and 17 by verifying the average distances covered (distance(m)), total metres in high intensity accelerations (High Acc(m) and decelerations (High Dec(m)), maximum speeds (MAX Speed ($km \cdot h^{-1}$)), and distance covered at high intensity (HSR Abs(m)) and high metabolic load distance (HMLD(m)). The following research questions are proposed (RQ):

RQ.1. What are the average measurements in terms of Distance(m), High Acc(m) and High Dec(m) and HSR Abs(m) for players aged 15, 16 and 17 according to their position in a competition match?

RQ.2. What is the average high metabolic load distance (HDML(m)) by position for players aged 15 to 17 participating in the study?

RQ.3. What is the average maximum speed reached by players aged 15, 16 and 17 in a match according to their age and position in the match?

RQ.4. Based on the results of the above, can a younger player compete on a team in a higher age category?

Method

Participants

A total of 57 male players, members of three teams part of a professional football club in the Community of Madrid, participated in the study. The players were aged from 15 (U16), 16 (U17) and 17 (U18) years of age, selected from a cadet category team and two Junior category teams. The cadet team is part of the "Superliga Cadete" division and the Junior teams from the "Autonómica Juvenil" and "Nacional Juvenil" divisions. To ensure confidentiality, all data was anonymised prior to analysis.

Instrument

The external loads were evaluated using GPS devices (WIMU PROTM), operating at a sampling frequency of 10 Hz. All GPS devices were stored in a customised storage case with capacity for 25 devices. The data was downloaded onto a PC and analysed using a personalised software package (WIMU SPRO version 990). The inertial device (WIMU PROTM) incorporates different sensors (four accelerometers, two gyroscopes, a magnetometer, a GPS chip and a UWB chip).

Variables of the Study

The GPS devices permit the monitoring of the following external load variables: first, distance(m), referring to the total distance covered by the player; second, High Acc(m) and High Dec(m), referring to the total distance covered in actions of high intensity acceleration and deceleration the magnitude could be 2 m/s2, 2,5 m/s/2, 3m/s2 or mare; third, HSR Abs (s), referring to the total distance covered at a speed above the absolute HSR threshold (by default, 21 km·h-1); fourth, MAX Speed ($km \cdot h^{-1}$), referring to the maximum speed reached by a player; the fifth and final variable is the HMLD(m), High Metabolic Load Distance, referring to the distance covered above a metabolic power threshold (by default, 25.5 $W \cdot kg^{-1}$).

Procedure

Prior to the pre-game warmup, the GPS devices were activated, allowing them to synchronise correctly with the GPS signal. After the player warmup session, the devices were fitted into a vest worn under the player's uniform and activated to record continuously. At the end of the match, the devices were collected and deactivated in the storage case. The data was later extracted using SPRO software, with cuts made corresponding to the match and exported to an Excel file for analysis using the PowerBi and Jamovi applications.

Statistical Analysis

Considering the research questions proposed at the start of this work, the data was analysed using the Jamovi tool (version 2.3). First, a descriptive analysis was conducted to determine the mean scores for the variables. A Levene test was performed to check the homogeneity of the variances and, depending on the results, the Fisher's one-way ANOVA for equal variances and the Welsh's ANOVA for different variances. For scores below 0.05 (typified value) a Tukey test (equal variances) and Games-Howell test (different variances) were made to identify the groups between which there were significant differences for each variable. Finally, a Shapiro-Wilk normality test was used in which for variables without differences in normal distribution Pearson's correlation was applied, and those with differences in normal distribution Spearman correlation was used to determine the relation between these variables. It is important to note that this procedure was carried out for each of the different positions of the players.

Results

The results of the study are provided in the Tables be-

low. Table 1 presents the mean scores for the variables Distance(m), High Acc(m), High Dec(m) and HSR Abs(m). Table 2 presents the mean scores for the variable HMLD(m) *Table 2*. Table 3 shows the mean scores for the variable MAX Speed (km·h^{-1}). Table 4 presents a comparison between groups by positions and finally, Tables 5 and 6 present the relations between all the variables.

Table 1.
Mean scores for the variables Distance(m), High Acc(m), High Dec(m) and HSR Abs(m)

Tukey Post-Hoc Test – Centrals					
			U16	U17	U18
High Dec(m)	U16	Difference in mean	—	98.7	-16.9
		p-values	—	0.005	0.849
	U17	Difference in mean		—	-115.6
		p-values		—	0.002
	U18	Difference in mean			—
		p-values			—

Note: High Dec(m) = high intensity deceleration

Table 1, referring to RQ1, shows that U16 and U18 Centrals, in terms of Distance(m) per match, had the highest mean scores compared to all other positions on the same teams (7,232 m and 8,530 m). For U17, the longest mean distances(m) were for Full-backs (9,230 m), higher than the rest of the teams. The positions covering the least Distance(m) for each team were: U16 Wingers (3,930 m), U17 Forwards (5,103 m) and U18 Full-backs (5,818 m).

For the variable High Acc(m), the highest figures were for the U17 Full-backs (402 m). Additionally, the results show that U16 Forwards (266 m) and U18 Forwards (359 m) had the highest mean scores for their respective teams. The lowest mean scores were for U16 Mid-fielders (161 m) and U18 Mid-fielders (247 m) and U17 Centrals (297 m).

The results for High Dec(m) indicate the highest values for U16 Centrals (297 m), U18 Wingers (350 m) and U17 Full-backs (301 m), with these last showing the highest mean scores for all groups. The lowest figures were for U16 Mid-fielders (188 m) and U18 Mid-fielders (283 m) and U17 Centrals (198 m).

For the variable, HSR Abs(m), the highest mean figures for all teams were for U17 Full-backs (607 m). The highest values for each of the teams were seen with the Forwards in both U16 (385 m) and U18 (563 m). The lowest values were found with U16 Mid-fielders (190 m) and U17 Mid-fielders (279 m) and with U18 Centrals (317 m).

Table 2.
Mean scores for the variable HMLD(m)

Games-Howell Post-Hoc Test – Full-backs					
			U16	U17	U18
Distance(m)	U16	Difference in mean	—	-3509	-96.1
		p-values	—	0.001	0.996
	U17	Difference in mean		—	3412.8
		p-values		—	0.004
	U18	Difference in mean			—
		p-values			—
High Acc(m)	U16	Difference in mean	—	-140	-70.8
		p-values	—	0.022	0.515
	U17	Difference in mean		—	69.1
		p-values		—	0.475
	U18	Difference in mean			—
		p-values			—
High Dec(m)	U16	Difference in mean	—	-143	-75.6
		p-values	—	0.031	0.375
	U17	Difference in mean		—	67.1
		p-values		—	0.528
	U18	Difference in mean			—
		p-values			—
HSR Abs(m)	U16	Difference in mean	—	-292	-106
		p-values	—	0.001	0.381
	U17	Difference in mean		—	186
		p-values		—	0.083
	U18	Difference in mean			—
		p-values			—
HMLD(m)	U16	Difference in mean	—	-734	-234
		p-values	—	0.003	0.572
	U17	Difference in mean		—	500
		p-values		—	0.082
	U18	Difference in mean			—
		p-values			—

Note: Distance(m) = total distance/ High Acc(m) = high intensity acceleration/ High Dec(m) = high intensity deceleration/ HSR Abs(m) = distance at absolute high intensity/ HMLD(m) = High metabolic load distance

Table 2, referring to RQ2, shows that U17 Full-backs the highest values (1,760 m) for HMLD(m) out of all players participating in the study, followed by U17 Mid-fielders (1,602 m) and U18 Forwards (1,446 m). The highest values for the U16 team were for Centrals (1,162 m). The lowest figures for HMLD(m) correspond to U16 Wingers and Mid-fielders (757 m and 872 m). Finally, for the U17 and U18, the lowest figures were for the Forwards (1,028 m) and Wingers (1,238 m).

Table 3.
Mean scores for the variable MAX Speed (km·h^{-1})

Tukey Post-Hoc Test – Wingers					
			U16	U17	U18
Distance(m)	U16	Difference in mean	—	-2812	-2288
		p-values	—	< .001	0.014
	U17	Difference in mean		—	524
		p-values		—	0.645
	U18	Difference in mean			—
		p-values			—
High Dec(m)	U16	Difference in mean	—	-99.6	-153.7
		p-values	—	0.036	0.002
	U17	Difference in mean		—	-54.0
		p-values		—	0.242

Table 3.
Mean scores for the variable MAX Speed (km·h^{-1})

Tukey Post-Hoc Test – Wingers					
			U16	U17	U18
	U18	Difference in mean			—
		p-values			—
	U16	Difference in mean	—	-95.2	-194.1
		p-values	—	0.186	0.005
HSR Abs(m)	U17	Difference in mean		—	-98.9
		p-values		—	0.071
	U18	Difference in mean			—
		p-values			—
	U16	Difference in mean	—	-534	-481.2
		p-values	—	< .001	0.008
HMLD(m)	U17	Difference in mean		—	52.9
		p-values		—	0.891
	U18	Difference in mean			—
		p-values			—

Note: Distance(m) = total distance/ High Acc(m) = high intensity acceleration/ HSR Abs(m) = distance at absolute high intensity/ HMLD(m) = High metabolic load distance.

Table 3, referring to RQ3, shows the highest mean speed for each position. Wingers scored the highest of all positions. In the case of U16, the results show that both Forwards and Wingers had the highest speeds (29.6 km·h^{-1}) on the team. U17 Wingers had a mean speed of 30.7 (km·h^{-1}) and U18 Wingers 30.8 (km·h^{-1}). The lowest speeds for each of the teams were for U16 Mid-fielders (26.6 km·h^{-1}) and U17 (28,0 km·h^{-1}) and U18 Centrals and Mid-fielders (28.7 km·h^{-1}).

Table 4.
Comparison of the Groups

Tukey Post-Hoc Test – Forwards					
			U16	U17	U18
	U16	Difference in mean	—	39.4	-93.1
		p-values	—	0.592	0.093
High Acc(m)	U17	Difference in mean		—	-132.6
		p-values		—	0.017
	U18	Difference in mean			—
		p-values			—
	U16	Difference in mean	—	41.1	-80.2
		p-values	—	0.489	0.108
High Dec(m)	U17	Difference in mean		—	-121.3
		p-values		—	0.014
	U18	Difference in mean			—
		p-values			—
	U16	Difference in mean	—	-12.0	-430
		p-values	—	0.995	0.014
HMLD(m)	U17	Difference in mean		—	-418
		p-values		—	0.018
	U18	Difference in mean			—
		p-values			—

Note: High Acc(m) = high intensity acceleration/ High Dec(m) = high intensity deceleration/ HMLD(m) = High metabolic load distance

With regards to RQ4, the results show significant differences between at least 2 of the 3 teams in certain variables for each position. *Table 4* shows significant differences for Wingers in the variable Distance(m) between team U16 and teams U17 and U18. However, there are no differences between teams U17 and U18. The same is the case for the variables High Dec(m) and HMLD(m). The third variable shows only significant differences between the teams U16 and U18.

In the case of Forwards, there are significant differences between the U17 and U18 teams or the variables HSR Abs(m), HMLD(m), High Dec(m) and High Acc(m). Furthermore, there are significant differences for team U16 in HMLD(m) compared to U18. There were no other significant differences between the teams in other variables.

For Mid-fielders, the figures for Distance(m), High Acc(m), High Dec(m) and HMLD(m) all show significant differences between the U16 and the U17 and U18 teams. Equally, in HSR Abs(m) and MAX Speed (km·h^{-1}), differences were found only between the U16 and U18 teams, with these differences being appreciable between the three teams. The results for Full-backs show significant differences between the U16 team and U17 team in Distance(m),

High Acc(m), High Dec(m), HSR Abs(m) and HMLD(m). Differences were also seen in the variable Distance(m) between the U17 and U18 teams.

For the Centrals, the only variable showing any significant differences is High Dec(m) which shows differences between the team U16 and U17 and between the Centrals of U17 and U18.

Table 5.
Correlation between Variables

Correlation Matrix of Variables Distance(m), High Acc(m), MAX Speed (km·h^{-1}) & HMLD(m) - Centrals					
		Distance(m)	High Acc(m)	MAX Speed (km·h^{-1})	HMLD(m)
Distance(m)	Spearman's R	—			
	p-values	—			
High Acc(m)	Spearman's R	0.585	—		
	p-values	< .001	—		
MAX Speed (km·h^{-1})	Spearman's R	0.402	0.504	—	
	p-values	< .001	< .001	—	
HMLD(m)	Spearman's R	0.771	0.737	0.479	—
	p-values	< .001	< .001	< .001	—

Note: Distance(m) = total distance/ High Acc(m) = high intensity acceleration/ MAX Speed (km·h^{-1}) = Maximum speed / HMLD(m) = High metabolic load distance

Table 6.
Correlation between Variables

Correlation Matrix of Variables High Acc(m), High Dec(m), MAX Speed (km·h^{-1}) & HMLD(m) - Mid-fielders					
		High Acc(m)	High Dec(m)	MAX Speed (km·h^{-1})	HMLD(m)
High Acc(m)	Pearson's R	—			
	p-values	—			
High Dec(m)	Pearson's R	0.838	—		
	p-values	< .001	—		
MAX Speed (km·h^{-1})	Pearson's R	0.355	0.419	—	
	p-values	< .001	< .001	—	
HMLD(m)	Pearson's R	0.855	0.939	0.410	—
	p-values	< .001	< .001	< .001	—

Note: High Acc(m) = high intensity acceleration/ High Dec(m) = high intensity deceleration/ MAX Speed (km·h^{-1}) = Maximum speed / HMLD(m) = High metabolic load distance

As shown in *Table 5* and *Table 6*, the results show a significant positive correlation for all other positions, which indicates that the higher the value of one variable the higher the value of the others. For example, in the case of Distance(m) for U17 Full-backs U17, a p-value above the mean (9,230 m) corresponds to a higher value for all other variables for this group.

Discussion

The aim of this study was to respond to the four research questions presented in the introduction. RQ1 refers to mean figures in terms of Distance(m), High Acc(m) and High Dec(m) and HSR Abs(m) and the results show that U17 Full-backs are the players who cover the greatest distances, have the most acceleration and cover the most metres at high intensity. These are also the players with the most decelerations after U18 Wingers. Similarly, it is important to take into account the style of play of each team in considering the results. For example, the maximum speed of a player in a match and other variables, are largely determined by the tactical needs of play at any given moment (Méndez-Villanueva et. al., 2011 cited in Villanueva, Cuenca, Farfan, Castro & Rodríguez, 2022). Thus, the U17 team has a style of play in which the Full-backs act as wing-backs, accounting for the highest figures in the mentioned variables.

For RQ2, referring to the mean scores for HDML(m) by team position, the results are similar to RQ1 where U17 Full-backs, U!7 Mid-fielders and U18 Forwards show the highest values in that order. Thus, apart from the influence of tactics on these figures, we can also refer to both the category and the general idea of the game since the U18 team, being in a higher division, may have opted for a more conservative model of play compared to U17, which has a more competitive style of play.

The results obtained in considering RQ3 indicate that U18 Wingers and Forwards, along with U17 Wingers and Full-backs show mean speed of above 30 km·h^{-1}, with the rest of positions showing similar speeds. However, the U16 team, in this and other variables, is generally a rank below the other two teams. This may be due to the duration of Junior matches, 90 minutes compared to the 80-minute cadet matches.

For RQ4 comparing the results obtained from the other research questions, it is important to differentiate between biological maturity and chronological age. Biological maturity refers to age as defined by the processes of maturation, while chronological age refers to the years, months and days since birth. Clearly, it is possible to find differences in biological maturity among individuals of the same chronological age (Lopes-Machado & Barbanti, 2007 cited in Torregrosa Calabuig, 2022). With this in mind, we can

find a team of adolescent players of the same age with significant physical differences, with a likely greater athletic performance among those with greater biological maturity compared to their less developed teammates. Thus, it is possible that some players have the physical capacity to play at a higher category due to their biological maturity. There may also be other factors which influence the data provided by the players, such as the encouragement or demands of a rival, the type of terrain, weather, actual time on the pitch, etc.

Also of note is the significant and positive correlation between the variables, suggesting a direct relation with the number of minutes played. Players in 90 minutes matches, compared to 80-minute cadet matches, will have more time to cover more distance than other players who are on the pitch for shorter periods and thus influencing the rest of the variables.

Finally, as noted above and in line with a study by Buchheit et al, and cited in a 2022 study by Torregrosa, football players between the ages of 10 and 18 cover an average of 4.5 to 7 km in a 60-to-90-minute match Studies have also explored the variables of external load in professional players and those of lower categories. One example is the study by Valencia Peña (2022), citing a systematic review by Palucci Vieira et al. in 2019, which noted that older players generally have an external load which are higher than those of younger players, with players between the ages of 12 and 16 covering an average of 6,000 metres. Studies by Dellal et al (2010-2011), noted in the work of Erkizia Aguirre (2021), a professional player in the Spanish League may cover an average of 10,496 m per match, some 549 m of this at high speed and 260 m at a Sprint. Thus, if we compare the results of the mentioned studies with those of this research we see that U16 players show similar results. However, U17 and U18 players showed figures which are approaching those of professional categories. These results suggest that grassroots football is becoming increasingly professionalised.

Conclusion

The results of this study show that U17 Full-backs have the highest values in Distance(m) (9230m), High Acc(m) (402m), HSR Abs(m) (607m) and HMLD(m) (1,760m) and U18 Wingers in High Dec(m) (350m) and MAX Speed($km \cdot h^{-1}$) (30.8 $km \cdot h^{-1}$). One conclusion to be drawn is the important role of the physical trainer in grassroots football, especially considering the influence of the growing professionalisation of these lower categories. Generally speaking, lower level farm teams do not have a physical training on staff, and training is usually organised by persons without any specialised training or qualification for this role, often being minors themselves. It is therefore important that trainers at the grassroots level have skills and knowledge not only of tactical-technical aspects but of sports training in order to plan personal training and manage external loads according to the level of the players. Thus, considering that the cadet and juvenile categories are generally those most considered farm teams for professional categories, the skill of trainers at this level, and the correct planning of training by clubs in developing younger players could facilitate the step towards higher categories and eliminate the prevalence of injuries. Further research in this area could offer greater information on the demands players are subject to in different categories and stages of development.

Limitations

With regards to the limitations of the present work, it should be noted that the data collected is absolute, without taking into consideration the actual playing time of the players in each match. Taking this factor into account may have offered more accurate data for the purposes of the study. Equally, other factors which are impossible to control may influence the results, such as the weather conditions during play, the type of surface on which the match was played, the physical size of the pitch and the internal load of each of the players.

Future Lines of Research

Considering the limitation of the present study, future research should continue collecting and analysing comparative data on lower categories of sport. It would also be interesting to add the factor of internal loads of players given that the feedback from players to trainers, both in match play and training, is as important as the objective data gathered through GPS devices. It is recommended to carry out an evaluation of the external load in training, thus comparing whether the intensity of the training has transfer in the matches.

Finally, these recommendations should also be applied to female football which has become increasingly professionalised and should be given the attention it deserves.

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Annexes

Games-Howell Post-Hoc Test – Forwards

			U16	U17	U18
HSR Abs(m)	U16	Difference in mean	—	96.5	-178
		p-values	—	0.114	0.114
	U17	Difference in mean		—	-275
		p-values		—	0.009
	U18	Difference in mean			—
		p-values			—

Note: HSR Abs(m) = distance at absolute high intensity

Correlation Matrix of Variables High Dec(m) & HSR Abs(m) – Centrals

		High Dec(m)	HSR Abs(m)
High Dec(m)	Pearson's R	—	
	p-values	—	
HSR Abs(m)	Pearson's R	0.775	—
	p-values	< .001	—

Note: High Dec(m) = high intensity deceleration/ HSR Abs(m) = distance at absolute high intensity

Correlation Matrix of Variables Distance(m) & HSR Abs(m) - Mid-fielders

		Distance(m)	HSR Abs(m)
Distance(m)	Spearman's R	—	
	p-values	—	
HSR Abs(m)	Spearman's R	0.492	—
	p-values	< .001	—

Note: Distance(m) = total distance/ HSR Abs(m) = distance at absolute high intensity

Variable Correlations Table – Wingers

Correlation Matrix of Variables Distance(m), HSR Abs(m) & MAX Speed (km·h^{-1}) - Wingers

		Distance(m)	HSR Abs(m)	MAX Speed (km·h^{-1})
Distance(m)	Spearman's R	—		
	p-values	—		
HSR Abs(m)	Spearman's R	0.680	—	
	p-values	< .001	—	
MAX Speed (km/h)	Spearman's R	0.432	0.582	—
	p-values	< .001	< .001	—

Note: Distance(m) = total distance/ HSR Abs(m) = distance at absolute high intensity / MAX Speed (km·h^{-1}) = Maximum speed

Correlation Matrix of Variables High Acc(m), High Dec(m) & HMLD(m) - Wingers

		High Acc(m)	High Dec(m)	HMLD(m)
High Acc(m)	Pearson's R	—		
	p-values	—		
High Dec(m)	Pearson's R	0.903	—	
	p-values	< .001	—	
HMLD(m)	Pearson's R	0.898	0.964	—
	p-values	< .001	< .001	—

Correlation Matrix of Variables Distance(m), HSR Abs(m) & MAX Speed (km·h^{-1}) - Wingers

		Distance(m)	**HSR Abs(m)**	**MAX Speed (km·h^{-1})**

Note: High Acc(m) = high intensity acceleration/ High Dec(m) = high intensity deceleration/ HMLD(m) = High metabolic load distance

Variable Correlations Table – Forwards

Correlation Matrix of Variables Distance(m), High Acc(m), HSR Abs(m) & MAX Speed (km·h^{-1})

		Distance(m)	**High Acc(m)**	**HSR Abs(m)**	**MAX Speed (km·h^{-1})**
Distance(m)	Spearman's R	—			
	p-values	—			
High Acc(m)	Spearman's R	0.903	—		
	p-values	< .001	—		
HSR Abs(m)	Spearman's R	0.710	0.922	—	
	p-values	< .001	< .001	—	
MAX Speed (km·h^{-1})	Spearman's R	0.439	0.540	0.561	—
	p-values	< .001	< .001	< .001	—

Note: Distance(m) = total distance/ High Acc(m) = high intensity acceleration/ HSR Abs(m) = distance at absolute high intensity / MAX Speed (km·h^{-1}) = Maximum speed

Correlation Matrix of Variables High Dec(m) & HMLD(m)

		High Dec(m)	**HMLD(m)**
High Dec(m)	Pearson's R	—	
	p-values	—	
HMLD(m)	Pearson's R	0.923	—
	p-values	< .001	—

Note: High Dec(m) = high intensity deceleration/ HMLD(m) = High metabolic load distance