Original Article

Evaluation of movement and physiological demands of full-back and center-back soccer players using global positioning systems

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ABSTRACT

Molinos, A. (2013). Evaluation of movement and physiological demands of full-back and center-back soccer players using global positioning systems. *J. Hum. Sport Exerc., 8*(4), pp.1015-1028. Purpose: This study investigated the physiological demands between Full-back and Center-Back soccer players during official matches and using Global Positioning System (GPS) devices. Methods: Four Full-back (FB) and four Center-back (CB) semi-professional soccer players (mean ± SD age 21,33 ± 2.07 y, height 179.53 ± 4,37 cm, and weight 76.62 ± 3.32 Kg) participated in this study during 2012. Match performance was reported as total distance, speed categories (stationary–walking (0–3.9 km/h), jogging (4.0–6.9 km/h), quick running (7.0–12.9 km/h), high-intensity running (13.0–17.9 km/h) and sprint (>18 km/h)), maximum speed, workload, high-intensity running distance (HIR: Sprint and High-intensity running), rest time and high/low intensity ratio. Data were expressed per 15-min period of game time, separate into positions roles. Results: in all periods of time, FB covered a significant higher total distance, HIR efforts, Workload and maximum speed. CB spent higher distance in walking speed category. FB had also a lower high/low ratio and shorter rest time. When compared with periods of time, rest time was longer each 15-min, but in the last period (75-90) HIR was higher than in the previous periods of time. Conclusions: Significant differences exist between Full-back and Center-back players, therefore, physical training in soccer should also be based on the specific requirements of the playing positions. **Key words**: TIME-MOTION ANALYSIS, POSITIONAL DIFFERENCES, GPS, SOCCER, PERFORMANCE ANALYSIS.

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INTRODUCTION

Recent technological developments have permitted in the last years to quantify the physical demands and movements of team sport competitions.(Carling et al, 2008; Boyd et al., 2011) Common methods are used to measure physical demands as heart rate telemetry, (Coutts et al., 2009; Johnston et al., 2004) time–motion analysis (TMA),(Dawson et al., 2004; Di Salvo et al., 2007) and recently, Global Positioning Systems (GPS). (McLellan & Lovell, 2013; Aughey & Fallon, 2010). This GPS device and also accelerometers have been used to assess the movements and physiological demands in many team sports including, rugby, (McLellan & Lovell, 2013) hockey, (Gabbett, 2010; Jennings et al., 2012) soccer (Castellano & Casamichana, 2010; Pino et al., 2007; Vescovi, 2012) and in particular, in Australian football (Dawson et al, 2004; Aughey & Falloon, 2010), while all 16 Australian football League (AFL) Clubs used GPS technology during the matches.(Wisbey et al., 2010).

The validity of heart rate information is questionable when activity levels are intermittent and at high intensities and also time-motion analysis is labor intensive, typically observes only one player at time, cannot function in real time and is prone to human error.[2] GPS time-motion analysis have been evaluated on team sport activities and have achieved good levels of accuracy and reliability, (Boyd & Aughey, 2011; Duffiel et al, 2010; Portas et al., 2010) mainly in 10 Hz GPS and 100Hz accelerometer devices. (Varley et al, 2012; Aughey, 2011).

Since we can use validate GPS and accelerometers sport scientists and conditioning coaches are able to measure and evaluate the real movement and physiological demands on team sports during training and competition.(Aughey & Falloon, 2010; Aughey, 2011). Thus, this provides information about speed, covered distance, play intensities, energy expenditure and other interesting features by players of different positions[14]. Also, recently studies have identified significant physical, physiological and bioenergetics requirements in players with different roles: (Bradley et al, 2009; Bloomfield et al, 2007; Di salvo et al, 2007).

- The total distance covered in a soccer match ranges 9-13 km, with a decrease of 5-10% in the 2nd half.
- Players spend 60-70% of the total match duration low-intensity activities (walking, jogging, slow running).
- Mean recovery time between very high-intensity activity (Sprint and High-intensity running) is 72 seconds, but this result differs greatly for different position players.
- Wide and central midfielders cover a greater total distance. Central defenders undertake less high-intensity running than all other positions.

In recent years, latest studies have demonstrated that individual differences in playing style, physical performance and playing position should be taken into account when planning training and nutritional strategies. (Bangsbo et al, 2006) Findings in the latest years showed that all defenders positions have not the same physical demands (Full-back perform more high-intensity activity, have less recovery time between exertions and the workload is greater than Center-back). (Bradley et al, 2009; Bloomfield et al, 2007; Di salvo et al, 2007).

However, to date there are only studies with good validate GPS and accelerometers in youth categories soccer (Harley et al, 2010) and beach soccer, (Castellano & Casamichana, 2010) because FIFA does not allow this devices in official competitions, thus the collection of data on elite soccer competitions has been performance only with time-motion analysis.

With this in mind, the purpose of this study was to investigate the physiological demands of defender players (Full-back and Center-back) in official soccer competitions of Semi-professional leagues, using GPS and accelerometer technology.

MATERIAL AND METHODS

Subjects

After receiving written consent from players, 8 semi-professional male soccer players were recruited from 2 different Team from the same League: 4 full-back players (FB) and 4 center back players (CB). Their characteristics were (mean ± SD): age 21,33 ± 2.07 y, height 179.53 ± 4,37 cm, and weight 76.62 ± 3.32 Kg. All participants had a soccer competition experience longer than 10 years, and generally undertook 3-4 days of soccer training each week plus one competitive match at weekends.

Methodology

Time-motion characteristics were recorded during matches in 2012. FB and CB were monitored during 8 officially matches. Every player was measured twice, collecting finally 8 files from 4 FB and 8 files from 4 CB (total files n = 16). All games were played in accordance with the rules outlined by the German Football Association (Deutscher Fuβball-Bund), and were refereed by qualified officials.

All procedures received approval from players and coaches. For approval of the referees, they received 24 hours before the match information about the research, devices and analysis.

Before each game, 1 FB and 1 BC (2 defensive players each match) were fitted with a GPS unit (MinimaxX S4, Catapult Innovations, Canberra, Australia), which operated at a sampling frequency of 10 Hz. The GPS unit also included triaxial accelerometers sampling at 100 Hz to provide greater accuracy on speed and acceleration. Units were worn in vest between the shoulder-blades, to reduce movement artifact.

Match analysis

For the analysis, the data were collected during the match, and classified at 15min time periods (6 periods: 0-15min, 15-30min, 30-45min, 45-60min, 60-75min, 75-90min). The physical variables studied were:

- Distance covered per minute,
- Maximum speed,
- Workload, developed by Catapult and Australian institute of sport as a measure of effort, which is not dependent on distance. Recent studies suggest these devices as a reliable tool to measure physical activity in team sports.2,30

The accumulated work load (AWL) can be computed as follows:

$$AWL_{t=n} = \sum_{t=0}^{t=n} \sqrt{((fwd_{t=i+1} - fwd_{t=i})^2 + (side_{t=i+1} - side_{t=i})^2 + (up_{t=i+1} - up_{t=i})^2)}$$

Where

fwd : forward acceleration,

side : sideways acceleration,

up : upwards acceleration,

t : time = 0,0.01,0.02,0.03….n.

- Speed categories: Sprint, High intensity, Quick running, Jogging, walking.
- HIR: distance covered in Sprint and high intensity running
- High/Low ratio: estimate during the distance covered at a speed of 0–12.9 km/h as a "low intensity" period (in seconds), while all the categories with speeds above 13 km/h were considered as "high intensity". It shows the time (sec.) spent by the player in "low intensity" each 1sec. of "high intensity" (1/"low" sec.)
- Rest time: estimate with the mean of high-intensity running efforts (Sprint + high intensity running) and divided by the time (seconds). The rest time show the mean of rest between HIR efforts.

For the analysis five speed categories were established: stationary–walking (0–3.9 km/h), jogging (4.0–6.9 km/h), quick running (7.0–12.9 km/h), high-intensity running (13.0–17.9 km/h) and sprint (>18 km/h). The speed zones and movement categories chosen are similar to those used in other studies conducted in different sports.5,12

Statistical analysis

Statistical analyses were conducted using SPSS v.17.0 (SPSS Inc., Chicago, IL). Descriptive data are presented as mean ± SD.

Data were analyzed using two-way analysis of variance (ANOVA) to examine the interaction of each numerical variables (rest time, high/low ratio, maximum speed, distance covered per minute, all speed categories, workload and HIR distance) at the different positional roles and periods of 15min.

The relationship between position roles and time periods to the numerical variables were analyzed by multiple linear regressions, from which the Pearson correlation was calculated, and coefficients of determination (r2) reported for each relationship. Statistical significance was set at $p < 0.05$.

RESULTS

Movement demands

Table 1 shows mean (±SD) movement demands for Center-back and Full-back players in 0-15, 15-30, 30-45, 45-60, 60-75 and 75-90 periods of time. The mean distance per minute (m/min) per match was 94.85 ± 8.82m/min for CB, which was 9,16% less ($p < 0.05$) than for FB (103.50 ± 11.61 m/min). CB and FB covered longer distance in the periods 0-15 (102.32 ± 6.17 m/min and 112.79 ± 8.26 m/min, respectively) and 15-30 (102.72 ± 6.60 m/min and 106.51 ± 11.11 m/min) than in the periods 30-45 (89.37 ± 5.03 m/min and 102.10 ± 7.04 m/min), 45-60 (92.28 ± 9.03 m/min and 98.85 ± 12.81 m/min), 60-75 (92.34 ± 7.79 m/min and 101.99 ± 10.47 m/min) and 75-90 (88.98 ± 7.06 m/min and 96.71 ± 15.30 m/min) ($p < 0.05$).

Table 1. *(±SD) movement demands for Full-back and Center-back soccer players separated by 15 min periods.*

Periods	Playing position	Total distance (m/min)	Sprint (m)	High-Intensity running (m)	Quick running (m)	Jogging (m)	Walking (m)
0-15	Center-Back	102.32 ± 6.17*,c,d,e,f	57 ± 33*	219 ± 83*,d	598 ± 65d,e,f	436 ± 93b,c	209 ± 18*,c,f
	Full-back	112.79 ± 8.26	184 ± 68	264 ± 35	573 ± 116	491 ± 95	180 ± 35
15-30	Center-Back	102.72 ± 6.60*,c,d,e,f	104 ± 30*,d	196 ± 41*	517 ± 99	520 ± 77a	205 ± 24*,c,f
	Full-back	106.51 ± 11.11	149 ± 39	225 ± 76	528 ± 104	523 ± 78	163 ± 39
30-45	Center-Back	89.37 ± 5.03*,a,b	57 ± 16*	139 ± 55*	529 ± 145	512 ± 68a,d	261 ± 22*,a,b,d,e
	Full-back	102.10 ± 7.04	139 ± 51*	248 ± 46	514 ± 83	552 ± 92	204 ± 29
45-60	Center-Back	92.28 ± 9.03*,a,b	58 ± 44*,b	166 ± 80*,a	497 ± 80a	444 ± 90c	219 ± 30*,c,f
	Full-back	98.85 ± 12.81	115 ± 65	216 ± 73	487 ± 161	487 ± 81	178 ± 34
60-75	Center-Back	92.34 ± 7.79*,a,b	64 ± 24*	165 ± 46*	440 ± 89a	455 ± 52	218 ± 30*,c,f
	Full-back	101.99 ± 10.47	149 ± 76	224 ± 89	456 ± 101	517 ± 86	184 ± 31
75-90	Center-Back	88.98 ± 7.06*,a,b	74 ± 43*	192 ± 54*	470 ± 76a	529 ± 40	244 ± 41*,a,b,d,e
	Full-back	96.71 ± 15.30	138 ± 78	251 ± 127	508 ± 181	517 ± 104	239+ ± 40

* p < 0.01 (Significantly different between Center-Back and Full-Back
\+ p < 0.05 (Significantly different between Center-Back and Full-Back).
a p < 0.05 (Significantly different from 0-15 period).
b p < 0.05 (Significantly different from 15-30 period).
c p < 0.05 (Significantly different from 30-45 period).
d p < 0.05 (Significantly different from 45-60 period).
e p < 0.05 (Significantly different from 60-75 period).
f p < 0.05 (Significantly different from 75-90 period).

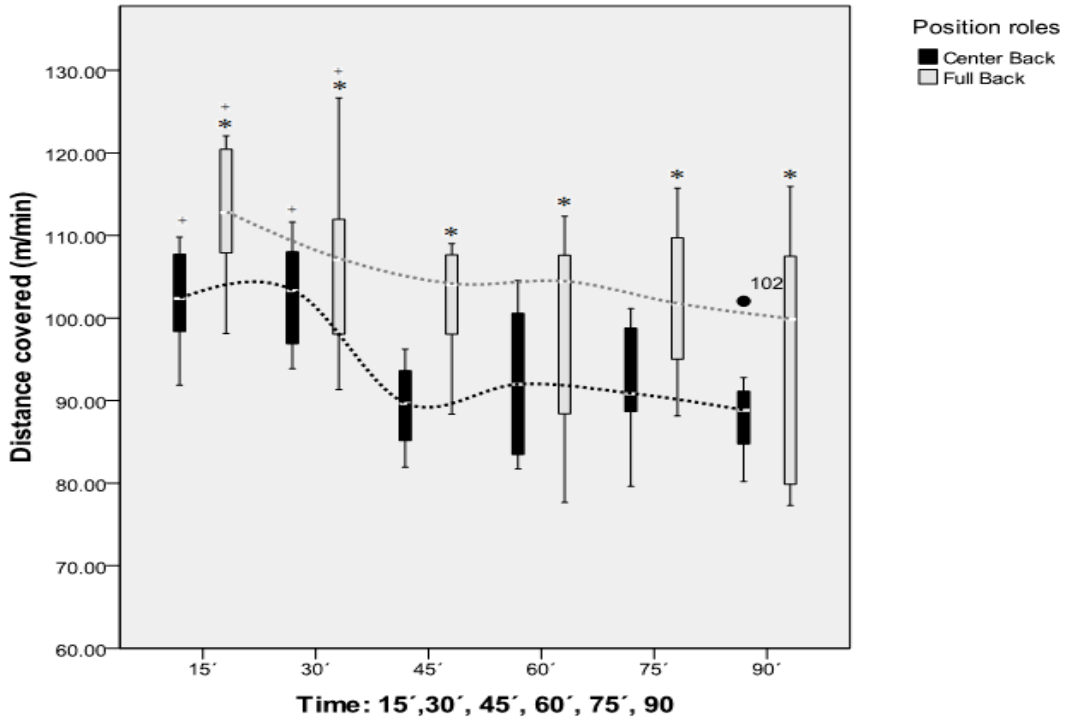

Figure 1. *Distance covered (m/min) in 15-min interval for Center-back players (black) and Full-back players (grey). *Significantly different (p < 0.05) between Center-Back and Full-Back. +Significantly different (p < 0.05) between periods of time*

FB demonstrated in all periods of time a longer distance covered in Sprint (0-15: 184 ± 68 m, 15-30: 149 ± 39 m, 30-45: 139 ± 51 m, 45-60: 115 ± 65 m, 60-75: 149 ± 76 m, 75-90: 138 ± 78 m) than CB (57 ± 33 m, 104 ± 30 m, 57 ± 16 m, 58 ± 44 m, 64 ± 24 m, 74 ± 43 m) ($p < 0.01$). FB also covered longer distance in High intensity running (264 ± 35 m, 225 ± 76 m, 248 ± 46 m, 216 ± 73 m, 224 ± 89 m, 251 ± 127 m) than CB (219 ± 83 m, 196 ± 41 m, 139 ± 55 m166 ± 80 m, 165 ± 46 m, 192 ± 54 m). ($p < 0.01$). There were not mean significant differences between FB and CB in Quick running (FB: 513 ± 124 m. CB: 510 ± 103 m) and Jogging activity (FB: 514 ± 87 m. CB: 482 ± 79 m) ($p > 0.05$). However, walking distance covered was longer at the end of the first period (30-45: 232 ± 38 m) and at the end of the match (75-90: 241 ± 38 m) than in the others periods (0:15: 194 ± 30m, 15-30: 183 ± 37 m, 45-60: 198 ± 37 m, 60-75: 202 ± 33 m) ($p < 0.05$), and also CB (225 ± 33 m) showed more distance than FB (189 ± 40 m) ($p < 0.01$).

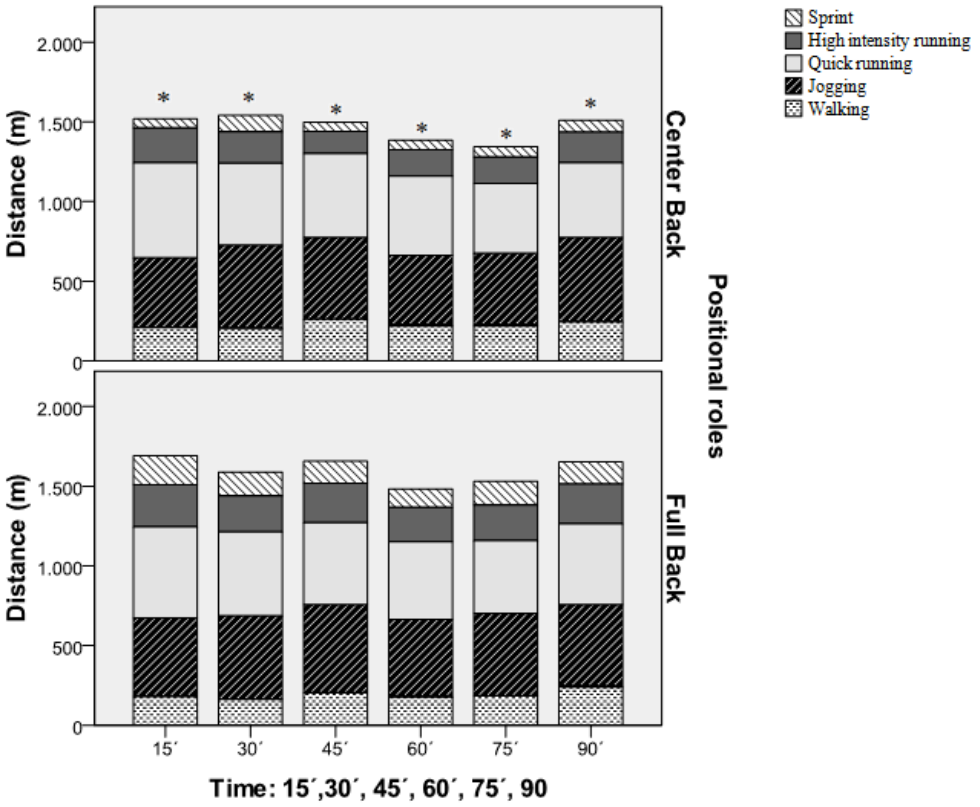

Figure 2. *Speed categories in 15-min interval for Center-back players (up) and Full-back players (down). *Significantly different ($p < 0.05$) between Center-Back and Full-Back.*

There were significant positive correlations between FB players and distance covered per periods of time ($r2 = 0.392$; $p < 0.01$), Sprint distance ($r2 = 0.606$; $p < 0.01$), High- intensity distance ($r2 = 0.394$; $p < 0.01$) and positive correlation between CB players and Walking distance ($r2 = 0.447$; $p < 0.01$). We found also significant negative correlations between periods of time and distance covered ($r2 = -0.438$; $p < 0.01$).

Match performance

Table 2 shows mean (±SD) match performance variables for Center-back and Full-back players in 0-15, 15-30, 30-45, 45-60, 60-75 and 75-90 periods of time.

Periods	Playing position	Workload	HIR (m)	Maximum speed (m/s)	*high/low ratio* (sec.)	Rest time (sec.)
0-15	Center-Back	78.69 ± 9.81$^{+,d,e}$	276 ± 108^{*,d}	6.60 ± 0.73*	1/17.11 ± 14.23*	47.65 ± 19.13^{*,c,d,f}
	Full-back	88.12 ± 9.68	448 ± 83	7.79 ± 0.27	1/8.62 ± 2.27	30.21 ± 4.80
15-30	Center-Back	79.89 ± 10.95$^{+,e}$	300 ± 60*	7.22 ± 0.75*	1/13.79 ± 4.16*	44.95 ± 11.21^{*,f}
	Full-back	83.63 ± 10.16	374 ± 97	7.53 ± 0.64	1/11.80 ± 3.46	36.34 ± 7.33
30-45	Center-Back	74.51 ± 8.73$^{+,e}$	197 ± 67*	7.01 ± 0.80*	1/22.52 ± 6.66*	64.01 ± 17.77^{*,a}
	Full-back	87.57 ± 18.72	387 ± 79	7.27 ± 0.60	1/10.94 ± 2.85	36.34 ± 9.21
45-60	Center-Back	71.02 ± 13.60$^{+,a}$	224 ± 120^{*,a}	6.52 ± 0.50^{*,e}	1/20.77 ± 10.31*	61.54 ± 24.03^{*,a}
	Full-back	74.66 ± 16.93	331 ± 112	7.37 ± 0.67	1/12.83 ± 5.23	41.34 ± 11.80
60-75	Center-Back	65.70 ± 12.01$^{+,a,b,c}$	230 ± 58*	7.15 ± 0.98^{*,d}	1/16.80 ± 4.85*	50.13 ± 16.55*
	Full-back	74.13 ± 12.72	373 ± 142	7.77 ± 0.41	1/11.83 ± 6.46	39.14 ± 16.30
75-90	Center-Back	76.92 ± 13.37^{+}	266 ± 79*	6.91 ± 0.65*	1/17.23 ± 5.98*	53.79 ± 19.28^{*,a,b}
	Full-back	81.21 ± 22.77	389 ± 189	7.20 ± 0.58	1/13.88 ± 6.89	51.61 ± 21.78

** p < 0.01 (Significantly different between Center-Back and Full-Back*
$^{+}$ p < 0.05 (Significantly different between Center-Back and Full-Back).
^{a} p < 0.05 (Significantly different from 0-15 period).
^{b} p < 0.05 (Significantly different from 15-30 period).
^{c} p < 0.05 (Significantly different from 30-45 period).
^{d} p < 0.05 (Significantly different from 45-60 period).
^{e} p < 0.05 (Significantly different from 60-75 period).
^{f} p < 0.05 (Significantly different from 75-90 period).

Workload

The FB players showed a higher Workload (81.90 ± 15.71) than CB players (74.59 ± 11.86) during all the periods (p < 0.05). There were significant differences between the 3 periods of the first half (0-15: 83.40 ± 10.59, 15-30: 81.75± 10.38 and 30-45: 81.03 ± 15.63) and the 60-75 period (69.58 ± 12.59), where in the first half, the players had a higher Workload (p < 0.05).

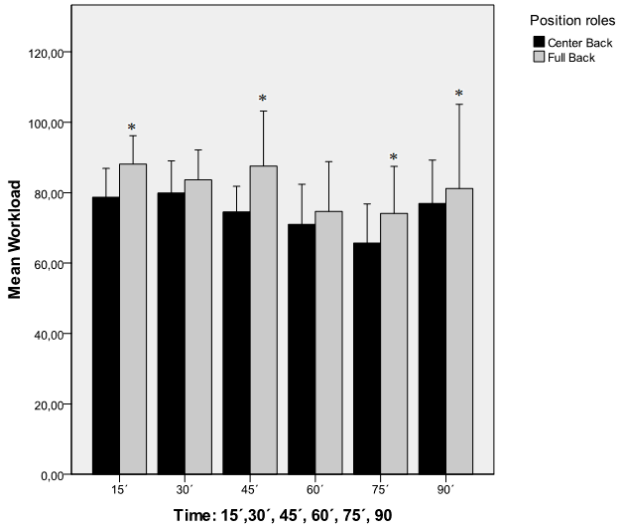

Figure 3. *Workload in 15-min interval for Center-back players (black) and Full-back players (grey). *Significantly different (p < 0.05) between Center-Back and Full-Back.*

High Intensity running distance

For the HIR distance (Sprint + High-intensity running distance), we found the FB players covered 54,39% longer mean distance (383.65 ± 15.59 m) than the CB (248.48 ± 15.14 m). ($p < 0.01$). The time period with highest mean of HIR distance was 0-15 (361.94 ± 128.76 m), in compare with the 30-45, the lowest for CB (197 ± 67 m) and 45-60 for FB (331 ± 112 m) ($p < 0.05$).

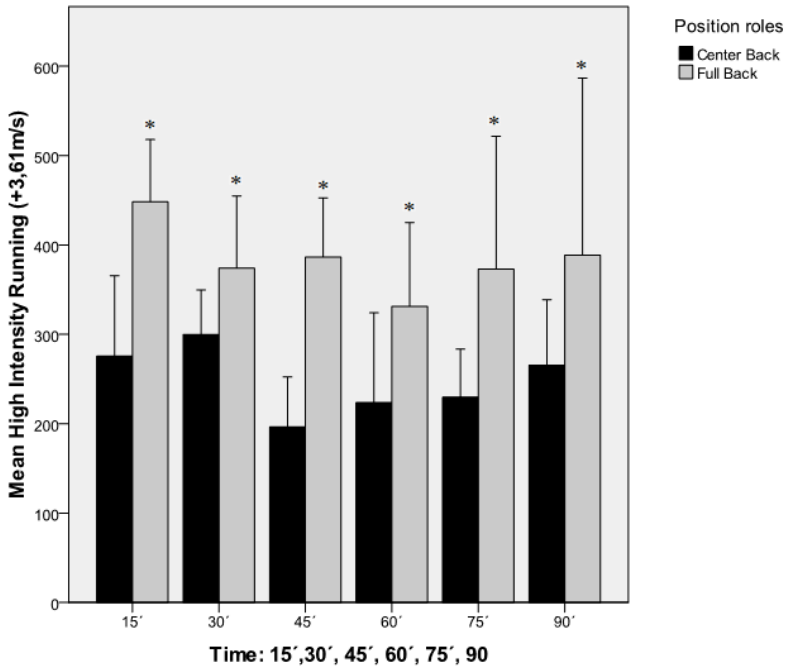

Figure 4. *High Intensity running (HIR: above 3,61m/s) in 15-min interval for Center-back players (black) and Full-back players (grey). *Significantly different ($p < 0.05$) between Center-Back and Full-Back.*

Maximum speed

Maximum speed (m/s) was higher in every period of time for FB (0-15: 7.79 ± 0.73 m/s, 15-30: 7.53 ± 0.64 m/s, 30-45: 7.27 ± 0.60 m/s, 45-60: 7.37 ± 0.67 m/s, 60-75: 7.77 ± 0.41 m/s, 75-90: 7.20 ± 0.58 m/s) than for CB (6.60 ± 0.73 m/s, 7.22 ± 0.75 m/s, 7.01 ± 0.80 m/s, 6.52 ± 0.50 m/s, 7.15 ± 0.98 m/s, 6.91 ± 0.65 m/s) ($p < 0.01$).

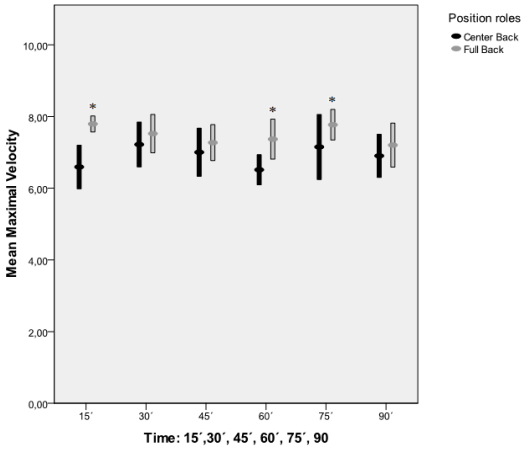

Figure 5. *Maximal velocity in 15-min interval for Center-back (black) players and Full-back players (grey). *Significantly different ($p < 0.05$) between Center-Back and Full-Back.*

High/low ratio

CB had a mean of 18.08 sec. at "low intensity" per each 1 sec. of "high intensity" (1/18.08 ± 8.61 sec). FB performance lower high/low ratio (1/11.53 ± 4.65 sec), and therefore more time at "high intensity" than CB. There were no significantly different between periods of time. However FB spent more time in "high intensity" during every period of the match (1/8.62 ± 2.27 sec, 1/11.80 ± 3.46 sec, 1/10.94 ± 2.85 sec, 1/12.83 ± 5.23, 1/11.83 ± 6.46, 1/13.88 ± 6.89 sec) than CB (1/17.11 ± 14.23 sec, 1/13.79 ± 4.16 sec, 1/22.52 ± 6.66 sec, 1/20.77 ± 10.31, 1/16.80 ± 4.85, 1/17.23 ± 5.98 sec). ($p < 0.01$).

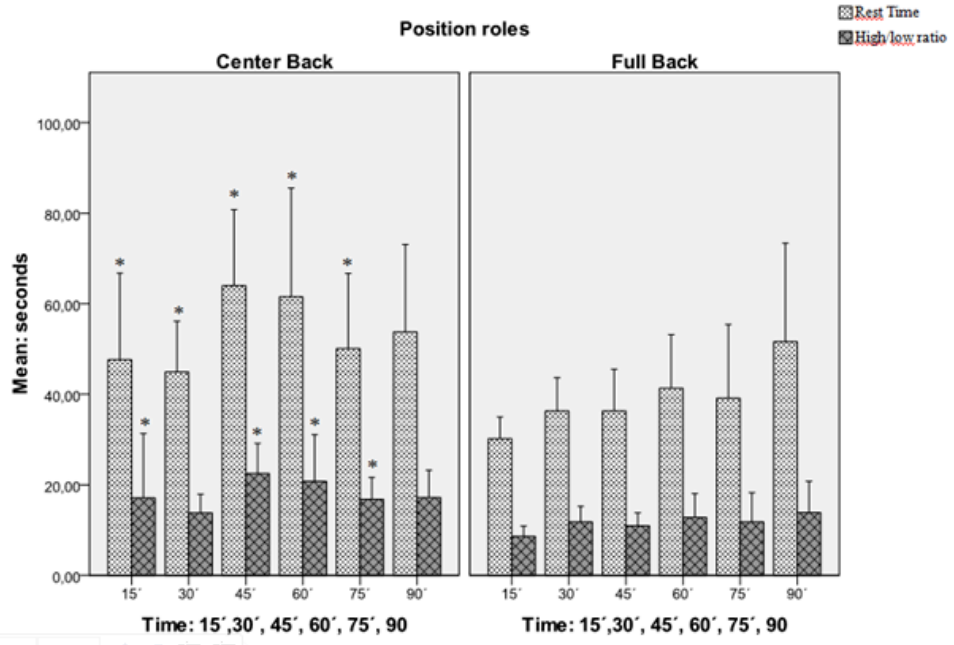

Figure 6. *Rest time ( ) and high/low ratio ( ) in 15-min interval for Center-back players (left) and Full-back players (right). *Significantly different ($p < 0.05$) between Center-Back and Full-Back.*

Rest time

There are significant differences in the Rest time (sec) between FB and CB. FB have a 37.2% shorter mean of rest time between HIR efforts (38.60 ± 13.23 sec) than CB (53.75 ± 18.65 sec) ($p < 0.01$). We found also differences between periods of time, thus in the last period of the match (75-90) the players needed a longer rest time (CB: 53.79 ± 19.28 sec, FB: 51.61 ± 21.78 sec) than during 0-15 (CB: 47.65 ± 19.13 sec, FB: 30.21 ± 4.80 sec) and 15-30 (CB: 44.95 ± 11.21 sec, FB: 36.34 ± 7.33 sec). ($p < 0.01$). Figure 6.

Although Workload measures the acceleration and is not dependent on distance, we found positive correlation with total distance covered ($r2 = 0.598$; $p < 0.01$). Workload had also a strong correlation with HIR distance ($r2 = 0.681$; $p < 0.01$) and negative correlation with the high/low ratio ($r2 = -0.547$; $p < 0.01$) and rest time ($r2 = -0.629$; $p < 0.01$).

Between HIR, low/high ratio and rest time, we found a strong correlation. Thus, the more HIR distance covered the players, less high/low ratio ($r2 = -0.837$; $p < 0.01$) and less rest time they have ($r2 = -0.823$; $p < 0.01$).

There was significant positive correlation between low/high ratio and rest time ($r2 = 0.874$; $p < 0.01$) and also when the players covered a longer distance, they had less high/low ratio ($r2 = -0.627$; $p < 0.01$) and less rest time ($r2 = -0.727$; $p < 0.01$).

DISCUSSION

This is the first study to investigate the different of movement and physiological demands of Full-back and Center-back soccer players using GPS. It is also the first investigation with high accuracy and reliability GPS (10 Hz) and accelerometer (100Hz) devices used during official semi-professional soccer matches.

The purpose of this study was to identify and detail the physical demands of two different defensive positions (Full-back and Center-back) of Semi-professional players during competitive match-play through a Global Positioning System. Significant differences were found between the two different position roles, displayed higher absolute total distance for the FB than CB. The distance covered per minute was higher for the FB (103,50m/min) than CB (94,84m/min), in every time period. We found also significant differences in time periods, covering longer distance in the first 2 periods (0-15: 107.55m/min. and 15-30: 104,62m/min) than at the end of the first half (30-45: 95m/min) and during the entire second half (45-60: 95.56m/min, 60-75: 96.79m/min. and 75-90: 99.07 m/min).

These results demonstrate a clear fatigue affect on movement demands. Although the decrease in the distance covered from the 30-45 period to 75-90 period, we observed a small increase of HIR activity in the 75-90 period (non significant results), which demonstrates the intensity rise in the last minutes of the match (all matches we observed had a tight result in the last period) and the importance of a good physical condition to performance at the end of the game.

The findings of this study suggest that FB request longer Sprint distance (145,95m/min) than CB (69.15m/min), as well as High-intensity running (FB: 237.95m/min. and CB: 179.37m/min). For the slowest speed category (walking), CB developed longer mean distance covered (225.80m/min) than FB (189.41m/min), which suggests, and it is also correlated with total distance ($r2 = -0.447$; $p < 0.01$), that the playing position who cover longer distance in walking speed, develops less total distance in the match. It demonstrate a clear difference on movement demands, depending on the positional roles, as has been found in other investigations with soccer players. (Bradley et al, 2009; Bloomfield et al, 2007; Di salvo et al, 2007).

This study was also the first to collect workload data from Accelerometers in official matches. The important findings show that FB players (81.90) have higher Workload than CB (74.59) and as well as HIR activity, both positional roles (FB and CB) had in the last period of time (75-90) an increase in the workload (81.21 and 76.92, respectively), though a rise in amount of Sprints and High-intensity running. The Workload has a strong relationship with other data like total distance, Sprint and High intensity running, as well as a negative correlation with high/low ratio and Rest time; therefore we could use these devices to observe the load and intensity in matches and also during trainings to assess the exercises, physical training and progression. (Boyd et al., 2011; Boyd et al., 2010)

Maximum speed was clearly higher for the FB than CB. The FB players have usually an offensive role, which allows these players to make long Sprints on the wings.[8] these results demonstrate the importance to improve the maximal velocity in FB players.

Another investigation developed an intensity ratio, but in this case the analysis were collected in beach soccer and with work/rest ratio (work above 4 km/h and rest 0-3.9km/h), (Castellano & Casamichana, 2010) therefore we cannot use these results to compare our study. The findings from our data prove the intensity of the activity. FB displayed a higher main of high intensity activity (11.53 seconds of low intensity per each second of high intensity) than CB (18.08 seconds of low intensity per each second of high intensity), which demonstrates again the differences in intensity during activity. With this data we give important information for the physical trainers, who will be able to adapt the training of the players depending on the positional roles. Moreover, FB players had a lower mean between rest time and HIR efforts (FB: 38.60sec. and CB: 53,50sec) than CB, which shows how important is a quickly recovery. Although in the last period of the match (75-90), we observed a rise of HIR activity and distance covered, the both players needed longer rest time that in previous periods. Mohr et al.[9] reported the same results with soccer players in the last 15 min of the game.

Future research of movement and physiological demands during competitive match-play in elite soccer players using GPS and accelerometers should further investigate the findings of the present study.

CONCLUSIONS

The purpose of this study was to verify differences among defensive playing positions and to quantify physical and movement demands during matches. Significant differences exist between Full-back and Center-back players, with the Full-back spending a significant higher total distance covered, HIR efforts (sprint and High-intensity running), Workload and maximum speed and also a lower high/low ratio and shorter rest time during all periods of time (0-15, 15-30, 30-45, 45-60, 60-75, 75-90) than the Center-back players. Although the present findings demonstrate the need for a well developed aerobic capacity to allow Full-back players to cover longer distance in a match and to recover faster after HIR efforts, they also demonstrate the need to train the anaerobic alactic (ATP-CP) system to enable longer and greater amount of Sprints than Center-back. Therefore, physical training in soccer should also be based on the specific requirements of the playing positions, for example Full-back players could benefit from interval running over longer distances and shorter rest time whereas Center-back players would benefit more from agility and acceleration in accordance to the finding of this investigation.

The data presented in this study could be considered norms for semi-professional defensive players.

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PRACTICAL APPLICATIONS

In this study we demonstrated the physical and movement differences between FB players and BC during official matches. Such data could be used for physical trainers to adapt the training depending on the positional roles of the players, and to prepare them for the demands of semi-professional matches.

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