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The Profile of the Internal Load of Amateur Soccer Players during Official Matches with Formation 1-4-3-3 and Relationships with Indexes of External Load

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Abstract: The purpose of this study was to investigate the internal load of amateur soccer players during official championship matches when playing with the 1-4-3-3 formation. Additionally, the possible relationship between internal load variables and external load indices was explored. The study involved 18 amateur soccer players, and the Polar Team Pro GPS system was used to record external load and heart rate (HR) during official championship matches. Internal load was assessed using %HRmax and Edward's training impulse ($TRIMP_{Edw}$). External load indices included total distance (TD), pace (distance/min), number of sprints, distance covered in different speed zones, accelerations (>2 m/s^2), and decelerations (<−2 m/s^2). Players were categorized as central defenders (CD), side defenders (SD), central midfielders (CM), side midfielders (SM), and forwards (F). The results indicated no differences in internal load indices among playing positions. During matches, SM performed the most sprints, while CD performed the fewest ($p < 0.05$). CD covered the shortest distances in speed zones >7.20 km/h, whereas CM and SM covered the longest distances ($p < 0.05$). Additionally, CD had fewer accelerations and decelerations compared to SM ($p < 0.05$). In the first half, differences were observed in pace (distance/min) ($p < 0.05$), but not in the second half. Between halves, differences in %HRmax were observed for all positions, while $TRIMP_{Edw}$ differed in CM and F. CM showed the most differences between halves. Throughout the matches, a high correlation was found between %HRmax and pace (distance/min), while $TRIMP_{Edw}$ correlated with TD, as well as distances in high-speed zones (14.40–25.19 km/h). This suggests that $TRIMP_{Edw}$ is a comprehensive indicator dependent on volume (TD) and on high-intensity actions, which are crucial in soccer, influencing players' and teams' performances. Therefore, for assessing the internal load of amateur soccer players, $TRIMP_{Edw}$ may be a more useful indicator. This study provides valuable information for coaches of amateur soccer teams using the 1-4-3-3 formation regarding running profiles, accelerations/decelerations, and the profile of internal load in each playing position. This information can be used to individualize training based on players' playing positions.

Keywords: soccer; internal and external load; TRIMP; heart rate; correlations

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1. Introduction

Soccer is an intermittent sport, and one of the key performance factors is physical fitness. Players need to develop both aerobic and anaerobic energy production mechanisms. In recent years, the frequency of matches has increased significantly [1], and the use of GPS (global positioning system) technology and heart rate monitors is very common between professional soccer teams during training microcycles. These technologies allow for the precise recording of external and internal loads on soccer players. Load management is a crucial aspect of coaching, and how coaches handle load characteristics such as intensity and volume will determine the effectiveness of the training process. Therefore, monitoring the load during a match can help determine the volume and intensity of loads to be used during the training microcycle [2].

The external load in a match is the set of actions that a soccer player takes during it. Recent studies have reported specific ratios for various external load parameters in relation to the match, providing coaches with thousands of data points from a single match. Commonly used parameters include total distance (TD), distance in different speed zones, accelerations, and decelerations [3,4]. The organism's response to psycho-physiological stimuli during a match constitutes the internal load [5]. Internal load measurement involves indicators related to the cardiovascular system (heart rate), neuromuscular system (rating of perceived exertion—RPE), and metabolic function (lactic acid) [6,7]. Additionally, several training impulse models (TRIMP) have been developed for estimating internal load, such as the Edward model, usually measured in arbitrary units [8]. According to the TRIMP method of Edward (1993) [9] ($TRIMP_{Edw}$), to calculate the internal load, they use accumulated time in five arbitrary heart rate zones multiplied by a weighting factor (1–5).

The external and internal load a player experiences during a match is influenced by their playing position and the team formation [10]. More specifically, previous studies have reported that central midfielders cover the longest distance compared to other positions [4,11], while wide midfielders and full backs cover the longest distance at high speed and sprint [12,13]. Also, the formation with which the team plays seem to affect the running performance of soccer players [14]. Baptista et al. (2019) [14] observed that players in the 1-4-5-1 formation covered more distance at high intensity than in the 1-3-5-2 formation.

In previous studies investigating the effect of position on formation, they observed that defenders in the 1-4-4-2 formation cover shorter overall distance and distance at high intensity compared to 1-4-3-3 and 1-4-5-1 formations [15]. Another study reported that central midfielders accelerate more often in the 1-4-2-3-1 formation and cover longer distances at high intensity in the 1-4-4-2 formation compared to other formations [16].

Regarding the internal load on soccer players in relation to the playing position or formation they play, studies are limited [7,17]. More specifically, Suarez-Arrones et al. (2015) [7] and Torreno et al. (2016) [17] observed that wide midfielders showed the lowest average heart rate and the highest internal load index compared to other positions, while center defenders showed a lower internal load index than all other positions in the 1-4-4-1-1 formation. Most studies in this area focus on professional or developmental-level soccer, leaving a gap in understanding the loads experienced by amateur players seeking performance improvement.

Therefore, the aim of this study was to investigate the internal load profile of amateur soccer players when playing in the 1-4-3-3 formation and explore possible relationships between internal load indicators and selected external load indices.

2. Materials and Methods

2.1. Subjects

The sample consisted of the 18 male players of an amateur soccer team during their official matches. Participants' characteristics presented in Table 1. All players participated in four training sessions a week and one match. Workouts included small-space competitive games and fitness exercises (aerobic capacity, speed). Consent forms were signed by adult participants or parents of youth participants after being informed about the potential risks and benefits of the study. The local Institutional Review Board approved the study (approval number 179/2023), in the spirit of the Helsinki Declaration.

Table 1. Participants' physical characteristics.

Variable	Mean ± SD
Age (years)	20.6 ± 2.4
Training age (years)	11.6 ± 3.4
Height (cm)	178.5 ± 4.1
Weight (kg)	72.5 ± 9.9
Body fat (%)	16.7 ± 3.1
Body mass index	22.7 ± 2.8
VO_{2max} (ml/kg.min)	48.8 ± 2.0

SD, standard deviation; VO_{2max}, maximum oxygen consumption.

2.2. Body Fat Measurement

The body fat percentage was estimated by measuring four skin folds (biceps, triceps, subscapularis, suprailiac) measured with the Lange skinfold meter (Lange, Beta Technology, Santa Cruz, CA, USA). All skin folds were on the right side of the athletes, as described in research by Slaughter et al. (1988) [18]. Finally, the estimate of body density was calculated according to the equation of Durnin and Rahaman (1967) [19] for people over 16 years of age, and the percentage of body fat was calculated from the equation of Siri (1956) [20].

2.3. Assessment of Maximum Oxygen Uptake

The Yo-Yo intermittent recovery test (level 1) (YYIR1) was used to assess VO_{2max}. The YYIR1 consists of 20 m shuttle runs with a progressive increase in running speed controlled by auditory signals from a sound playback device. Participants run 20 m, touch the finish line, and return following auditory cues, continuing until exhaustion. Their performance in the test was then used to calculate VO_{2max} using the equation of Leger et al. (1988) [21] (VO_{2max} = 31.025 + 3.238 × 1 − 3.248X2 + 0.1536X1X2, X1 = maximum running speed, km/h, X2 = age, years) (Table 1). The test was conducted on a synthetic turf. During the test, the football players wore the Polar Team Pro (Kempele, Finland) to record the maximum heart rate (HRmax).

2.4. Internal Load: Heart Rate and Training Impulse Edward ($TRIMP_{Edw}$)

The heart rate (HR) of the soccer players during matches was recorded in real time using the Polar Team Pro (Kempele, Finland). The variables collected and used during the matches included the percentage of maximum heart rate (%HRmax) and the time spent in five different heart rate zones (TimeHR1 50–59%, TimeHR2 60–69%, TimeHR3 70–79%, TimeHR4 80–89%, TimeHR5 90–100%). Additionally, Edwards' Training Impulse (Edwards' TRIMP, $TRIMP_{Edw}$) was used to assess internal load (Edward…). The equation used for calculating $TRIMP_{Edw}$ is shown below (Equation (1)):

$$TRIMP_{Edw} = (\text{duration in zone } 1 \times 1) + (\text{duration in zone } 2 \times 2) + (\text{duration in zone } 3 \times 3) + (\text{duration in zone } 4 \times 4) + (\text{duration in zone } 5 \times 5) \quad (1)$$

zone 1 = 50–59% of HRmax, zone 2 = 60–69% of HRmax, zone 3 = 70–79% of HRmax, zone 4 = 80–89% of HRmax, and zone 5 = 90-to-100% of HRmax

2.5. External Load

The recording of external load was conducted using a GPS system (Global Positioning System, 10 Hz Polar Team Pro, Kempele, Finland). The variables of external load that were recorded included total distance covered (TD), distance per minute (Dist/min, m/min), the number of sprints (Sprint > 25.20 km/h), distance covered in five different speed zones (speed zones: z1 0.10–7.19 km/h, z2 7.20–14.39 km/h, z3 14.40–19.79 km/h, z4

19.80–25.19 km/h, z5 > 25.20 km/h), the number of decelerations (Dec3: < −3.00 and Dec2 −2.99–−2.00 m/s^2), and the number of accelerations (Acc2: 2.00–2.99 and Acc3: >3.00 m/s^2).

2.6. Measurement Procedure

Before the commencement of match recordings, anthropometric measurements were taken on the field. Subsequently, a 15 min warm-up was conducted, followed by the assessment of VO_{2max} using the YYIR1. The measurement took place on a soccer field with synthetic turf, at least 48 h after the match.

As mentioned earlier, official championship matches were recorded. Players wore GPS devices before warm-up, and the data from the recording were transferred to an Excel sheet after the match. The validity and reliability of the GPS system have been previously reported [22,23] and utilized in soccer players [4,24]. To minimize variability among the GPS devices, each player used the same transmitter in all matches.

In the research analysis, only data meeting the following conditions were utilized:

- Pertained to matches in which no player was ejected.
- Pertained to official championship matches.
- Utilized data from players who participated in the entire match.
- Excluded data from players who changed positions during halftime.
- Excluded goalkeepers.
- The team formation was 1-4-3-3.

For the purpose of the study, 12 official league matches of the amateur soccer team were observed. Match analyses were conducted 4–11 times (for players) each over a one-year period (n = 86 match files). All matches were played on a soccer field with synthetic turf.

2.7. Positions in Formation

The player positions were based on an 1-4-3-3 formation, separated into central defenders (CD, 3 players), side defenders (SD, 4 players), central midfielders (CM, 4 players), side midfielders (SM, 4 players), and forwards (F, 3 players).

2.8. Statistical Analysis

IBM SPSS statistical package (Statistics for Windows, Version 25.0. Armonk, NY, USA: IBM Corp) was used for statistical analysis. Data are presented as mean ± standard deviation. Confidence intervals (95% CI) are also provided. Descriptive statistics were conducted using Descriptives Statistics. The Shapiro–Wilk test was employed to check the normality of the data. A repeated measures analysis of variance (GLM Repeated Measures ANOVA) was conducted, and in cases of statistically significant differences, the post hoc Bonferroni test was applied. Differences between the first and second halves of the match were assessed using Student's dependent t-test for paired samples. For the investigation of correlations, the statistical Pearson correlation was applied. Partial eta squared values were reported, categorized as small (0.01–0.059), moderate (0.06–0.137), and large (>0.138) according to Cohen (1988) [25]. Coefficients of variation (CV) were used to assess the reliability of the test. The level of statistical significance was set at $p < 0.05$.

3. Results

3.1. External Load Indicators

From the results for the entire match, no differences were observed among playing positions in the total distance covered by players ($F = 0.166$, $p = 0.954$, $\eta^2 = 0.016$) and in the distance per minute ($F = 1.689$, $p = 0.171$, $\eta^2 = 0.141$). Differences were noted in z2 ($F = 4.796$, $p = 0.003$, $\eta^2 = 0.319$), where CM differed from CD ($p = 0.007$) and SM ($p = 0.006$). In z3 ($F = 6.490$, $p < 0.001$, $\eta^2 = 0.388$), CD differed from all other positions (SD, $p = 0.002$; CM, $p < 0.001$; SM, $p = 0.012$; F, $p = 0.048$). In z4 ($F = 12.381$, $p < 0.001$, $\eta^2 = 0.547$), CD differed from SD ($p < 0.001$), SM ($p < 0.001$), and F ($p < 0.001$), and CM differed from SD ($p = 0.006$) and

SM (p = 0.019). In z5 (F = 4.043, p = 0.007, η^2 = 0.283), CD differed from SM (p = 0.022). Differences were observed in the number of sprints (F = 4.766, p = 0.003, η^2 = 0.317) between SM and CD (p = 0.015) and CM (p = 0.028). Also, differences were observed in the number of accelerations (Acc2) (F = 2.894, p = 0.034, η^2 = 0.224) between CD and SD (p = 0.027) and in the number of decelerations (Dec2) (F = 4.586, p = 0.004, η^2 = 0.314) between CD and SD (p = 0.027) and CM (p = 0.004). Overall, the external load indicators for the entire match are presented in Figures 1 and 2. Confidence intervals (CI) for all variables are shown in Table 2.

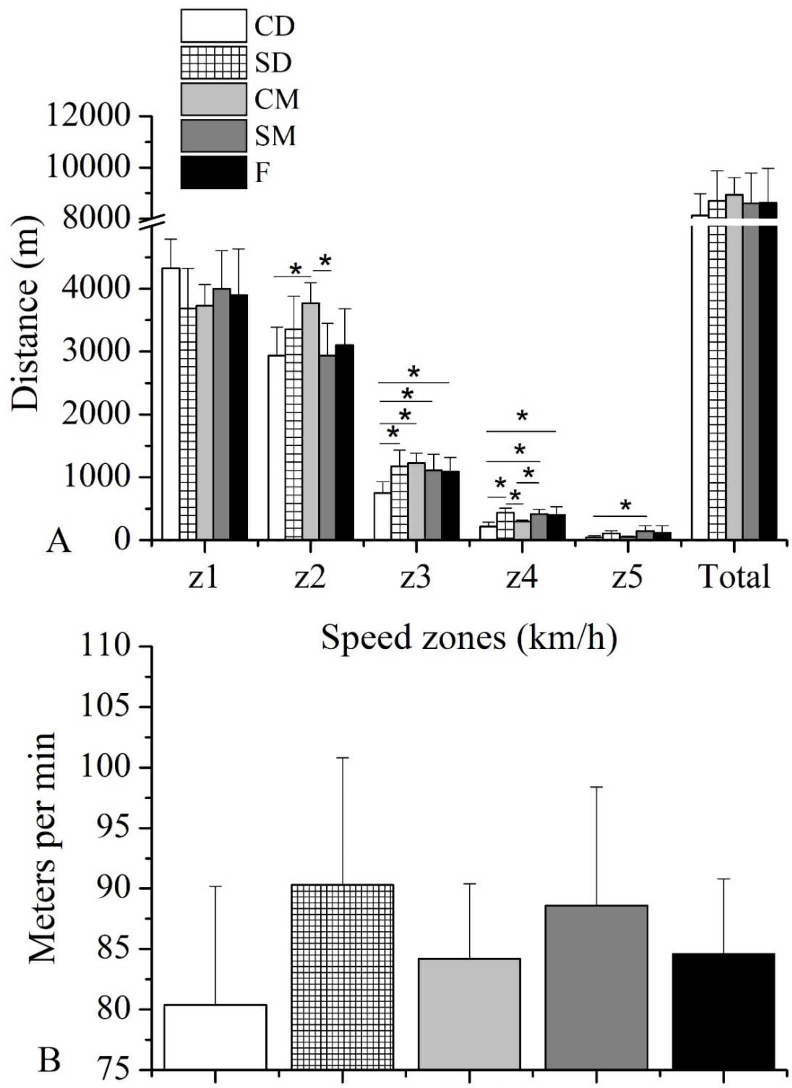

Figure 1. (**A**). Position differences per speed zone in the match. (**B**). Differences in running pace between positions. * Denotes a significant difference (p < 0.05). Speed zones: z1 0.10–7.19 km/h, z2 7.20–14.39 km/h, z3 14.40–19.79 km/h, z4 19.80–25.19 km/h, z5 > 25.20 km/h. CD: central defenders, SD: side defenders, CM: central midfielders, SM: side midfielders, F: forwards.

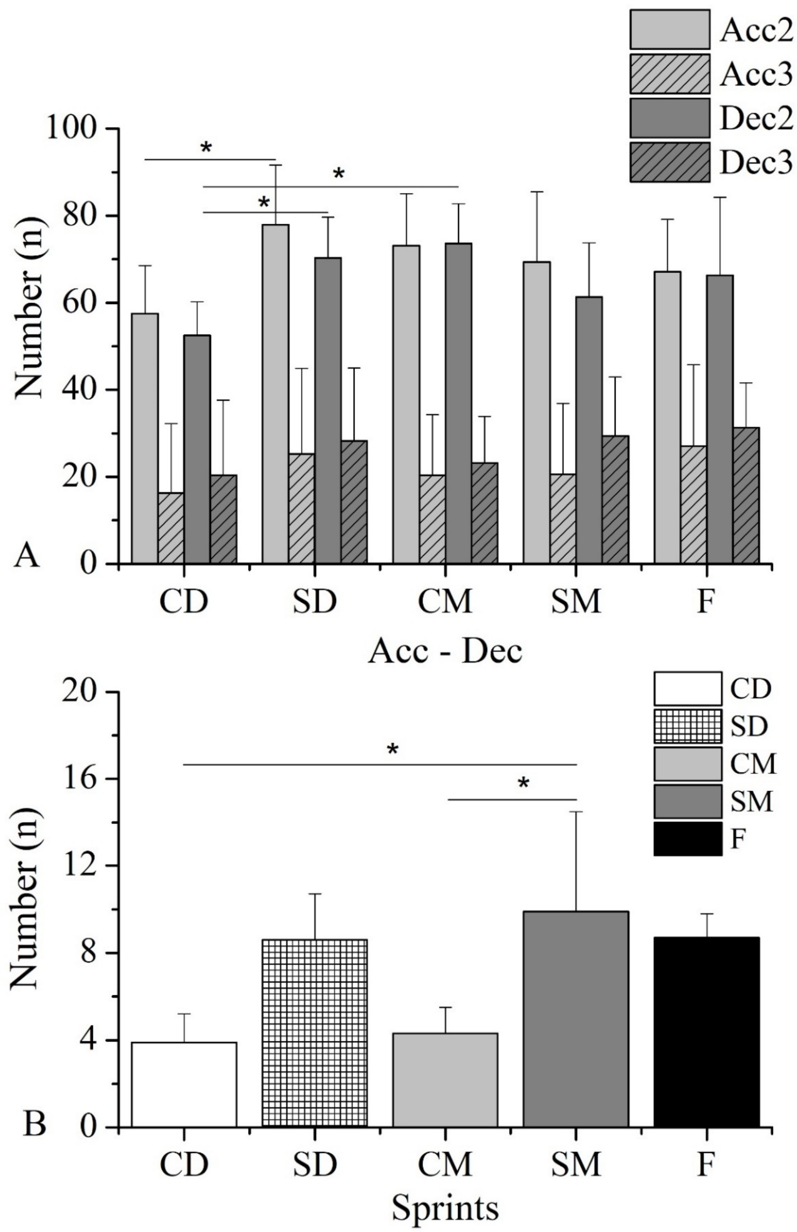

Figure 2. (**A**). Differences in accelerations and decelerations between positions. (**B**). Differences in number of sprints between positions. * Denotes a significant difference ($p < 0.05$). Acc2: 2.00–2.99, Acc3: >3.00 m/s^2, Dec2: −2.99–−2.00 m/s^2, Dec3: <−3.00. CD: central defenders, SD: side defenders, CM: central midfielders, SM: side midfielders, F: forwards.

Table 2. Confidence intervals (95% CI).

	CD	**SD**	**CM**	**SM**	**F**
Full match					
% HRmax	79.2–84.5	81.6–88.3	81.1–84.2	81.1–85.4	80.3–84.7
$TRIMP_{Edw}$	302–403	322–420	340–395	306–402	292–419
TD	7044–11,205	7754–9655	8420–9445	7703–9499	7259–9965
D/min	73–88	82–99	79–89	81–96	78–88
Sprint	2.9–4.9	6.8–10.3	3.4–5.2	6.4–13.4	1.6–15.8
z1	3971–4673	3167–4207	3475–3984	3540–4455	3170–4631

z2	2596–3276	2924–3783	3527–4016	2546–3320	2528–3677
z3	613–886	967–1387	1103–3345	915–1304	867–1312
z4	169–267	371–496	276–314	359–473	273–529
z5	24–65	65–143	34–62	81–208	6–230
Acc2	49.2–65.8	66.7–89.1	64.1–82.7	56.3–82.6	55.1–79.2
Acc3	1.5–31.0	9.1–41.2	9.7–30.8	7.4–33.9	8.4–45.9
Dec2	46.7–58.3	62.5–77.9	66.7–80.5	51.2–71.5	48.4–84.1
Dec3	7.2–33.0	14.5–41.9	15.2–31.3	18.4–40.4	21.1–41.6
First half					
% HRmax	82.3–87.2	84.2–88.6	86.2–88.0	84.3–87.3	83.2–84.4
$TRIMP_{Edw}$	174–199	184–203	192–202	168–198	161–206
TD	4149–4426	4659–4950	4693–5024	4656–4935	4132–4962
D/min	91.4–94.8	102.4–107.0	103.6–107.7	102.2–106.3	97.4–105.8
Sprint	3.5–6.7	8.1–14.9	4.5–9.4	7.6–12.3	4.7–7.9
z1	2135–2248	1918–2051	1924–2021	2165–2302	2019–20,181
z2	1528–1700	1780–2040	1972–2218	1583–1801	1662–1921
z3	435–557	708–841	546–833	543–768	484–688
z4	83–177	186–356	114–289	197–356	118–311
z5	4–79	9–207	4–114	27–176	12–117
Acc2	26.6–33.6	36.9–51.4	36.6–48.3	34.7–46.0	29.2–41.7
Acc3	1.3–15.7	6.2–23.2	5.0–18.4	5.8–19.6	5.2–24.5
Dec2	25.8–32.1	35.3–44.9	40.6–47.5	31.1–40.5	26.1–49.5
Dec3	4.1–16.6	9.8–23.2	8.6–18.9	11.1–24.6	12.6–21.9
Second half					
% HRmax	79.1–84.5	80.4–87.4	80.0–83.9	80.8–85.2	79.7–85.6
$TRIMP_{Edw}$	145–183	133–214	135–183	107–179	121–197
TD	3327–4369	3222–5011	3308–4423	2883–4690	3025–4859
D/min	73.9–87.6	65.2–101.5	71.1–90.8	68.1–96.7	70.8–94.3
Sprint	0.2–5.5	2.5–6.5	0.4–5.4	3.1–7.2	0.3–8.1
z1	1713–2297	1327–2220	1358–1930	1305–2137	1239–2297
z2	1010–1552	1120–1924	1190–1835	888–1687	1063–1802
z3	264–489	423–671	468–600	350–638	359–643
z4	62–184	141–286	91–172	134–248	132–242
z5	0.3–79	27.2–78	1.0–64.0	45.6–121.0	1.5–115.1
Acc2	21.2–39.9	27.9–44.1	24.8–37.2	19.9–40.6	22.6–39.4
Acc3	0.3–15.4	3.7–18.6	4.5–12.7	2.6–13.2	2.8–21.5
Dec2	18.6–28.1	26.3–37.1	24–35.4	18.2–34.8	19.9–36.4
Dec3	3.1–16.7	4.8–20.1	6.1–12.8	8.2–15.5	7.6–20.6

% HRmax: percentage of maximum heart rate; TRIMPEdw: Edward training impulse for internal load; TD: total distance; D/min: distance (m) per minute; speed zones: z1: 0.10–7.19 km/h, z2: 7.20–14.39 km/h, z3: 14.40–19.79 km/h, z4: 19.80–25.19 km/h, z5: > 25.20 km/h; Acc2: 2.00–2.99, Acc3: >3.00 m/s^2, Dec2: −2.99–−2.00 m/s^2, Dec3: <−3.00; CD: central defenders, SD: side defenders, CM: central midfielders, SM: side midfielders, F: forwards.

From the results of the ANOVA for differences between positions in the first half, differences were observed in total distance (TD) (F = 8.646, $p < 0.001$, $\eta^2 = 0.458$). Specifically, CD differed from SD ($p < 0.001$), CM ($p < 0.001$), and SM ($p < 0.001$). Differences were also observed in the rate (m/min) (F = 6.554, $p < 0.001$, $\eta^2 = 0.390$), with CD differing from SD ($p = 0.004$), CM ($p < 0.001$), and SM ($p = 0.003$). Differences were observed in different speed zones: z1 (F = 4.590, $p = 0.004$, $\eta^2 = 0.309$), z2 (F = 3.317, $p = 0.019$, $\eta^2 = 0.245$), z3 (F = 4.243, $p = 0.006$, $\eta^2 = 0.293$), z4 (F = 3.166, $p = 0.023$, $\eta^2 = 0.236$). In z1, SM differed from SD ($p = 0.026$) and CM ($p = 0.026$); in z2, CD differed from CM ($p = 0.023$); in z3, CD differed from SD ($p = 0.01$) and CM ($p = 0.016$); and in z4, CD differed from SM ($p = 0.033$). In Dec2, differences were observed among CD (F = 6.218, $p < 0.001$, $\eta^2 = 0.378$) with SD ($p = 0.014$) and CM ($p < 0.001$). In Acc2, CD differed (F = 5.467, $p = 0.001$, $\eta^2 = 0.348$) from SD ($p = 0.002$), CM ($p = 0.007$), and SM ($p = 0.043$). In the second half, no differences were observed between positions. All statistical indices are presented in Table 3.

Table 3. ANOVA results.

		Full Match	First Half	Second Half
	F	1.196	1.835	0.569
% HRmax	*p*	0.327	0.141	0.686
	η^2	0.104	0.152	0.053
	F	0.175	1.191	0.701
$TRIMP_{Edw}$	*p*	0.250	0.329	0.596
	η^2	0.017	0.104	0.064
	F	0.166	8.646 *	0.149
TD	*p*	0.954	<0.001	0.969
	η^2	0.016	0.458	0.014
	F	1.689	6.554 *	0.042
D/min	*p*	0.171	<0.001	0.996
	η^2	0.141	0.390	0.004
	F	4.766 *	0.961	0.839
Sprint	*p*	0.003	0.439	0.509
	η^2	0.317	0.086	0.076
	F	1.798	4.590 *	0.699
z1	*p*	0.148	0.004	0.597
	η^2	0.149	0.309	0.064
	F	4.796 *	3.317 *	0.605
z2	*p*	0.003	0.019	0.662
	η^2	0.319	0.245	0.056
	F	6.490 *	4.243 *	1.810
z3	*p*	<0.001	0.006	0.145
	η^2	0.388	0.293	0.150
	F	12.381 *	3.166 *	2.514
z4	*p*	<0.001	0.023	0.056
	η^2	0.547	0.236	0.197
	F	4.043 *	1.053	1.508
z5	*p*	0.007	0.392	0.218
	η^2	0.283	0.093	0.128
	F	2.894 *	5.467 *	0.877
Acc2	*p*	0.034	0.001	0.486
	η^2	0.224	0.348	0.079
	F	0.454	0.623	0.427
Acc3	*p*	0.769	0.649	0.788
	η^2	0.043	0.057	0.040
	F	4.586 *	6.218 *	1.313
Dec2	*p*	0.004	<0.001	0.281
	η^2	0.314	0.378	0.114
	F	0.827	1.370	0.551
Dec3	*p*	0.516	0.261	0.669
	η^2	0.076	0.118	0.051

* Denotes a significant difference ($p < 0.05$). % HRmax: percentage of maximum heart rate; $TRIMP_{Edw}$: Edward training impulse for internal load; TD: total distance; D/min: distance (m) per minute; speed zones: z1: 0.10–7.19 km/h, z2: 7.20–14.39 km/h, z3: 14.40–19.79 km/h, z4: 19.80–25.19 km/h, z5: > 25.20 km/h; Acc2: 2.00–2.99, Acc3: >3.00 m/s^2, Dec2: −2.99–−2.00 m/s^2, Dec3: <−3.00.

In the second half, the performance of the players decreased. Specifically, the total distance covered by CM players (t = 3.638, *p* = 0.005, d = 1.150) and SM players (t = 2.299, *p* = 0.047, d = 0.727) decreased in the second half. CM players reduced their performance in speed zones z1 (t = 2.692, *p* = 0.025, d = 0.851), z2 (t = 4.429, *p* = 0.002, d = 1.401), z3 (t = 2.226, *p* = 0.049, d = 0.717), and z4 (t = 2.709, *p* = 0.024, d = 0.857). The differences between halves are presented in Figure 3, and the statistical indices are shown in Table 4.

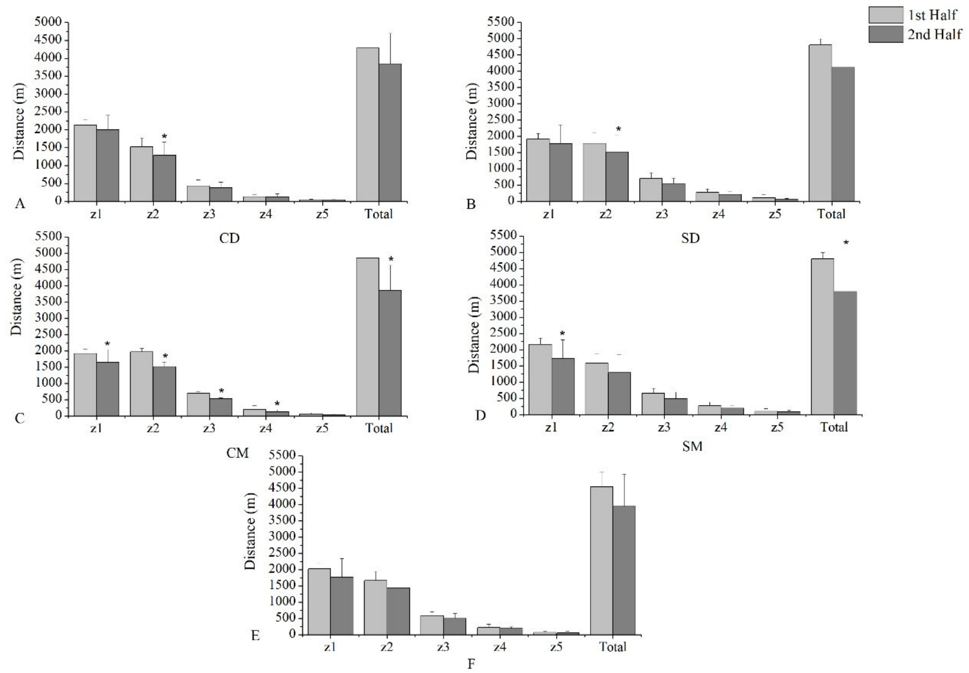

Figure 3. Match running performance differences between halves for each playing position per speed zone. (**A**) Position CD; (**B**) position SD; (**C**) position CM; (**D**) position SM; (**E**) position (**F**). * Denotes a significant difference (*p* < 0.05). Speed zones: z1: 0.10–7.19 km/h, z2: 7.20–14.39 km/h, z3: 14.40–19.79 km/h, z4: 19.80–25.19 km/h, z5: > 25.20 km/h. CD: central defenders, SD: side defenders, CM: central midfielders, SM: side midfielders, F: forwards.

Table 4. Statistical indexes for differences between halves.

	CD	**SD**	**CM**	**SM**	**F**
	t = 6.101	t = 4.269 *	t = 5.604 *	t = 3.145 *	t = 2.792 *
% HRmax	*p* < 0.001	*p* = 0.003	*p* < 0.001	*p* = 0.012	*p* = 0.032
	d = 1.848	d = 1.423	d = 1.772	d = 0.994	d = 1.055
	t = 2.081	t = 1.173	t = 3.886	t = 2.137	t = 2.443 *
$TRIMP_{Edw}$	*p* = 0.067	*p* = 0.274	*p* = 0.004	*p* = 0.061	*p* = 0.049
	d = 0.658	d = 0.391	d = 1.229	d = 0.676	d = 0.923
	t = 2.103	t = 1.794	t = 3.638 *	t = 2.299 *	t = 2.255
TD	*p* = 0.065	*p* = 0.123	*p* = 0.005	*p* = 0.047	*p* = 0.065
	d = 0.665	d = 0.575	d = 1.150	d = 0.727	d = 0.852
	t = 4.420 *	t = 2.258 *	t = 4.496 *	t = 2.509 *	t = 3.14 3*
D/min	*p* = 0.002	*p* = 0.049	*p* = 0.001	*p* = 0.033	*p* = 0.020
	d = 1.398	d = 0.753	d = 1.422	d = 0.793	d = 1.188
	t = 1.024	t = 1.317	t = 1.238	t = 1.391	t = 0.778
Sprint	*p* = 0.333	*p* = 0.224	*p* = 0.247	*p* = 0.198	*p* = 0.466
	d = 0.324	d = 0.439	d = 0.391	d = 0.440	d = 0.294
	t = 1.194	t = 0.874	t = 2.692 *	t = 2.347 *	t = 1.526
z1	*p* = 0.263	*p* = 0.408	*p* = 0.025	*p* = 0.043	*p* = 0.178
	d = 0.378	d = 0.291	d = 0.851	d = 0.742	d = 0.571

z2	t = 2.841 * *p* = 0.019 d = 0.898	t = 2.970 * *p* = 0.018 d = 0.990	t = 4.429 *p* = 0.002 d = 1.401	t = 1.868 *p* = 0.095 d = 0.591	t = 2.003 *p* = 0.092 d = 0.757
z3	t = 1.429 *p* = 0.187 d = 0.452	t = 1.832 *p* = 0.104 d = 0.611	t = 2.266 * *p* = 0.049 d = 0.717	t = 2.186 *p* = 0.057 d = 0.691	t = 1.917 *p* = 0.104 d = 0.725
z4	t = 0.384 *p* = 0.710 d = 0.122	t = 0.990 *p* = 0.351 d = 0.330	t = 2.709 *p* = 0.024 d = 0.857	t = 1.728 *p* = 0.118 d = 0.546	t = 0.715 *p* = 0.501 d = 0.270
z5	t = −0.099 *p* = 0.923 d = 0.031	t = 1.409 *p* = 0.196 d = 0.470	t = 1.723 *p* = 0.112 d = 0.549	t = 0.573 *p* = 0.581 d = 0.181	t = 1.289 *p* = 0.245 d = 0.487
Acc2	t = 1.563 *p* = 0.152 d = 0.494	t = 1.639 * *p* = 0.014 d = 0.546	t = 3.520 * *p* = 0.007 d = 1.113	t = 1.599 *p* = 0.082 d = 0.619	t = 1.129 *p* = 0.302 d = 0.427
Acc3	t = 0.616 *p* = 0.553 d = 0.195	t = 2.991 * *p* = 0.017 d = 0.997	t = 2.096 *p* = 0.066 d = 0.663	t = 2.781 * *p* = 0.021 d = 0.879	t = 2.209 *p* = 0.069 d = 0.835
Dec2	t = 2.235 *p* = 0.052 d = 0.707	t = 2.392 * *p* = 0.044 d = 0.797	t = 5.242 * *p* < 0.001 d = 1.658	t = 2.137 *p* = 0.061 d = 0.676	t = 2.299 *p* = 0.061 d = 0.869
Dec3	t = 0.704 *p* = 0.499 d = 0.223	t = 1.827 *p* = 0.105 d = 0.609	t = 3.277 * *p* = 0.010 d = 1.036	t = 2.646 * *p* = 0.027 d = 0.837	t = 1.626 *p* = 0.155 d = 0.615

* Denotes a significant difference ($p < 0.05$). % HRmax: percentage of maximum heart rate; TRIMPEdw: Edward training impulse for internal load; TD: total distance; D/min: distance (m) per minute; speed zones: z1: 0.10–7.19 km/h, z2: 7.20–14.39 km/h, z3: 14.40–19.79 km/h, z4: 19.80–25.19 km/h, z5: > 25.20 km/h; Acc2: 2.00–2.99, Acc3: >3.00 m/s^2, Dec2: −2.99–−2.00 m/s^2, Dec3: <−3.00; CD: central defenders, SD: side defenders, CM: central midfielders, SM: side midfielders, F: forwards.

Additionally, the number of Acc2 decreased for SD players (t = 1.639, *p* = 0.014, d = 0.546) and CM players (t = 3.520, *p* = 0.007, d = 1.113), and more intense accelerations of Acc3 decreased for SD players (t = 2.991, *p* = 0.017, d = 0.997) and SM players (t = 2.781, *p* = 0.021, d = 0.879). SD players reduced the number of Dec2 (t = 2.392, *p* = 0.044, d = 0.797). SM players reduced Dec3 (t = 2.646, *p* = 0.027, d = 0.837), while CM players reduced both Dec2 (t = 5.242, *p* < 0.001, d = 1.658) and very intense decelerations of Dec3 (t = 3.277, *p* = 0.010, d = 1.036). The differences between halves are presented in Figure 4.

In all playing positions, there was a decrease in pace (distance/min) between the two halves (CD: t = 4.420, *p* = 0.002, d = 1.398; SD: t = 2.258, *p* = 0.049, d = 0.753; CM: t = 4.496, *p* = 0.001, d = 1.422; SM: t = 2.509, *p* = 0.033, d = 0.793; F: t = 3.143, *p* = 0.02, d = 1.188). The changes between halves are presented in Figure 5.

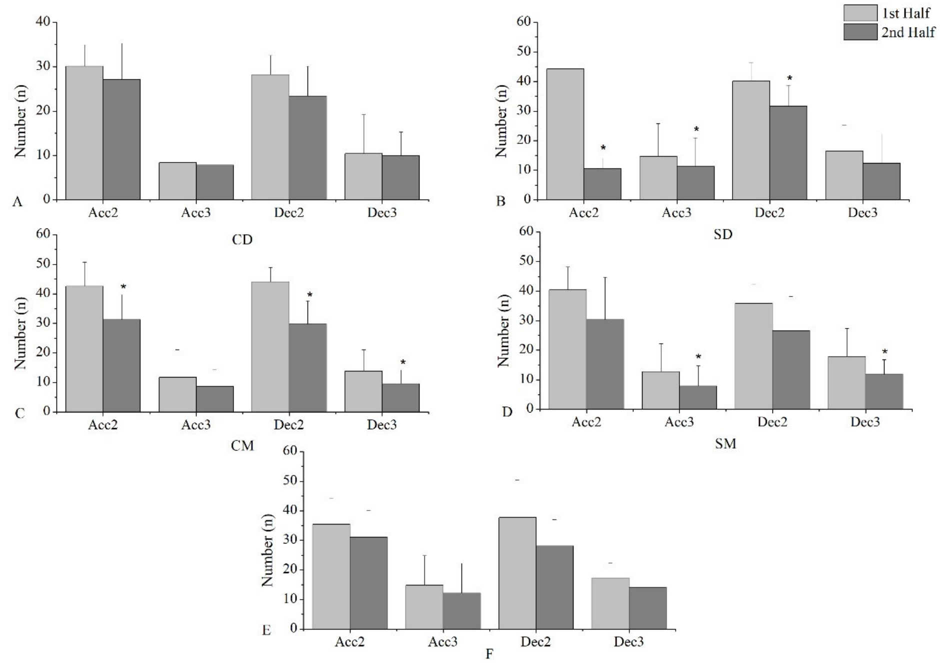

Figure 4. Acceleration and deceleration differences between halves for each playing position. (**A**) position CD; (**B**) position SD; (**C**) position CM; (**D**) position SM; (**E**) position (**F**). * Denotes a significant difference ($p < 0.05$). Acc2: 2.00–2.99, Acc3: >3.00 m/s², Dec2: −2.99–−2.00 m/s², Dec3: <−3.00.

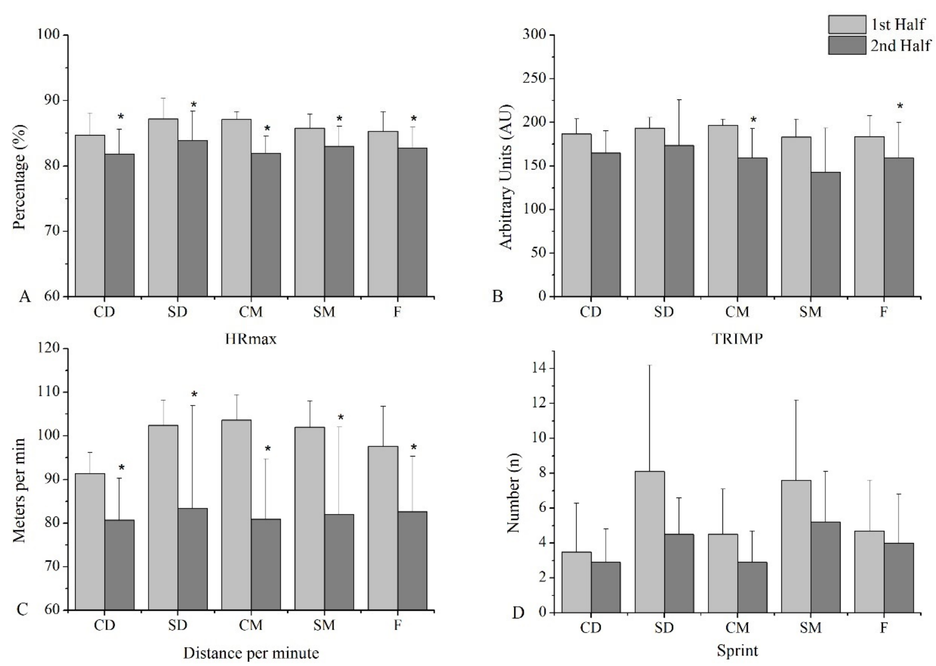

Figure 5. (**A**). Differences of %HRmax between halves for each playing position. (**B**). Differences of $TRIMP_{Edw}$ load between halves for each playing position. (**C**). Differences of distance per minute between halves for each playing position. (**D**). Differences of number of sprints between halves for each playing position. * Denotes a significant difference ($p < 0.05$). CD: central defenders, SD: side defenders, CM: central midfielders, SM: side midfielders, F: forwards.

3.2. Internal Load Indicators

From the results for the entire match, no differences were observed between positions in either of the two internal load variables (% HRmax: F = 1.196, p = 2.327, η^2 = 0.104; $TRIMP_{Edw}$: F = 0.175, p = 0.950, η^2 = 0.017) (Figure 6). Furthermore, no differences were observed between positions in each half separately (first half: (% HRmax: F = 1.835, p = 0.141, η^2 = 0.152; $TRIMP_{Edw}$: F = 0.191, p = 0.329, η^2 = 0.104; second half: (% HRmax: F = 0.569, p = 0.686, η^2 = 0.053; $TRIMP_{Edw}$: F = 0.701, p = 0.596, η^2 = 0.064)). The internal load indicators for the entire match are presented in Figure 5B. From the results, it was evident that % HRmax differed significantly between the two halves in all positions. Specifically, in all positions, the % HR decreased (CD: t = 6.101, p < 0.001, d = 1.848; SD: t = 4.269, p = 0.003, d = 1.423; CM: t = 5.604, p < 0.001, d = 1.772; SM: t = 3.145, p = 0.012, d = 0.994; F: t = 2.792, p = 0.032, d = 1.055) (Figure 5A). The internal load evaluated using the $TRIMP_{Edw}$ method decreased for CM (t = 3.886, p = 0.004, d = 1.229) and F (t = 2.443, p = 0.049, d = 0.923).

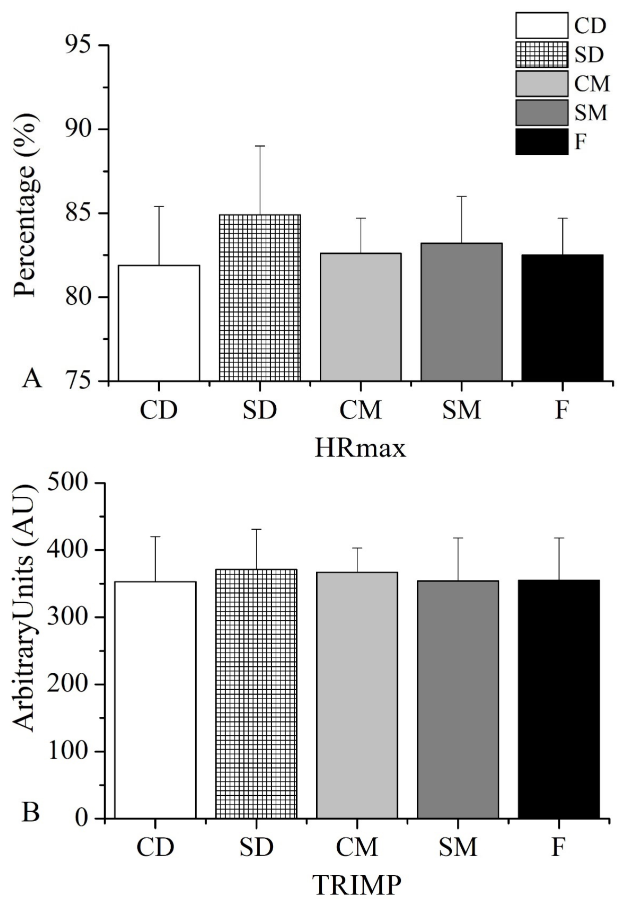

Figure 6. (**A**). Differences in percentage of heart rate max between positions. (**B**). Differences of $TRIMP_{Edw}$ load between positions. CD: central defenders, SD: side defenders, CM: central midfielders, SM: side midfielders, F: forwards.

3.3. Relationships between Internal and External Load Indicators

From the correlation results, it was observed that % HRmax positively correlated with the pace (distance/minute, D/min) (r = 0.540, p < 0.001). Additionally, a negative correlation was observed with the distances covered by the players in z1 (3935 ± 613 m) (r = −0.442, p = 0.002). $TRIMP_{Edw}$ showed a strong positive correlation with TD (r = 0.547, p < 0.001) and with zones 1 to 4 (z1: r = 0.529, p < 0.001; z2: r = 0.543, p < 0.001; z3: r = 0.326, p =

0.027; z4: r = 0.362, p = 0.013). In z5 (r = 0.281, p = 0.058) and in the number of sprints (r = 0.282, p = 0.057), there was a trend towards positive correlations.

In the first half, correlations of % HRmax were observed with TD (r = 0.412, p = 0.004), D/min (r = 0.391, p = 0.007), the distance covered in z2 (r = 0.346, p = 0.019), and the number of Dec2 (r = 0.365, p = 0.013). $TRIMP_{Edw}$ showed a positive correlation with TD (r = 0.338, p = 0.022) and with z2 (r = 0.429, p = 0.003). In the second half, correlations of % HRmax were observed with D/min (r = 0.371, p = 0.011), the distance covered in z2 (r = 0.350, p = 0.017), and the number of Dec2 (r = 0.378, p = 0.01). $TRIMP_{Edw}$ showed a positive correlation with most external load indicators (TD: r = 0.887, p < 0.001; D/min: r = 0.733, p < 0.001; z1: r = 0.857, p < 0.001; z2: r = 0.737, p < 0.001; z3: r = 0.470, p < 0.001; z4: r = 0.322, p = 0.029; Dec3: r = 0.384, p = 0.008; Dec2: r = 0.654, p < 0.001; Acc2: r = 0.642, p < 0.001). All correlation indices are presented in Table 5.

Table 5. Correlation of statistical indexes.

	Full Match		**First Half**		**Second Half**	
	% HRmax	**$TRIMP_{Edw}$**	**% HRmax**	**$TRIMP_{Edw}$**	**% HRmax**	**$TRIMP_{Edw}$**
TD	r = −0.043 p = 0.0774	r = 0.547 * p < 0.001	r = 0.412 * p = 0.004	r = 0.338 * p = 0.022	r = 0.274 p = 0.066	r = 0.887 * p < 0.001
D/min	r = 0.540 * p < 0.001	r = −0.237 p = 0.112	r = 0.391 * p = 0.007	r = 0.203 p = 0.176	r = 0.371 * p = 0.011	r = 0.733 * p < 0.001
Sprint	r = 0.122 p = 0.419	r = 0.282 p = 0.057	r = 0.036 p = 0.814	r = −0.142 p = 0.348	r = 0.042 p = 0.781	r = −0.030 p = 0.845
z1	r = −0.442 * p = 0.002	r = 0.529 * p < 0.001	r = −0.235 p = 0.115	r = −0.148 p = 0.326	r = 0.096 p = 0.526	r = 0.857 * p < 0.001
z2	r = 0.024 p = 0.872	r = 0.543 * p < 0.001	r = 0.346 * p = 0.019	r = 0.429 * p = 0.003	r = 0.350 * p = 0.017	r = 0.737 * p < 0.001
z3	r = 0.211 p = 0.160	r = 0.326 * p = 0.027	r = 0.244 p = 0.102	r = 0.095 p = 0.529	r = 0.281 p = 0.058	r = 0.470 * p < 0.001
z4	r = 0.259 p = 0.082	r = 0.362 * p = 0.013	r = 0.177 p = 0.239	r = 0.034 p = 0.822	r = 0.241 p = 0.107	r = 0.322 * p = 0.029
z5	r = 0.098 p = 0.518	r = 0.281 p = 0.058	r = 0.064 p = 0.671	r = −0.180 p = 0.230	r = 0.037 p = 0.809	r = −0.056 p = 0.711
Acc2	r = −0.103 p = 0.501	r = 0.223 p = 0.141	r = 0.230 p = 0.124	r = −0.069 p = 0.651	r = 0.266 p = 0.074	r = 0.642 * p < 0.001
Acc3	r = 0.216 p = 0.155	r = 0.083 p = 0.588	r = 0.140 p = 0.354	r = 0.191 p = 0.205	r = 0.085 p = 0.575	r = 0.290 p = 0.051
Dec2	r = 0.005 p = 0.975	r = 0.447 * p = 0.002	r = 0.365 * p = 0.013	r = 0.220 p = 0.143	r = 0.378 * p = 0.010	r = 0.654 * p < 0.001
Dec3	r = 0.204 p = 0.180	r = 0.060 p = 0.694	r = 0.146 p = 0.344	r = 0.186 p = 0.216	r = 0.144 p = 0.339	r = 0.384 * p = 0.008

* Denotes a significant difference (p < 0.05). % HRmax: percentage of maximum heart rate; TRIMPEdw: Edward training impulse for internal load; TD: total distance; D/min: distance (m) per minute; speed zones: z1: 0.10–7.19 km/h, z2: 7.20–14.39 km/h, z3: 14.40–19.79 km/h, z4: 19.80–25.19 km/h, z5: > 25.20 km/h; Acc2: 2.00–2.99, Acc3: >3.00 m/s^2, Dec2: −2.99–−2.00 m/s^2, Dec3: <−3.00.

4. Discussion

The aim of this study was to investigate the internal load of amateur soccer players during official soccer matches played with the 1-4-3-3 formation and to explore possible relationships with external load indicators. The results revealed the following: (1) In all playing positions during the second half, a decrease in %HRmax was observed. (2) In all playing positions during the second half, a decrease in running pace (m/min) was noted. (3) CM exhibited the greatest decline in most indicators in the second half. (4) A reduction in $TRIMP_{Edw}$ was observed only in the CM and F positions. (5) %HRmax was significantly correlated with running pace (m/min), while $TRIMP_{Edw}$ was correlated with TD and distances covered in different speed zones during matches. (6) No differences were observed in the two internal load indicators among different playing positions.

In recent years, researchers have been attempting to observe the relationships between the external load experienced by soccer players during matches and internal load indicators. However, studies that utilize heart rate (HR) as an internal load indicator are limited, and most of them employ the rating of perceived exertion (RPE) [5,26]. They examine the relationship during training sessions or simulated matches and not actual matches [27–30].

Starting with $TRIMP_{Edw}$ in the present study, it was found to be positively correlated with TD; distance in zones z1, z2, z3, and z4; and the number of Dec2. Additionally, in the first half, it positively correlated with the TD and z2, while in the second half, it showed positive correlations with almost all variables. Positive correlations were also reported in a previous study [31], where $TRIMP_{Edw}$ was positively correlated with total distance ($r = 0.72$). However, the above study focused on training sessions rather than actual matches. In the same study, a correlation of $TRIMP_{Edw}$ with distance at high intensity and the number of sprints was observed. In the present study, % HRmax correlated with running pace in both halves and throughout the entire match. A recent study [32] observed moderate to large correlations between time spent in low- and moderate-intensity activities and HR zones of low and moderate intensity. No correlations were observed at high intensities. In their study, Silva et al. (2018) [33] noted a correlation between time spent above 80% HRmax and the number of intense accelerations and repeated intense efforts.

Both in the present study and in the studies mentioned earlier, either no correlations were found with the covered distance, or the correlations were weak. It is known that during matches, HR does not respond immediately to intense actions, especially when these efforts have very short durations. This may explain the lack of correlations with high-speed zones [32,34]. From the internal load indicators in the present study, it appears that % HRmax is best estimated by the players' running pace (m/min), while the $TRIMP_{Edw}$ index is best estimated by the total distance (TD) and distances in zones (1,2,3,4) and Dec2.

As mentioned in the results, no differences were observed in the two internal load indicators (% HRmax, $TRIMP_{Edw}$) among different playing positions. This suggests that the external load experienced by the players in the 1-4-3-3 formation forces them to compete under similar internal load. Therefore, although the external load differs, as will be discussed below, the same was not observed in the internal load. This observation reinforces coaches' understanding of specialized training (external load) regarding playing positions.

Regarding the external load in full matches, no differences were observed in TD and running speed (m/min). In z1, no differences were observed between positions. Our findings are in agreement with those of Di Salvo et al. (2007) [35]. However, in a previous study with the same formation in professional soccer players, differences were observed [4]. It should be noted here that different speed zones were used, making comparisons difficult. In the z2, the CD covered the least distance, and the CM covered the most. Similar findings are reported in previous studies, although they used different speed zones [4,35]. In z3, the CD covered the least distance, and the CM covered the most. Similar findings were also reported by Vardakis et al. (2020) [4]. In the z4, again, the CD covered the least distance, with the SD and CM covering the most. These findings are in agreement with Vardakis et al. (2020) [4]. Finally, in the z5, the SM covered the most distance, with the CD and CM covering the least. This finding is consistent with Di Salvo et al. (2007) [35] and Vardakis et al. (2020) [4].

Formations and playing positions can influence the running performance of soccer players [10]. The tactical role that each player must serve according to their position on the field, as well as the available space on the field, can affect their running performance [4]. Another point to note in the findings of this study is that differences were observed between positions in the first half but not in the second half. According to the results of this study, we can explain this by observing that most differences were found between the

CD and the CM and SM, covering the longest distances. Perhaps fatigue or tactical reasons affected the CM and SM, and as seen from the comparison of the two halves, they significantly reduced the distances covered in all zones (overall: CM 20.4% and SM 21%). In other positions, the performance decrease was smaller (CD 10.3%, SD 14.3%, F 13.3%). This resulted in no differences between positions in the second half. The running performance decrease observed in this study was likely due to player fatigue and not tactical reasons, as a significant decrease in running speed was observed for all positions in the second half.

It should be mentioned that in the present study, there were no measured factors that could affect the running performance of the players such as the ranking of the opposing team (opponent quality), the match outcome, and whether the match was home or away. From the literature review, it appears that the above factors may affect the external load of soccer players. More specifically, there are studies that report that the external load is influenced by the quality of the opponent [36–38], by match location [38,39], and by the match outcome [36,40,41]. Therefore, when analyzing the results, we should be cautious as contextual factors can influence them. In the present study, six home and six away matches were observed, while the random choice of the matches observed ensures the existence of all categories of the above contextual factors in the study.

The comparison between the two halves showed that CM and SM reduced the TD in the second half, while CD and F showed a tendency to decrease. In a previous study by Torreno et al. (2016) [17], it was observed that all positions reduced TD in the second half and the distance covered at speeds greater than 13 km/h. A decline in running performance in the second half has also been reported in other recent studies [4]. Additionally, the performance of SD decreased in accelerations (Acc2, Acc3) and decelerations (Dec2). Furthermore, CM reduced the number of Acc2 and Dec2, as well as Dec3 in the second half. Finally, SM reduced the number of very intense accelerations and decelerations (Acc3, Dec3). A decrease in the number of accelerations and decelerations in the second half was also mentioned in recent studies [42]. The playing positions can influence this variable. In certain playing positions, there is more space for players to accelerate, so usually the wide players show more and more intense decelerations [42,43], while CD players do not exhibit many intense accelerations/decelerations.

$TRIMP_{Edw}$ decreased in the second half for CM and F, while it decreased in SM without being a significant change. The %HRmax decreased for all playing positions in the second half. Torreno et al. (2016) [17] observed that the internal load index they used decreased for all playing positions in the second half, while %HRmax decreased for SD and F.

In soccer, over the last few decades, there has been a recording of the external load that soccer players experience during a match in order to create the profile of the physical demands of each playing position. Analyzing these data helps tailor training regimens to match the specific physiological demands of the sport, ensuring that players develop the necessary fitness levels and skills required for peak performance on the field. Understanding external load is pivotal for designing periodized training programs that progressively challenge players' physical capabilities while avoiding overtraining and injury.

Conversely, internal load focuses on the physiological and psychological responses of soccer players to external stressors. Heart rate, perceived exertion, and hormonal markers are among the indicators used to gauge internal load. Monitoring internal load provides insights into players' fatigue levels, recovery needs, and overall well-being. Striking a balance between external and internal loads is crucial for optimizing performance and minimizing the risk of injuries. Coaches aim to manage training intensity and volume effectively, ensuring that players are adequately challenged while allowing sufficient recovery to enhance adaptation. Recognizing the interplay between external and internal loads is fundamental for developing a holistic approach to soccer player development and performance optimization.

The study also has some limitations. The study was conducted on an amateur soccer team, and the number of matches observed was for one season. Therefore, caution is needed when generalizing its findings, as the total sample of observations (n) is relatively limited. Of the internal load indicators, only heart rate and $TRIMP_{Edw}$ were used. Lactic acid and RPE measurements would provide additional information. Also, factors related to the opponent and the score of the match were not taken into account. More specifically, the running performance of a team can be affected by the level of the opposing team and its ranking position, as well as by the score changes during a match. This can affect a team's running performance. Future studies that will be applied to more amateur soccer teams (increase sample size) will confirm and strengthen the findings of this study. Also, studies that will categorize the internal and external load of players playing in the 1-4-3-3 formation in relation to the ranking of the opposing team and the score changes during match will provide additional useful information for coaches.

5. Conclusions

In conclusion, it was evident from the above that %HRmax showed a high correlation with the pace (m/min) but not with the high-speed movement zones. $TRIMP_{Edw}$ exhibited high correlations with TD and moderate correlations with high-speed zones. This suggests that the $TRIMP_{Edw}$ index is more comprehensive as it depends additionally on the high-intensity efforts that are necessary in soccer and determine the performance of players and teams. Therefore, for the assessment of the internal load of amateur soccer players, $TRIMP_{Edw}$ might be a more useful index.

The results of this study will help coaches better calculate the amount of training they need to implement during the microcycle. More specifically, this study showed the external load that soccer players receive during matches when playing in the 1-4-3-3 formation. Therefore, coaches, knowing the requirements, can plan the external load they will apply during the microcycle (TD, high-speed running, sprinting, accelerations, decelerations). Also, the internal load is directly related to the training result. High internal load can lead to overtraining and injury, while low internal load can lead to detraining. Therefore, a tool such as $TRIMP_{Edw}$ that can assess the internal load helps coaches avoid the above situations and train amateur soccer players more effectively. Many amateur teams have talented and ambitious players who aspire to become professionals. For this reason, studies that contribute to the improvement of training planning are essential. This study provides valuable information to coaches of amateur soccer teams playing in a 1-4-3-3 formation regarding the running profile, accelerations/decelerations, and the internal load profile in each playing position. It also recommends $TRIMP_{Edw}$ as a more effective tool for evaluating internal load.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in this study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy.

Conflicts of Interest: The authors declare no conflicts of interest.

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