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Match load during competitive matches and difference among player positions in elite soccer players

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Abstract. The purpose of this investigation was to quantify the match load within a soccer match among different players' positions in male professional soccer. Twenty-four male elite soccer players (age: 24.1 ± 3.3 years; height: 172.1 ± 5.2 cm; body mass: 73.1 ± 4.4 kg; body fat: 12.3 ± 3.2%) from a club of the Brazilian first-division soccer league participated in this study. All soccer players included in the study participated in ten official matches for 91.4 ± 2.8 min. During ten official matches, the external load of all soccer players was monitored and quantified by means of portable global position system (GPS) devices operating at a sampling frequency of 10 Hz and incorporating a 100 Hz triaxial accelerometer. The two-way ANOVA yielded main effects for group in total distance ($F_{2,21} = 17.68$, $p = 0.0001$), player load ($F_{2,21} = 31.19$, $p = 0.0001$) and maximal speed ($F_{2,21} = 4.36$, $p = 0.02$). In addition, Bonferroni post hoc ($p < 0.05$) showed significant differences in the total distance ($p<0.001$) and player load ($p<0.001$) among midfielders vs. forward and defenders. The results of this investigation confirm that midfielders soccer player shows greater total distance and player load in 60% of investigated matches. These results of this study provide information to coaches and physical trainers about specific variables during matches that should be observed during recovery to optimize resistance and power output.
Key words*: elite soccer players, match load, global position system.*

Introduction

Soccer matches are characterized by high-speed running and long distances covered while dribbling, passing, kicking or throwing the ball, with players required to make quick, precise movements, actions requiring multi-directional deceleration and acceleration, in addition to rapid changes of direction, all placing high demands on several physical components (1-3). Thus, physical stress during matches contributes with morphological, metabolic, and functional adaptations that are advantageous when seeking competitive results by increasing in physical performance (4-6). On the other hand, match load monitoring is crucial for providing information on the efficacy of the volume and intensity doses and for supporting injury prevention strategies (1-5).

External match-load is derived from measures of a players movement during matches or training. Therefore, the global positioning system (GPS) is important technological tool to externally dictate load during training and for monitoring during matches. The GPS provides information about the players total distance, velocity, types of tasks, player load, accelerations, decelerations, and changes in Direction (2,5,6). In general, these technologies have results in portable methods that allows coaching staff to examine the response of players to a quantified training stimulus to determine whether soccer players are meeting or exceeding the desired training load, and adding vital information with which to monitor the loads experienced by individual athletes throughout the competitive season (3,6,7).

Thus, the purpose of the present study was to quantify the match load within a soccer match (determined by GPS) among different players positions in male professional soccer. We hypothesized that selected performance variables would demonstrate a significant difference among players soccer positions.

Material and Method

Study Design. This is a randomized comparative study. The sample size was determined by including all participants that complied with the eligibility criteria. All soccer players were monitored by the global positioning system (GPS) during 10 official matches with an interval of 72 hours inter-matches. Soccer athletes were divided into three groups: forward, midfielder and defender. During matches were assessment total distance, maximal speed, player load, efforts ≥18 km/h and efforts ≥24 km/h. All assessments occurred between 5:00 and 9:00 P.M. and were assessment during of the competitive season.

Participants. This study included 24 healthy male elite soccer players (age: 24.1 ± 3.3 years; height: 172.1 ± 5.2 cm; body mass: 73.1 ± 4.4 kg; body fat: 12.3 ± 3.2%) from a club in the Brazilian first Division participating in national and international competitions organized by the Brazilian Soccer Confederation (CBF) and South American Soccer Confederation (CSF). The participants' training frequency was 6.1 ± 0.7 day/week, with a mean duration for each session training of 69.9 ± 7.8 min using training programs consisting of jumps, contesting possession, resistance training, sprints, accelerations and decelerations.

All soccer players included in the study participated in 10 official matches for 91.4 ± 2.8 min. The participants were eligible if they had not been smokers for the previous 3 months or more; had no cardiovascular or metabolic diseases, systemic hypertension (140/90mmHg or use of antihypertensive medication), recent musculoskeletal injury (in the last 6 months), or pain in any region of the body; and had not used anabolic steroids, drugs or any medication with the potential to impact physical performance (self-reported). This study was approved by the institutional Ethics Committee for Human Experiments (CAAE: 76189817.0.0000.5235) and was performed by national standards in sport and exercise science research. All participants signed the informed consent form.

Anthropometric measurements. Body composition was measured following an 8h overnight fast by bioelectrical impedance analysis using a device with built-in hand and foot electrodes (BIO 720, Avanutri, Rio de Janeiro, Brasil). The participants wore their normal indoor clothing and were instructed to stand barefoot in an upright position with both feet on separate electrodes on the device's surface and with their arms abducted and both hands gripping two separate electrodes on each handle of the device. All biometric measurements were carried out in an air-conditioned room (21°C). No clinical problems occurred during the study.

Training load monitoring and global position system (GPS). During ten official matches, the external load of all soccer players was monitored and quantified by means of portable global position system (GPS) devices (MinimaxX, v.4.0, Catapult Innovations) operating at a sampling frequency of 10Hz and incorporating a 100Hz triaxial accelerometer. Each player wore a special harness enabling the device to be fitted to the upper part of his back. The GPS devices were activated 10 min prior to the start of each official match in accordance with the manufacturer's instructions. After each match, GPS files were downloaded to a computer and analyzed using software provided by the manufacturer (Logan Plus Version 4.2.3, Melbourne, Australia). The players' data were excluded from analysis if they failed to complete any match due to injury and/or substitution.

The GPS devices used in the current study did not delineate forward, backward, or lateral directions, with all movement being considered universal. The indicators of the external load were as follows: 1) total distance covered; 2) frequency of efforts ≥18 km/h); 3) frequency of efforts ≥24 km/h); 4) maximal speed during matches. In addition, data obtained combining accelerations produced in three planes of body movement by means of a 100Hz triaxial accelerometer within the GPS device were used to classify the external training load using the player-load equation. Player load is used as an indicator of the external load because acceleration is proportional to force and may provide a useful measure of the total load applied to a player within a match (1,2). Player Load (measured in arbitrary units –u.a.) was calculated by Logan Plus software using the following equation:

$$(ay1 - ay{-}1)^2 + (ax1 - ax{-}1)^2 + (az1 - az{-}1)^2$$

where ay = antero-posterior acceleration, ax = medio-lateral acceleration, and az = vertical acceleration.

Statistical Analysis. Data are presented as means and standard deviations (±SD). The Shapiro–Wilk normality tests and the homoscedasticity test (Bartlett criterion) were applied. Comparisons between matches for each variable were independently performed with one-way repeated-measures ANOVA followed by Tukey's post hoc tests. Two-way analysis of variance (ANOVA) was used to test for main and interaction effects of the group and timing of measurement for each outcome variable independently. The level of significance for all statistical comparisons was set at $p < 0.05$ using GraphPad® (Prism 6.0, San Diego, CA, USA) software.

Results

Repeated-measures one-way ANOVA (Table I and II) showed no significant between-match differences for total distance covered, maximal speed, player load, frequency of efforts ≥18 km/h, and frequency of efforts ≥24 km/h. Table III although demonstrated no significant differences for total distance covered, maximal speed, frequency of efforts ≥18 km/h and frequency of efforts ≥24 km/h, but Player Load was significantly different between matches ($F_{9,63} = 2.389$, p=0.02, $\eta^2 = 0.25$).

Table I. Performance variables of forward of the professional soccer players per match (n = 8)

Match	Total distance (meters)	Maximal speed (km/h)	Player load (a.u.)	Frequency of efforts ≥18km/h	Frequency of efforts ≥24 km/h
#1	8.756 ± 1.437	32 ± 2	941 ± 178	53 ± 6	9 ± 2
#2	9.291 ± 2.185	31 ± 1	922 ± 240	53 ± 21	9 ± 4
#3	7.833 ± 1.429	31 ± 2	834 ± 123	46 ± 9	7 ± 3
#4	8.096 ± 1.156	32 ± 2	855 ± 102	43 ± 9	8 ± 3
#5	8.811 ± 1.483	32 ± 3	875 ± 130	50 ± 6	7 ± 3
#6	8.111 ± 1.053	31 ± 1	782 ± 123	42 ± 10	8 ± 3
#7	7.625 ± 1.653	32 ± 1	766 ± 131	44 ± 15	8 ± 3
#8	8.473 ± 1.376	31 ± 2	849 ± 125	53 ± 13	10 ± 1
#9	8.223 ± 875	33 ± 5	821 ± 85	51 ± 8	10 ± 3
#10	8.496 ± 1.319	31 ± 1	854 ± 143	49 ± 14	10 ± 3
Statistics	$F_{9,63} = 0.979$ $p = 0.465$	$F_{9,63} = 0.638$ $p = 0.759$	$F_{9,63} = 1.146$ $p = 0.344$	$F_{9,63} = 1.092$ p =0.381	$F_{9,63} = 1.180$ $p = 0.323$

Values are shown as mean ±SD.

Table II. Performance variables of midfielder of the professional soccer players per match (n = 8)

Match	Total distance (meters)	Maximal speed (km/h)	Player load (a.u.)	Frequency of efforts ≥18 km/h	Frequency of efforts ≥24 km/h
#1	10.308 ± 1.036	30 ± 1	1.071 ± 116	58 ± 12	7 ± 2
#2	9.803 ± 1.127	29 ± 2	1.020 ± 136	48 ± 11	6 ± 3
#3	10.396 ± 1.038	29 ± 1	1.074 ± 101	54 ± 8	6 ± 3
#4	10.079 ± 1.137	29 ± 2	1.111 ± 105	53 ± 12	6 ± 3
#5	10.256 ± 1.619	31 ± 3	1.017 ± 130	49 ± 12	8 ± 3
#6	10.234 ± 1.094	30 ± 1	1.027 ± 76	59 ± 14	8 ± 5
#7	10.194 ± 1.053	29 ± 2	1.027 ± 120	53 ± 11	7 ± 3
#8	10.058 ± 846	28 ± 2	1.038 ± 87	54 ± 10	7 ± 2
#9	10.049 ± 2.082	29 ± 1	989 ± 213	49 ± 16	6 ± 3
#10	10.604 ± 1.600	29 ± 1	1.061 ± 84	46 ± 9	5 ± 1
Statistics	$F_{9,63} = 0.256$ $p = 0.983$	$F_{9,63} = 1.334$ $p = 0.237$	$F_{9,63} = 0.780$ $p = 0.634$	$F_{9,63} = 1.443$ p =0.189	$F_{9,63} = 0.885$ $p = 0.543$

Values are shown as mean ± SD.

Table III. Performance variables of defender of the professional soccer players per match (n = 8)

Match	Total distance (meters)	Maximal speed (km/h)	Player load (a.u.)	Frequency of efforts ≥18 km/h	Frequency of efforts ≥24 km/h
#1	9.319 ± 1.028	29 ± 2	873 ± 88	41 ± 19	7 ± 4
#2	8.669 ± 898	30 ± 2	785 ± 99	38 ± 16	7 ± 5
#3	9.136 ± 832	28 ± 3	908 ± 80	41 ± 22	6 ± 5
#4	9.138 ± 1.034	30 ± 2	869 ± 74	48 ± 23	9 ± 6
#5	9.530 ± 575	29 ± 2	887 ± 70	44 ± 19	8 ± 6
#6	8.690 ± 923	29 ± 2	823 ± 79	37 ± 13	5 ± 3
#7	8.603 ± 834	30 ± 1	833 ± 99	41 ± 18	7 ± 4
#8	8.972 ± 1.353	30 ± 2	833 ± 110	43 ± 21	8 ± 6
#9	9.049 ± 1.391	30 ± 2	870 ± 76	41 ± 25	7 ± 4
#10	9.150 ± 732	29 ± 2	847 ± 78	42 ± 23	7 ± 6
Statistics	$F_{9,63} = 1.448$ $p = 0.187$	$F_{9,63} = 0.355$ $p = 0.951$	$F_{9,63} = 2,389$ $p < 0.02$*	$F_{9,63} = 1.157$ p =0.337	$F_{9,63} = 1.320$ $p = 0.244$

** Statistically significant at p< 0.02 in repeated-measures one-way analysis of variance between match 2 vs. match 3. Values are shown as mean ± SD.*

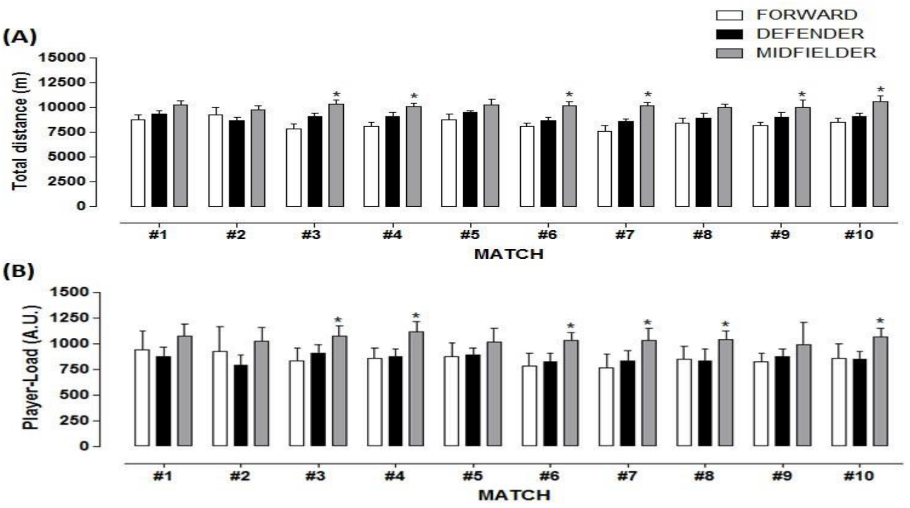

Figure 1. Mean ± standard deviation values for comparisons between groups (forward x defender × midfielder) and different training loads (total distance and player load) in professional soccer players. *p<0.001 - forward vs. midfielder

The two-way ANOVA yielded main effects for the group in total distance ($F_{2,21}$ = 17.68, p = 0.0001), player load ($F_{2,21}$ = 31.19, p = 0.0001) and maximal speed ($F_{2,21}$ = 4.36, p = 0.02) (Figure 1A, 1B and 2C, respectively). In addition, Bonferroni post hoc (p < 0.05) showed significant differences in the total distance (p<0.001) and player load (p<0.001) among midfielders vs. forward and defenders. However, maximal speed (p<0.05) was significantly greater among forward vs. midfielders and defenders in just one match. On the other hand, two-way ANOVA no showed main effects for the group in frequency of efforts ≥18 km/h ($F_{2,21}$ = 1.51, p = 0.24) and ≥24 km/h ($F_{2,21}$ = 0.75, p = 0.48) (Figure 1 and 2).

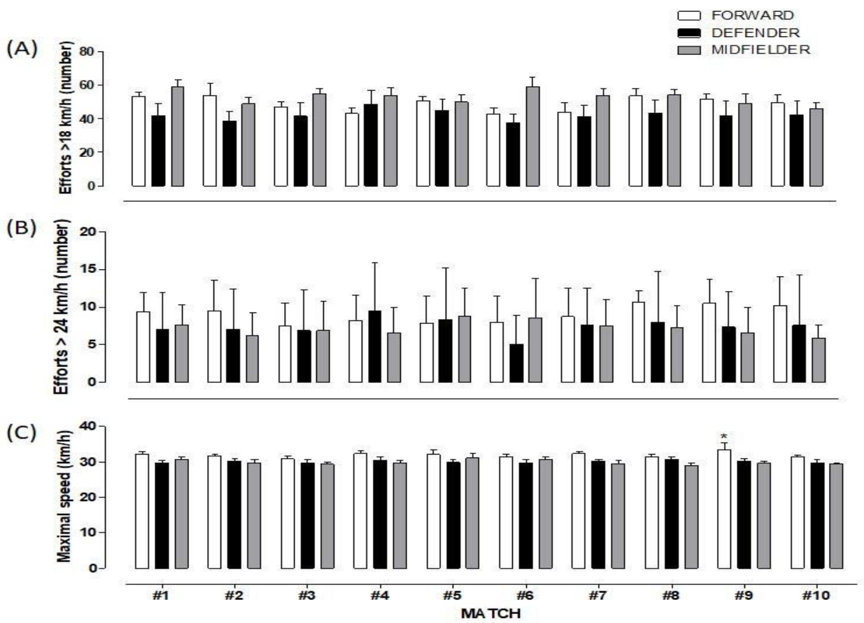

Figure 2. Mean ± standard deviation values for comparisons between groups (forward x defender × midfielder) and different training loads (frequency of efforts ≥18 km/h, frequency of efforts ≥24 km/h and maximal speed) in professional soccer players. *p<0.05 - forward vs. midfielder.

Discussion and Conclusion

The finding of this study showed that midfielders presented increase significant volume and intensity during 60% of the monitored matches. These results proved by the GPS during 10 official matches when compared to forward and defender. But this response during matches may not be sufficient to handle the intensity and stress associated with competitive soccer, leading to a higher risk of injuries. However, training load monitoring are crucial for providing information on the efficacy of training doses and for supporting injury prevention strategies (4).

Physiological stress during matches results in a temporary decrease in physical performance and an increase in post-match fatigue (1,8,9). In this respect, monitoring of training loads is crucial for providing information regarding the efficacy of training doses, and to assist recovery strategies. According to our results, we observed a high total distance in the midfielders possibly for covering more fields than other players during a match and helping to move the ball between the defense and the offense in order to facilitate goal-scoring opportunities. Thus, some studies concluded that midfielders showed a greater distance covered between 8% and 10.8% when compared to attacking and defending players, respectively (9-11). However, it seems that high total distance of the midfield players during the matches can be influenced by variables, other than those obtained by GPS, such as ball possession, number of key passes, dribbles, and shots (9). On the other hand, it seems that the greater volume of the midfielders during matches can contribute significantly to the incidence of injuries, such as: dislocation joints, haematoma and hamstring injuries (12,13). In this scenario, it is important to note that Injury risk is high especially during matches.

Nowadays, player load is considered viable method to track the external load in order to analyze movements such as accelerations, decelerations, and changes of direction during training and matches (1,2). Thus, the combined data from a triaxial accelerometer and time-motion analysis demonstrate that player-load should be considered part of the total load for a player during match-play, which is accumulated in a variety of forms across different playing positions (1,5). In addition, it has been observed a strong relationship was found between player load and metabolic power, which player load was obtained through the body movements detected by accelerometry and metabolic power through of the product of speed and energy cost of the activity derived from inclination and acceleration (14). In this scenario proposes that the magnitude of player load may highly depend on accelerations measured from motion as a consequence of locomotion at any speed (7). Corroborating this statement, a study showed that accelerations contribute to 7–10% of the total player load for all player positions, whereas decelerations contributed to 5–7% (15). In relation to player positions, our results of the player load midfielders showed an increase of 18,2% and 18% when compared to forwards vs. defenders, respectively. Other studies have shown similar results, where the difference in player load between midfielders x attackers and defenders was 15% and 19.8%, respectively (15,16). Thus, as mentioned earlier, the midfielders characteristic is to be an intense athlete to facilitate goal-scoring opportunities, but shown high risk of injury. In general, the player load may help coaches to better understand the different ways players achieve match load and could be used in developing individualized programs that better meet the player positions and minimize the risk injury in elite soccer (14-16).

Also, it is important to mention that the development of new technologies for diagnoses among soccer players is necessary to better understand the physiological responses to competition and advance injury risk prevention methods associated with match load and intensity (1-3). Valuable information may be identified about match load during matches, consequently, more detailed evaluations of injury risk and performance, and other factors that may signal injury risk (1-3).

The limitation of the study is the absence of measures of physiological parameters of physical exertion during matches, which would be interesting; this yet does not affect the answer to the study question. However, our sample was homogeneous although longitudinal studies are needed to define a cause-and-effect relationship among match load, strength muscle, and physiological adaptations in elite soccer players.

The results of this investigation confirm that midfielders soccer player shows greater total distance and player load in 60% of investigated matches. These results of this study provide information to coaches and physical trainers about specific variables during matches that should be observed during recovery to optimize resistance and power output.

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