Demonstration of mechanical and physiological variables in professional football matches

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Abstract.

The main objective of this study was to show the data obtained through a system of controlling the load-based GPS technology, for mechanical and physiological variables analyzed, obtained during the friendly games made by a professional 1st division Spanish football team during the 2007-08 season. The second objective in this study was to show the differences in these variables analyzed by the positions of the field players. They have been monitored 21 field professional players (28 ± 3.8 years old, 179 ± 4.5 cm, 75.2 ± 4.2 kg; VT2 Speed: 13.8 ± 0.6 km / h, HR at VT2 : 174 ± 10.8 p / m; aerobic Top speed: 18.6 ± 1 mph, HR Maximum: 192 ± 8.1 p / m) of the first team of a professional football club from the Spanish 1st Division League (season 2007-08). We have used 10 Spi Elite units with GPS receiver, triaxial accelerometer and integrated HR chip receiver (GPSports Systems Pty.. Ltd., 2003, Australia). Based on the results we concluded that: A) It is very useful the use of technologies that allow us to comprehensively monitor the player. B) The variables used are an important aid to control the conditional player performance during a game and in the individualization of the training process. C) It is important to have individualized references data obtained during games to control each player training.

Introduction.

Several studies have provided data on physical and physiological demands of football matches (Withers et al., 1982; Ekblom, 1986; Bangsbo et al., 1991; Reilly, 1996; Ohashi et al., 2002; Di Salvo et al. 2006; Zubillaga, A. 2006), using different technologies increasingly advanced and accurate. It is not until very recently that we have global (GPS) and local (LPS) positioning systems sufficiently precise, with specific software for analysis, so that the analysis of these requirements is much more comprehensive and adjusted.

In order to have a starting point in addressing collective and individual demands of the competition on the professional football player, as well as control of training loads, we have been using for two seasons 10 control units Spi Elite (GPSports, Australia)-based GPS technology with embedded HR control, as well as triaxial accelerometer.

This systematic use both in training and in all friendly games made, has enabled us to collect individualized information from each monitored player, allowing us to observe and monitor how each player performs with the demands made by these games and training sessions,

enabling greater control over both individual and collective competitive loads and session and microcicle loads.

Following are the synthesis of data from all friendly games in the 2007-08 season, that serve us as a benchmark for assessing the adequately training load expressed by each player in different weeks, training sessions and tasks.

The main objective of this study was to show the data obtained through load control based GPS technology system, for the mechanical and physiological variables analyzed, obtained during the friendly games played by a professional Spanish 1st division football team during the 2007-08 season. The second objective in this study was to show the differences in these variables when analyzed by the positions of the field players.

Material and methods.

Subjects.

They have been monitored 21 field professional players (28 ± 3.8 year old, 179 ± 4.5 cm, 75.2 ± 4.2 kg; VT2 Speed: 13.8 ± 0.6 km / h in HR VT2 : 174 ± 10.8 b / m; maximal aerobic speed: 18.6 ± 1 km/h, HR Maximum: 192 ± 8.1 b / m) of the first team of a professional football club from the Spanish 1st Division (season 2007-08), getting a total of 144 entries.

The analized games have been played during the preseason (7 matches) and along the first part of the championship (4 games), against rivals of varying competitive level (regional and up to Spanish. Italian and Portuguese 1st division).

We have removed all records in which it has been detected any anomaly related to data acquisition (HR or accelerometer). Likewise we have taken into account for this analysis only records for the players who participated in complete halfs of the game (first and / or second part). The data presented are ½ game time.

Material

We have used 10 Spi Elite units with GPS receiver, accelerometer and triaxial receiver chip with integrated HR (GPSports Systems Pty.. Ltd., 2003, Australia), collecting information regarding heart rate (HR), position, distance, speed and acceleration. This device has an approximate weight of 75 grams, is being placed on the back along with a chest belt to receive the HR, allowing the registration data at 1 hz.

The data obtained have been downloaded on a laptop computer and processed by software GPSports Team V1.2.1.12 AMS.

Variables for load control

The first variable included is the mean time period of each game for ½ whole part (interval).

We have analyzed each player HR identifying baseline data regarding the maximum HR obtained in a stress test conducted in treadmill with gas analysis, and corroborated by data obtained during matches and training sessions. 6 HR control zones have been established, which are as follows: <60% HRmax, 60-70% HRMax, 70-85% HRmax, 85-90% HRMax, 90-95%

HRmax, > 95% HRmax. We have included a variable that is the time in which each player shows a HR >85% HRmax as a parameter of high intensity HR (summation of the zone 4, 5 and 6).

We have analysed the total distance and the distances covered by each player depending on the speed, identifying data regarding the speed of ventilatory threshold VT2 and the maximum aerobic speed (VMA) obtained in a stress test done with a treadmill gas analysis, and the maximum speed shown by each player in any game or workout controlled. 6 control zones have been established based on individual velocity, and are as follows: 0-6 km/h (data standard for all players), 6 km/h to VT2 speed, VT2 speed to VMA, VMA to half between VMA and 80% of the individual maximum speed expressed (MaxSp), half between VMA and 80% of MaxSp to 80% of MaxSp, >80% of the Vmax. We have included a variable that is the distance travelled by each player above the value of their individual VMA as a parameter of distance travelled at high intensity (summation of zones 4, 5 and 6).

Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
0-60% HRMax	60-70% HRMax	70-85% HRMax	85-90% HRMax	90-95% HRMax	>95% HRMax
0-6 km/h	6-V VT2	V VT2-VMA	VMA-50% VMA y 80% MaxSp	50% VMA y 80% MaxSp-80% MaxSp	>80% MaxSp
0-6 km/h	6-14 km/h	14-18 km/h	18-21 km/h	21-24 km/h	>24 km/h

Table 1. Load control zones. The latest row is an example of the speed corresponding a player with VT2 V = 14 km/h, VMA = 18 km/h and MaxSp = 30 km/h.

We have included the values of average and maximum HR obtained during the interval analyzed, as well as the values of average speed (AvSp) and maximum speed (MaxSp) for the same period.

We also analyzed the number of times each player reaches the speed zone 6 (nº MaxSp), and the number of times each player reaches what would be the same zone 6 but for the acceleration (Nº Amax); this value is not individualized regarding the maximum individual acceleration as the software still does not facilitate the identification of areas regarding the acceleration values obtained. The process to obtain this value has been done conducting a prior study to obtain the maximum acceleration data of each player, both through specific test, matches and in training, and make the average for the team. From here, we identifie the value of the area of analysis for the Amax.

Finally we include two variables: the first is the number of times that there is an acceleration exceeding 1 m/s2 (Nº A1 actions); this is a value that allows us to identify all accelerations relating to actions that may represent a minimally important muscle implication for the player; the second is the result of dividing the interval time between the number of actions, that show us the average time between the beginning of each action for each player (rhythm).

Statistical analyses.

We have calculated the average values and its standard deviation, as well as the highest and lowest ranks (in brackets) for each of the analyzed variables.

We also present average line values (defenses, midfielders and strikers) and position values (fullback, central back, pivots or centre midfielders, wingers and forwards or strikers) in the corresponding comparative tables.

Results.

Interval

The average length of each game time analyzed is 46:07±00:30,8 minutes (46:58,6 - 45:18 minutes) (Table 2).

Speed and acceleration

The average of the average speed has been 6,7±0,6 km/h (7,9 – 5,7 km/h), while the average of the maximum speeds achieved during games was 27,6±1,9 km/h (31,2 – 23,7 km/h) (Table 2).

As for the average number of times each player has a considered maximum speed (over 80% of the individual maximum speed), the result was 3,2 ± 1,8 times (7 – 0,9 times) .

We include in this section the average number of times each player shows an acceleration regarded as maximum (over 80% of the average maximum acceleration of the team), being the values obtained as follows: 2,6 ± 1,2 times (4,6 – 0,4 times).

The average number of accelerations with a value greater than 1m/s ² or nº of actions, is 114±15 actions (145 - 92); when relating these data with the value of the interval time, we get the average time between the beginning of individual actions, which we call rhythm, being the result of 24,9±3,3 s (30,1 – 18,9 s) (Table 2).

	Interval	AvSp	MaxSp	Nº MaxSp	Nº MaxA	Nº Actions	Rhythm
Average	46:07	6,7	27,6	3,2	2,6	114	24,9
SD	00:30,8	0,6	1,9	1,8	1,2	15	3,3
Max	46:58,6	7,9	31,2	7	4,6	145	30,1
Min	45:18	5,7	23,7	0,9	0,4	92	18,9

Table 2. Values for the average, SD, maximum and minimum of the showed variables: interval (minutes), AvSp (km/h), MaxSp (km/h), Nº MaxSp, Nº MaxA, Nº actions, Rhythm (seconds).

Next (tables 3 and 4) we show the average values distributed by lines and positions.

	Interval	AvSp	MaxSp	Nº MaxSp	Nº MaxA	Nº Actions	Rhythm
Defenses	46:14	6,1	27,4	2,2	2,2	111	25,8
Midfielders	46:07	7,1	27	3,1	2,4	122	23,2
Forwards	45:58	6,7	29,8	4,6	3,4	103	27,2

Table 3. Averages by lines (units of measurement equal to table 2).

	Interval	AvSp	MaxSp	Nº MaxSp	Nº MaxA	Nº Actions	Rhythm
Full backs	45:58	6,4	28,0	2,0	2,8	117	24,5

Central Backs	46:29	5,9	26,8	2,4	1,7	105	27,2
Pivots	45:59	7,0	25,4	2,1	1,4	123	23,3
Wingers	46:17	7,2	29,1	4,5	3,8	121	23,2
Strikers	45:58	6,7	29,8	4,6	3,4	103	27,2

Table 4. Averages for positions (units of measurement equal to table 2).

Distance

The average value of the distance travelled along one half of a match is 5107±460,2 m (6062,1 – 4421,6 m).

Moreover the values for the distance in each of the established zones, as well as the distance travelled over the individual VMA are as follows: distance in Zone 1: 1720±135,1 m (2009,9 - 1496,7 m); distance in Zone 2: 2305±372,4 m (3218,8 – 1749,6 m); distance in Zone 3: 726±218,4 m (1133,7 – 384,7 m); distance in Zone 4: 213±70,7 m (342,4 – 96,6 m); distance in Zone 5: 99±49,0 m (237,1 – 31,0 m); distance in Zone 6: 45±29,2 m (101,4 – 10,6 m); distance above the individual VMA (sum of the zones 4, 5 and 6): 356±137,9 m (674,7 – 164,7 m) (Table 5).

	Distance	Dist. Z1	Dist. Z2	Dist. Z3	Dist. Z4	Dist. Z5	Dist. Z6	Dist. >VMA
Average	5107	1720	2305	726	213	99	45	356
SD	460,2	135,1	372,4	218,4	70,7	49,0	29,2	137,9
Max	6062,1	2009,9	3218,8	1133,7	342,4	237,1	101,4	674,7
Min	4421,6	1496,7	1749,6	384,7	96,6	31,0	10,6	164,7

Table 5. Values for the average, SD, maximum and minimum of variables presented: Total distance, distance in each of the 6 zones and distance over the individual VMA (all units in meters).

We include below (tables 6 and 7) the average values distributed by lines and positions.

	Distancie	Dist. Z1	Dist. Z2	Dist. Z3	Dist. Z4	Dist. Z5	Dist. Z6	Dist. >VMA
Defenses	4727	1726	2195	530	175	71	30	276
Midfielders	5440	1680	2508	894	217	98	43	358
Forwards	5105	1800	2073	694	295	166	76	538

Table 6. Averages by lines (units of measurement in meters).

	Distance	Dist. Z1	Dist. Z2	Dist. Z3	Dist. Z4	Dist. Z5	Dist. Z6	Dist. >VMA
Full backs	4880	1700	2325	550	191	86	27	305
Central Backs	4573	1753	2065	509	158	55	33	247
Pivots	5365	1659	2556	891	167	68	23	259
Wingers	5533	1706	2447	897	280	136	67	483
Strikers	5105	1800	2073	694	295	166	76	538

Table 7. Averages for positions (units of measurement in meters).

Heart Rate

The average value of the average HR shown by the players is 160±6,7 bpm (173 - 150 bpm), while the value of the HRmax is 189±6,1 bpm (201 – 180 bpm) .

Moreover values for the time during which each player is in each of the established HR zones, as well as times when the HR is over 85% of the individual HRmax, are as follows: time in Zone 1: 00:52±00:47,2 minutes (03:05,0 - 00:00 minutes); time in Zone 2: 04:13±02:54,3 minutes (11:40,9 - 00:05,5 minutes); time in zone 3: 19:42±05:00,6 minutes (28:35,4 - 09:21,5 minutes); time in zone 4: 11:54±3:44,8 minutes (24:09,0 - 05:06,3 minutes); time in zone 5: 07:58±03:45,4 minutes (15:50,8 - 02:05,4 minutes); time in zone 6: 01:26±02:04,6 minutes (09:06,3 - 00:00 minutes). Time over 85% of the individual HRmax (sum of the zones 4, 5 and 6): 21:18±06:38,6 minutes (35:57,0 - 07:27,3 minutes) (Table 8) .

	AvHR	HRmax	Tº Z1	Tº Z2	Tº Z3	Tº Z4	Tº Z5	Tº Z6	Tº >85% HRmax
Average	160	189	00:52	04:13	19:42	11:54	07:58	01:26	21:18
SD	6,7	6,1	00:47,2	02:54,3	05:00,6	03:44,8	03:45,4	02:04,6	06:38,6
Max	173	201	03:05	11:40,9	28:35,4	24:09	15:50,8	09:06,3	35:57
Min	150	180	00:00	00:05,5	09:21,5	05:06,3	02:05,4	00:00	07:27,3

Table 8. Values for the average, SD, maximum and minimum of variables presented: average HR (bpm), maximum HR (bpm), time in each of the 6 zones, and time above the 85% HRmax (sum of the zones 4, 5 and 6) (in minutes).

We include below (Tables 9 and 10) average values distributed by lines and positions.

	AvHR	HRmax	Tº Z1	Tº Z2	Tº Z3	Tº Z4	Tº Z5	Tº Z6	Tº >85% HRmax
Defenses	159	189	00:50	05:08	21:49	10:41	06:27	01:18	18:26
Midfielders	160	188	00:55	03:42	18:42	12:44	08:54	01:05	22:43
Forwards	168	193	00:58	03:49	15:53	11:57	10:10	03:10	25:18

Table 9. Averages by lines (units of measurement as in table 8).

	AvHR	HRmax	Tº Z1	Tº Z2	Tº Z3	Tº Z4	Tº Z5	Tº Z6	Tº >85% HRmax
Full backs	156	189	01:02	06:18	21:01	10:38	06:05	01:04	17:46
Central Backs	162	190	00:37	03:58	22:38	10:44	06:49	01:33	19:06
Pivots	162	191	00:23	02:39	17:19	13:53	10:39	01:05	25:36
Wingers	157	186	01:35	05:01	20:27	11:17	06:43	01:05	19:06
Strikers	168	193	00:58	03:49	15:53	11:57	10:10	03:10	25:18

Table 10. Averages by lines (units of measurement as in table 8).

Discussion.

The aim of this study was to describe the mechanic demonstration profile (distances, velocities and accelerations) along with the cardiovascular demonstration (HR) shown in the various games played (all of them friendly games) against rivals from different levels (regional - national / International) by field players of a professional team militant in 1 st Spanish division during the 2007-08 season. These data will help us to better understand the physical effort done, and it serves us as a benchmark for better individualization of the training loads, not only in the various proposed tasks, but in training sessions and training weeks.

We must bear in mind that collected data during the games are the result not only of the players physical capacity (Di Salvo, 2001), but also, (and probably more important) from the intrinsic characteristics of each game: collective tactic organization (own and rival) (Bangsbo and Lindquist, 1992; Shephard, 1999), playing position (Castagna and Octavio, 1999, and Thomas Reilly, 1976; Tumilty, 1993), level of the opponent team (Bangsbo, 1994), result, type of competition (Reilly, 1996; Reilly, 1997; Zubillaga, 2006), individual and collective motivation for every game, mainly. It is quite possible that the data obtained in official matches (league, cup, etc.) could vary one or more of the variables analyzed. We hope that in future studies can be performed analysis of official matches with this technology or other more precise.

We have seen how this difference between some variables obtained in official competition games and friendly games (during the same season) is clear for all positions except for strikers, who show virtually the same results (Table 11).

	Distancia	AvSp
Average	5503	7
SD	625	0,9
Max	6867	8,9
Min	4471	5,6
Defenses	5187	6,6
Midfielders	6029	7,7
Forwards	5131	6,5
Full backs	5412	6,9
Central Backs	4935	6,3
Pivots	5822	7,5
Wingers	6207	8
Strikers	5131	6,5

Table 11. Averages for lines and positions corresponding to the total distance and average speed in ½ time in official competition games (distance in meters and average speed in km/h). Data obtained with AMISCO System.

Firstly we can see the differences between each position for virtually all analyzed variables, which gives us a characteristic profile of each one.

When analyzing the actions, we observe as those conducted at maximum intensity (Nº MaxSp and Amax) represent a very low percentage of the total (2,8% and 2,3% respectively, and 5,8% together). However we must not forget that these maximal actions usually are associated with game situations that supose a greater danger (for our team or oponent) and may be

determinant for the final score (Masach, 1992). In order to be done this type of “limit” situations, must match a space and a suitable time.

We must bear in mind that the Amax, as the system measures it, depends not only of time available to accelerate (acceleration distance), but also upon the previous speed (at the beginning of the acceleration) and the action taken previously (standing start acceleration, with previous speed or after a jump or a change of direction). To deepen this kind of analysis, one must not only increase the accuracy of the system in data capture, but also in developing software for further treatment.

By positions, the strikers are those with a higher maximum percentage of maximum actions with respect of the total, showing a 7,8%, while the central backs are those that express a lower percentage (3,9%), being the defensive line which presents the lowest values (4%). Logically, and as the prior target of the defensive line is to defend, you must show a high level of efficiency, ie. achieve the objective (defend) with the lowest possible cost (as we shall see below), plus the position that they usually occupy (face to the ball), allows them to resolve situations by simply occupy a better position in the field.

We found one case of a winger player, which in ½ playing time has made 10 actions reaching his SpMax zone and 10 more reaching his Amax zone. In addition, in the second half of the same game, this same player was able to do 10 more actions reaching his SpMax zone, but only 2 in the Amax. This shows how important it may be to be properly prepared to cope with such efforts that sometimes occur in competition.

These two variables are the ones that we will use to determine the aspects concerning the mechanic maximum intensity.

With regard to Nº total actions (accelerations over 1 m/s ^{2}) and its relationship with the duration of the interval (rhythm), we see how, on average, midfielders are those who have less time to recover between actions, while central backs and strikers show the lower rythm. The position of each of them, the closeness regarding the position of the ball, and their game task (attack, defense or both), may be a probable cause of differences between positions and lines. In any case we must not forget that within the interval of time are included the typical game stops (ball outside, fouls, injuries, etc.). For this reason may be interesting to introduce a new variable as is the time with ball in play, and use that value to get the ball in play rythm, which can be used to control the training tasks load aimed at developing high intensity specific endurance (mainly maintenance or possessions games).

Comparing these data with those obtained in various tasks of training (Lapuente, unpublished data) we have seen the value of this variable (rythm) in monitoring the training load and its influence on the conditional demand of the tasks: the smaller is the number of participating players per team (possessions and small sided games) lower the average time available between actions (Table 12).

	Space	Interval	Nº A1 Actions	Rhythm
Fb 3x3 + p	40x30m	2:02	10,7	00:13
Fb 6x6 + p	50x50-60m	6:03	23,0	00:17
Fb 8x8 + p	65x70m	12:09	38,0	00:20

Table 12. Mean rhythm of participation in small sided games with goalkeepers depending on the Nº of players involved: interval (minutes and seconds, Nº A1 actions: Nº, rythm: seconds).

We note also that with the increased Nº of players so does the interval time, therefore this is not a determining factor in the intensity of exercise or task, but just the opposite: depending on the intensity of exercise we must use an optimum work interval time.

There is another implicit factor that cannot be quantified (but is present during the tasks) which is the collective tactic organization: the greater Nº of involved players in the task, the greater the collective organization (mainly in positions that each player holds, and later in the way of playing and even in the game system applied); this organization promotes that the efforts may be distributed in a more balanced way between members of the same team, lagging hence the appearance of fatigue. This is a key factor in the analysis and interpretation of the demands of the games.

The Nº of actions, together with the total distance, are the variables used, related to the volume.

The data obtained from overall average distance travelled during the games can match those offered by some authors, being somewhat lower than those shown by others, as shown in the table 13.

Author	Year	Distance	Subjects
Ohashi et al.	1988	9845	2
Van Gool et al.	1988	10245	7
Dufour	1990	10000	
Bangsbo et al.	1991	10800	14
Bosco	1991	11000	
Pirnay et al.	1993	10200	
Martínez	2004	11240	18
Zubillaga	2006	5598 (45 minutes)	6112 records

Table 13. Overall average distance obtained in studies of the authors referenced (distance in meters for the entire game except Zubillaga, which corresponds to 45 minutes, shows at Nº of players analysed except Zubillaga, who are nº of records analyzed).

If we analyse the same variable but look at the player's position, we can see, as well as can be seen in data from other studies (Reilly and Thomas, 1976; Ekblom, 1986; Ohashi et al., 1987; Bangsbo, 1991; Zubillaga , 2006), that midfielders are those who run longer overall distances (measured values very similar between centre midfielders and wingers), while defenses show the lowest values (especially central backs).

The relationship of distance by lines is the same as the average speed (AvSp), logical as the time interval is the same: higher average speed for midfielders, followed by strikers and finally the defenses. However by positions there is a small difference, and we get a slightly higher average speeds for winger players, followed by pivots (center midfielders).

In this case we believe it is important to take into account in interpreting these data the speed maintained at relative recovery stages between efforts or actions: if the recovery is more

active, AvSp will be greater than if it is passive; besides this aspect also affect the total distance obtained.

With regard to data from the average of the top speeds reached during the matches, we can see a clear difference in favor of forwards with the rest, which highlights the importance of the intensity of the actions that occur in areas closest to scoring.

For positions, we confirm the forwards with a higher average maximum speed achieved, but followed closely by the wingers, and behind them the fullbacks, showing the lowest values the pivots. One of the possible factors that condition this data is given by the inherent characteristics of the position: the defenses (especially central back) only show MaxSp if it's absolutely necessary in work regarding their defensive pairings in the duels (usually forwards and wingers) ; unlike the central backs, as fullbacks collaborate on offensive work, they can express higher MaxSp in actions with greater distances ahead.

By comparing the MaxSp values obtained by lines and positions in games and during training (Table 14), we can see as the MaxSp are lower during the matches than during training, with one exception: the forwards manifested MaxSp levels clearly lower during training than during the games.

On one hand, during the games only must be demonstrated maximal speed if necessary, while in training, if they perform tasks specifically designed for the development of the MaxSp, it can be shown easily (as MaxSp is a target of this training).

Moreover, the fact that players who show being faster over the games, are the ones who reaches lower training MaxSp should make us reflect on the appropriateness of the tasks of training used, and the need to perform tasks individualized by positions. Otherwise, players where it makes sense to work aimed at the MaxSp, are those who use it less, meaning therefore, that his specific preparation is not all that might be suitable. In this sense it assumes greater importance individualized training load control systems (in this case the actions of maximum intensity) to avoid over-stimulation of maximum intensity stimuli and compensate it with preventive work and / or specific strengthening, or if it's the case, in order to increase the maximum intensity stimuli through individualized work.

This becomes even more meaningful to compare these figures with the individual highest (difference between the two: MaxSp reserve), and we see clearly how the forwards are who have a lower margin between the MaxSp used in games and the individual maximum speed, being the pivots those on the opposite end.

	Games	Training	Game + training	Maximum	Reserve MaxSp
Team Average	27,6	28,2	29,7	30,8	3,2
Defenses	27,4	29,8	29,8	31,6	4,2
Midfielders	27	27,7	29,4	30,5	3,5
Forwards	29,8	24,8	29,9	31,3	1,5
Full backs	28	30,4	30,5	32,1	4,1
Central Backs	26,8	29,1	29,1	31,1	3,3
Wingers	29,1	30,3	30,5	32	2,9

Pivots	25,4	26,8	28,7	29,7	4,3
Forwards	29,8	24,8	29,9	31,3	1,5

Table 14. Averages for positions corresponding to the maximum speed shown in games, training workouts, training sessions and matches, individual maximum, and difference between individual maximum and games (MaxSp reserve), by lines and positions (units in km/h).

A proposal for differentiated positions individualized training (pivots and strikers) could be similar to what follows:
- Pivot: Aerobic endurance to speed, through intermittent training with active recoveries (aerobic), using intensities within the zone defined as the maximum (> 80% MaxSp) but without reaching 100%.
- Strikers: Endurance to speed through repetition training with passive or semipassive recoveries, distances and higher recoveries than pivots, and maximum intensities.

In the distribution of the distances covered in terms of intensity (speed), we observe as on average, just run 356m over the VMA (sum of the zones 4, 5 and 6), representing a 7% of total ½ game time meters travelled. By lines is evident as the players closest to the opposite goal (forwards) are showing a higher value for this variable, while those further away (defenses) are on the opposite side.

Comparing these data lines with time >85% HRmax (sum of the zones 4, 5 and 6) (these are the variables related to high intensity), we see that the relationship between lines is the same, ie. are forwards who have a higher cardiovascular and mechanical wear, with the defenses that less wear manifest.

Performing this analysis by positions, it is clear that forwards are those who have a greater high intensity cardiovascular and mechanical wear. But it is interesting to compare the data obtained by forwads and pivots: both positions show a similar level of cardiovascular effort (same % of time >85% HRmax), but the % of distance travelled >VMA is just the opposite, maximum for strikers (10,5%) and lowest for pivots (4,8%). This shows us that we must attend to some other variable that explains why it is manifested a similar cardiovascular wear with a so different high intensity mechanical wear. There are three variables that we noticed that they provide this information: the rythm (average time between the beginning of each action) that in strikers is 27,2 seconds compared to the pivots that is 23,3 seconds; the % that represents AvHR with respect to its HRmax, that for strikers is 87% while for the pivots is a 84,7% (lower HR reserve for strikers); and the % that represents the AvSp regarding the MaxSp: for strikers is 22,5% and for pivots is 27% (lower speed reserve for pivots).

If we add the number of maximum actions done (MaxSp and Amax) and the MaxSp reached, that in both cases are opposite, with higher values for strikers, we can adjust with greater precision the mechanical and cardiovascular characteristics expressed during the matches (and training) by the players, clearly distinguishing characteristics by the line, position and even individually.

We must highlight the great progress and the importance of using new technology in controlling the training and competition load, allowing us a much more sensible interpretation

of the demands posed by competition matches for players (based not only on the HR, but providing data on mechanical variables), and of course the possibility of identifying and individualizing the training load.

Practical implications.

- It is very useful the use of technologies that allow us to comprehensively monitor the player.
- The variables used are an important aid to control the games physical demonstration and the individualization of the training process.
- It is important to have individualized reference data obtained during games to control each player training.

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