Original article

Running performance of under-17 football players during official matches

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Abstract

The aim of this study was to determine whether there are differences in running performance among lines of the team (defense, midfield, and attack) during competitive activities of under-17 football players. The study involved 18 under-17 football players from the "Vojvodina" FC selection in Serbia, with an average age of 15.89±0.44 years. Depending on their position in the team, players were divided into three groups (defense, midfield, attack). Running performance were measured using the GPS device "Gpexe it". Data were collected from 25 matches during one season. The measured variables included total distance covered, distance covered in zone 4 (19.8-25.2 km/h), distance covered in zone 5 (over 25.2 km/h), number of accelerations, and number of decelerations. All variable values were normalized relative to the time spent on the field during each match. At a general level, the results found a statistically significant difference between the groups (team lines) for the mentioned variables ($p < 0.05$), except for the variable distance covered in zone 4. It can be concluded that these results could be used as norms for running performance during competitive activities of football players (U17 category). Additionally, based on the defined scope and intensity, these results can help in designing the training process to maximize the motor potential of under-17 football players.

Keywords: defense, midfield, attack, total distance, high-intensity distance.

Introduction

In modern football, increasing emphasis is placed on the analysis of competitive activity in terms of movements. This includes total distance covered, running speed, number of duels, accelerations, decelerations, and many other indicators. These data can greatly define the level of running performance in matches, allowing sports professionals to prepare an adequate plan and program during the training process based on this information (McGuigan, 2017).

Various factors can influence the characteristics of volume and intensity during matches, such as the location of the match (home or away), altitude, pitch quality, opponent's quality or ranking, level of competition, match outcome (win, draw, loss), as well as the coach's role (formation, tactics, playing style) (Aquino et al., 2022). Additionally, factors like team's physical preparedness level, fatigue, match duration, and individual player abilities also play a significant role.

In addition to the total distance covered (volume), it has been found that the total distance covered at high intensity (over 19.8 km/h) increases with the age category of football players, while there is no significant difference in moderate-intensity distance (Vieira et al., 2019). One of the indicators considered as a factor of overall physical preparedness today is the total distance covered, while sprint distances and accelerations are the main physical determinants of performance in team sports (Haugen et al., 2014). The overall average distance covered by elite players during a match is between 10-13km (Bangsbo et al., 1991; Mohr et al., 2003; Krustrup et al., 2005; Bangsbo et al., 2006; Mascio & Bradley, 2013), while for goalkeepers, it's around 4 km. Categories of running performance in which players engage vary from author to author. For players competing in the U17 category (2x40 min), the average achieved values of running performance were: 8312±1054m for total distance covered, 6749±768 m for low-intensity running <13.0 km/h, 991±370 m for high-intensity running 13.1-16 km/h, 519±155 m for very high-intensity running 16.1-19 km/h, and 449±147 m for sprinting >19.1 km/h (Buchheit et al., 2010; Kádár et al., 2023).

In football, different positions in the team directly influence players movement activities. Accordingly, it has been found that central defenders cover a smaller total distance as well as a smaller distance at high intensity compared to players in other positions, which is closely related to their tactical duties (Bangsbo, 1994; Mohr et al., 2003; Krustrup et al., 2003). Additionally, central defenders are characterized by backward runs, lateral movements, and a high number of jumps, while full-backs (wing-backs) are characterized by high-intensity runs, sprints, mainly in straight-line movements. Midfielders achieve the highest values in the total distance covered compared to other positions in the team. However, differences in running performance can also exist within the same team line, with players in wide positions covering the greatest distance at high intensity (Carling et al., 2008). Central midfielders, in the defensive phase, are tasked with joining defensive players in preventing the opponent's attack, while in the attacking phase, their role is based on creating attacking actions. They are characterized by short sprints, changes of direction, and short distances of high intensity. Wingers and forwards achieve the highest running speeds in the game as well as frequency in high-intensity activities and sprints (Buchheit et al., 2010; Al Haddad et al., 2015; Izzo & Varde'i, 2017). Forwards are characterized by jumps, turns, curved and diagonal runs, playing in the final attacking zone, and their main task is to score goals and quickly evade opponents.

The aim of this study was to determine whether there are differences in movement activities among lines of the team (defense, midfield, and attack) during competitive activities. Running performance during competitive activities can be conducted through various parameters and methods. Monitoring the total distance covered and movements at high intensity during a match can provide insight into their individual characteristics. Tracking players' movements when they don't have the ball can reveal their ability in positioning, spatial movement, and collaboration with teammates. This includes analyzing defensive and offensive movements, as well as their ability to adhere to the team's tactics.

Methods

Experimental approach to the problem

The research belongs to the quantitative research approach, of a cross-sectional type. The time frame of the study encompasses one football season of the under-17 age group. The research design included measuring volume and intensity variables among participants from one team who were divided into three groups (team lines): defense (n=8), midfield (n=7), and attack (n=3).

Participants

The study involved 18 under-17 football players from "Vojvodina" FC selection in Serbia, with an average age of 15.89±0.44 years. Data were recorded from 25 matches during one season, only for players who started the matches. A total of 218 data points were collected, including 70 data points for defenders, 113 for midfielders, and 35 for attackers. At the beginning of the season, the average height of defenders was BH=176.61±6.96 cm, body mass BW=62.92±4.61 kg, for midfielders BH=173.58±4.41 cm, BW=65.36±5.36 kg, and for attackers BH=181.77±5.47 cm, BW=68.52±5.89 kg. The average time spent on the field by starting players was 84.13±22.32 min for defenders, 80.43±19.21 min for midfielders, and 81.74±18.81 min for attackers. This selection finished 5th in the Serbian U17 league. The study protocol was approved by the Ethics Committee of the Faculty of Sport, University "Union – Nikola Tesla" (approval number: 197-1/22). All participants signed written consent to participate in the research following the principles of the Helsinki Declaration.

Measurements and Procedures

The movement activities of "Vojvodina" FC players were monitored during official matches of the Serbian U17 league in the 2022/2023 season, starting from the sixth to the thirtieth round. In the first part of the season, the team played in a 1-4-4-2 formation, while in the second part, they used a 1-4-5-1 formation. To collect data, a GPS device branded "Gpexe it" (Figure 1) was used. This device, operating at 18Hz, was approved by FIFA for use in official matches. Before each match, starting players were provided with one vest and one GPS device. The devices were inserted into the vest, specifically into the pocket located on the player's back, between the shoulder blades. After each match, all devices were connected to a console, through which the data were transferred to the server using the "Gpexe Bridge" application. In a previous study conducted using the same 18Hz device, good to moderate validity and reliability were established for determining the distance covered (standard error of measurement SEE: 1.6-8.0%; coefficient of variation CV: 1.1-5.1%) and sprinting performance (SEE: 4.5-14.3%; CV: 3.1-7.5%) (Hope et al., 2018).

Image 1. "Gpexe It" device and vest.

Variables

The relative values of variables were obtained concerning the time players spent on the field during each match, aiming to provide a clearer and more precise picture of the volume and intensity in matches (Guerrero-Calderon et al., 2022).

The relative values of variables concerning the time spent on the field during the match are as follows:

- TD_r - Total distance covered/time, expressed in m/min;
- Speed_4_r - Distance covered in zone 4 recorded at a speed between 19.8 km/h-25.2 km/h / time, expressed in m/min;
- Speed_5_r - Distance covered in zone 5 recorded at a speed over 25.2 km/h / time, expressed in m/min;
- Acc_ec_r - Number of accelerations/time, expressed in n/min (acceleration is defined as any change in movement speed of 2.5m/s over a duration of 0.5s);
- Dec_ev_r - Number of decelerations/time, expressed in n/min (deceleration is defined as any change in movement speed of -2.5m/s over a duration of 0.5s).

Statistical analyses

For data processing, descriptive statistics were utilized (mean, standard deviation, coefficient of variation, minimum and maximum values, quartiles). To determine differences among the variables at the team line level (defense, midfield, attack), analysis of variance (ANOVA) with Bonferroni post-hoc test was employed. The significance threshold for statistical differences was set at $p < 0.05$. Eta squared (effect size) was calculated as the ratio of the sum of squares of deviations between different groups and the total sum of squares. Effect size criteria used for this research were 0.01 (small effect), 0.06 (medium), and 0.138 (large) (Pallant, 2011). Microsoft® Office Excel 2007 and SPSS for Windows, Release 17.0 (Copyright © SPSS Inc., 1989–2002) were used for data processing and analysis.

Results

In Table 1, descriptive indicators of the relative variables concerning the time players spent on the field during matches are presented. These results indicate that midfielders achieved the highest volume, i.e., total distance covered (114.38±8.54 m/min). Regarding high-intensity variables Speed 4_r and Speed_5_r, attackers achieved the highest values (5.57±7.88 m/min vs. 6.15±1.56 m/min), as well as for accelerations (Acc_ec_r = 0.30±0.10 n/min) and decelerations (Dec_ev_r = 0.47±0.15 n/min). The results of the variables in Table 1 can be converted into absolute values when multiplied by the time starting players spent on the field from the beginning of the match. For example, the total distance covered for midfielders during 80 minutes would be 9150 m, for attackers 8667 m for 82 minutes, and for defenders 8277 m for 84 minutes.

In Table 2, based on ANOVA, differences between groups for defined variables are presented. It was found that there is a statistically significant difference between groups for variables TD_r ($p < 0.000$), Speed_5_r ($p < 0.000$), Acc_ec_r ($p < 0.011$), and Dec_ev_r ($p < 0.000$), while there was no statistically significant difference for variable Speed_4_r. The actual difference between the mean values of groups for variables TD_r and Speed_5_r is large (eta squared = 0.17 vs. 0.20), while for variables Acc_ec_r and Dec_ev_r, it was medium (eta squared = 0.04 vs. 0.09).

Table 1. Basic descriptive statistics of relative values by team lines.

Variables	Team lines	Mean	SD	CV%	Min	Max
TD_r (m/min)	defense	98.53	13.73	13.93	46.80	124.47
	midfield	114.38	8.54	7.47	99.46	129.78
	attack	105.70	14.47	13.69	24.97	136.94
Speed_4_r (m/min)	defense	5.57	7.88	141.55	1.62	68.14
	midfield	5.31	1.96	36.94	1.99	10.28
	attack	6.15	1.46	23.70	1.91	11.74
Speed_5_r (m/min)	defense	1.41	0.89	63.13	0.31	4.32
	midfield	0.56	0.42	74.34	0.00	1.88
	attack	1.43	0.76	52.99	0.07	3.55
Acc_ec_r (n/min)	defense	0.25	0.10	40.67	0.09	0.50
	midfield	0.31	0.13	41.24	0.07	0.62
	attack	0.30	0.10	32.78	0.03	0.67
Dec_ev_r (n/min)	defense	0.38	0.12	31.34	0.17	0.67
	midfield	0.42	0.12	27.86	0.18	0.75
	attack	0.47	0.15	31.38	0.13	0.93

TD_r – Relative total distance covered, **Speed_4_r –** Relative distance covered at a speed between 19.8-25.2 km/h, **Speed_5_r** – Relative distance covered at a speed over 25.2 km/h, **Acc_ec_r** – Relative number of accelerations, **Dec_ev_r** – Relative number of decelerations.

Table 2. Basic indicators of analysis of variance (ANOVA) for relative variable values.

		Sum of Squares	df	Mean Square	F	Sig.
TD_r (m/min)	Between Groups	7661.11	2	3830.56	22.69	**0.000**
	Within Groups	36331.12	215	168.98		
	Total	43992.23	217			
Speed_4_r (m/min)	Between Groups	27.494	2	13.75	0.63	0.533
	Within Groups	4686.93	215	21.800		
	Total	4714.43	217			
Speed_5_r (m/min)	Between Groups	30.02	2	15.01	27.43	**0.000**
	Within Groups	117.66	215	0.55		
	Total	147.69	217			
Acc_ec_r (n/min)	Between Groups	0.105	2	0.053	4.58	**0.011**
	Within Groups	2.48	215	0.012		
	Total	2.58	217			
Dec_ev_r (n/min)	Between Groups	0.38	2	0.190	11.00	**0.000**
	Within Groups	3.72	215	0.02		
	Total	4.10	217			

TD_r – Relative total distance covered, **Speed_4_r –** Relative distance covered at a speed between 19.8-25.2 km/h, **Speed_5_r** – Relative distance covered at a speed over 25.2 km/h, **Acc_ec_r** – Relative number of accelerations, **Dec_ev_r** – Relative number of decelerations.

In Table 3, differences between team lines for defined variables are presented. Regarding the total distance, it was found that there is a statistically significant difference between team lines, i.e., between defense and midfield ($p < 0.000$), defense and attack ($p < 0.001$), and midfield and attack ($p < 0.000$). As for the variable

Speed_5_r, there were statistically significant differences between defense and midfield players (p < 0.000) and midfield and attack players (p < 0.000). However, there was no statistically significant difference between defensive players and attackers (p < 0.844). For the acceleration variable, there was a statistically significant difference between defensive players on one hand, and midfield (p < 0.009) and attack players (p < 0.009) on the other hand. For the deceleration variable, there was a statistically significant difference between defensive players and attackers (p < 0.000).

Table 3. Differences of variables between team lines (ANOVA) with Bonferroni post-hoc test for relative variable values.

Variable			Mean Difference (I-J)	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
TD_r (m/min)	defense	midfield	-15.85*	2.35	-21.53	-10.17
		attack	-7.17*	2.05	-12.12	-2.21
	midfield	attack	8.68*	2.22	3.33	14.04
Speed_5_r (m/min)	defense	midfield	0.08*	0.13	0.52	1.17
		attack	-0.02	0.12	-0.30	0.26
	midfield	attack	-0.87*	0.13	-1.17	-0.56
Acc_ec_r (n/min)	defense	midfield	-0.05*	0.02	-0.10	0.00
		attack	-0.04*	0.02	-0.09	0.00
	midfield	attack	0.01	0.02	-0.04	0.05
Dec_ev_r (n/min)	defense	midfield	-0.05	0.02	-0.10	0.01
		attack	-0.10*	0.02	-0.15	-0.05
	midfield	attack	-0.05	0.02	-0.11	0.00

TD_r – Relative total distance covered, **Speed_5_r** – Relative distance covered at a speed over 25.2 km/h, **Acc_ec_r** – Relative number of accelerations, **Dec_ev_r** – Relative number of decelerations.

Discussion

The aim of this study was to determine whether there are differences in running performance among lines of the team (defense, midfield, and attack) during competitive activities of under-17 football players. In this research, it was found that there is a statistically significant difference in volume, i.e., in TD_r, between defense, midfield, and attack. These results are consistent with previous studies examining similar characteristics in elite Polish and Danish youth football players. Specifically, the analysis of Polish and Danish players' results showed that the total distance covered is higher in midfield players compared to other positions. Additionally, the results of this study align with previous research where midfield players achieved the highest total distance of 114.38 m/min. This difference was expected due to the nature of the midfield position, which involves both offensive and defensive duties, covering the largest area of the field.

When it comes to differences in distance covered at high intensity (Speed_5_r), over 25.1 km/h, it is observed that defensive and offensive players statistically covered a greater distance than midfield players, even by 60%. Data analysis leads to the conclusion that defensive players have high values in the Speed_5_r variable due to the full-back positions. Nowadays, full-backs in modern football, in addition to defensive actions, also participate in attacking plays and have a more prominent role in the attacking phase, mostly through wing plays and crosses. Distances covered by players in these situations are between 60-80m and are mostly at high intensity or sprinting, directly linked to the success of attacking plays and faster positioning in the defensive phase. This has been confirmed in previous studies with senior (Mallo et al., 2015; Modric et al., 2019, 2020) and youth-level players (Buchheit et al., 2010; Dolanski et al., 2018).

In the variables of acceleration and deceleration, midfielders and attackers achieved higher results compared to defense. These results were expected due to the nature of the position, frequent changes of direction, acceleration during goal-scoring attempts, evading opponents, creating pressure, and stealing the ball from the opponent. Midfielders and attackers were the most exposed to acceleration and deceleration activities. This data can be used in individual training program planning. The data obtained in this study, defining the volume and intensity by team lines, can also be used in training load management.

As a limitation of this study, the sampling method can be considered, i.e., to make the results more applicable, it is necessary to increase the representativeness (more clubs from the same age category) and the sample size (more players divided by position).

Practical Implications

Based on the data obtained in this study, the workload in terms of volume and intensity during competitive activities of U17 football players was defined. Differences between team lines were also shown. All of this can greatly benefit the coach in managing the workload during the training process to maximize the players' motor potential. Identifying certain deficiencies in defined variables can also be useful for coaches in individual work. The combination of these aspects allows for a comprehensive analysis of U17 football players movements during competitive activities and provides a basis for developing personalized training programs and improving their on-field performance. Table 4 shows the relative quartile values of the variables in relation to the team line. These values of defined variables can have practical application in ranking the running performance of U17 players according to their position on the team.

Table 4. Relative values of variables in relation to team lines displayed through quartile differences.

Team lines	Percentile	TD_r (m/min)	Speed_4_r (m/min)	Speed_5_r (m/min)	Acc_ec_r (n/min)	Dec_ev_r (n/min)
defense	<20	≤87.75	≤2.85	≤0.64	≤0.16	≤0.27
	20-40	87.76-93.86	2.86-3.48	0.65-1.09	0.17-0.21	0.28-0.33
	40-60	93.87-102.27	3.49-4.86	1.1-1.32	0.22-0.27	0.34-0.38
	60-80	102.28-110.38	4.87-6.57	1.33-2.01	0.28-0.34	0.39-0.51
	80≤	110.39≤	6.58≤	2.02≤	0.35≤	0.52≤
midfield	<20	≤106.03	≤3.27	≤0.15	≤0.21	≤0.33
	20-40	106.04-110.37	3.28-4.77	0.16-0.41	0.22-0.24	0.34-0.38
	40-60	110.38-115.46	4.78-5.68	0.42-0.57	0.25-0.33	0.39-0.44
	60-80	115.47-124.06	5.69-6.81	0.58-0.98	0.34-0.43	0.45-0.54
	80≤	124.07≤	6.82≤	0.99≤	0.44≤	0.55≤
attack	<20	≤97.60	≤4.89	≤0.78	≤0.21	≤0.35
	20-40	97.61-103.49	4.9-5.84	0.79-1.19	0.22-0.28	0.36-0.41
	40-60	103.5-110.34	5.85-6.43	1.2-1.54	0.29-0.32	0.42-0.51
	60-80	110.35-114.96	6.44-7.20	1.55-2.06	0.33-0.37	0.52-0.60
	80≤	114.97≤	7.21≤	2.07≤	0.38≤	0.61≤

TD_r – Relative total distance covered, **Speed_4_r** – Relative distance covered at a speed between 19.8-25.2 km/h, **Speed_5_r** – Relative distance covered at a speed over 25.2 km/h, **Acc_ec_r** – Relative number of accelerations, **Dec_ev_r** – Relative number of decelerations.

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