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Original Investigation

Playing position as a predictor of strength and endurance among U-19 soccer players

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Purpose: The main goal of this research was to determine differences in strength and endurance between attack, midfield, and defense lines in young soccer players.
Methods: A sample of 38 U-19 soccer players (N_1= 13 attack, N_2= 14 midfield, and N_3= 11 defense) was measured for motor and functional status, which included one test for the assessment of endurance, five tests for motor skills, and three for anthropometric measures.
Results: Analyses of highly reliable data (Intraclass correlation (ICC) ranged from .809– .929; inter-item correlation (IIR) ranged from .85– .93; coefficient of variation (CV) ranged from .02– .07), one-way between-subjects ANOVA revealed a significant main effect with large effect size (P= .032; η^2= .407) in power manifestations, while a Bonferroni correction highlighted differences between midfielders and defense players (P= .017).
Conclusions: The identified differences were probably due to differences in position-specific dominant movement structures. The results provide in-depth insight into the complex interactions between observed factors and can be useful for the development and application of contemporary position-specific training systems for young soccer players.

Keywords: power, endurance, young soccer players, position-related differences

Introduction

Mathematically, soccer can be fully described only with dynamic systems theory[1]. Observing it is predominantly characterized by the need for high functional requirements and the ability to control and perform sudden, rapid changes in dependence of the particular game context[2]. Additionally, it is characterized by a range of specific movements with and without a ball, which aim to create an advantage over an opponent[3]. From a structural viewpoint, a soccer game involves two-way interactions of tactical systems between opposing teams as well as well anthropological demands that vary based on overall gameplay conditions[4].
In the soccer field, players are divided into lines: attack (striker), midfield (central midfielders and wingers), and defense (goalkeeper, central back, and fullback). Although it is clear that positions are supposed to be adapted to the given game systems with specific tasks as well as physiological and psychological loads, there is an ongoing, growing scientific debate on the determinants of success in soccer, depending on the playing position[5]. More specifically, the question arises of completely describing a position-specific need in the entire anthropological status. Research has confirmed that central backs are taller and stronger, wingers are generally shorter and lighter, and morphological similarities have been found between central backs and strikers[6,7]. Apart from morphological characteristics, there are differences in the functional loads that a particular position must be able to withstand[8,9]. Moreover, considering the game's system or an opponent's strength, functional loads vary, but it has been proven that wingers run the most during a match and that they are closely followed by defensive midfielders. A central-back runs the least, while midfielders and strikers are in the middle[10].
Power, as being responsible for giving maximum acceleration to body mass, can be defined through various laboratory or field tests[11], and its optimization is a fundamental requirement in contemporary soccer. However, there is an issue with reliably and validly measuring the power and usage of different field tests, which have not been shown to be consistently correlated with soccer-specific power applied in real situations[12]. Also, it must be underlined that the plyometric approach to developing muscle force output is the most commonly used method for developing power, and its positive effects have been reported[13].
Considering what is mentioned above, the question arises about the possible existence of position-specific differences in the motor statuses of young soccer players as additional valuable data on the understanding of soccer games. Therefore, the main goal of this paper is to inspect and interpret interposition differences in the motor and functional abilities of young (U-19) soccer players.

Method

Participants
First, the required sample size was estimated following methodologies described in the literature[14] based on pooled estimators of variables describing the scores of junior soccer players in used variables[15-17]. For a type-I error of α=.05 and a type-II error of β= .20 (i.e., power of .80), an overall sample size of 35 to 44 was identified as optimal for detecting significant

effects. Consequently, the sample of respondents consisted of $N= 38$ ($N_1= 13$ attack, $N_2= 14$ midfield, and $N_3= 11$ defense) U-19 soccer players (age 18.22±0.71 years) who competed in the 1st National Junior Championship and had been involved in soccer training for at least eight years (training background 10.50±1.26 years; body height=184.09±4.91 cm; body mass=74.84±5.78 kg; BMI=22.09±1.56 $kg \cdot m^{-2}$). The sample consisted only of players who had not been injured in the previous six months. All participants were completely aware of the purpose of the study and were informed that they could withdraw from the measurements at any time without any consequences. All procedures were carried out in complete accordance with the Helsinki Declaration.

Variables

The assessment of motor and functional abilities was determined by seven field tests: functional abilities through the Yo-Yo Intermittent Recovery Test Level 1 (total distance covered in meters, *Yo-YoLv1*); strength: one-legged triple jump right (left) leg in meters, (*OneLegTJR* and *OneLegTJL*, respectively), medicine ball chest throw (*CHEST*) in meters, standing long jump (*SLJ*) in meters, and 30-sec push-ups (*PU30*) as number of repetitions. Additionally, anthropometric characteristics were assessed using body height, body mass, and body mass index. The variables were chosen according to the recommendations from contemporary literature[18,19].

Methodology

Before the procedure, participants were given a short questionnaire on their current health status and recent musculoskeletal injuries. Three participants were excluded due to current health issues (one participant) and recent injuries (two participants). Morphological measures were taken by an experienced physical education teacher with more than 30 years of experience and were conducted in the dressing rooms of an air-conditioned hall, with an average temperature ranging from 23°C to 25°C. Body weight was measured to the nearest 0.1 kg using the Seca 764 Digital Column Scale (Seca GmbH & Co. KG, Hamburg, Germany). Height was measured to the nearest 0.1 cm using the integrated stadiometer of the same device All participants were instructed to adhere to standardized measurement procedures – they stood barefoot in an upright position with their arms at their sides when measuring height. They wore lightweight sports clothing during weighing to minimize potential measurement errors. Measurements were done at the beginning of July for four consecutive days before regular training sessions at approximately the same time of day (between 8:00 am and 10:00 am). The assessment of all motor and functional variables was performed three times by an experienced sports scientist and best result was observed for further analysis. To avoid the effect of fatigue push-ups were performed on three consecutive days. Push-ups were performed according to the protocol explained to all participants. In this protocol, participants lowered their bodies from a position of full arm extension until their chest and thighs touched the ground and then returned to the starting position. Scoring was based on the total number of correctly executed push-ups before the participant reached fatigue or altered the proper body position.

As being usual practice, Yo-Yo test was measured single time. Test assessed participants' aerobic capacity under controlled conditions, adhering to a standardized execution protocol[15]. The test was conducted on a flat, marked track with a length of 20 meters and an additional 5-meter recovery zone, ensuring precise measurement conditions. Participants ran between two lines 20 meters apart, following auditory signals generated by the mobile application Yo-Yo Test 1.0.35, which ensured accurate interval timing and control of the test's sound indicators.

Following this test, assessments of explosive strength in the lower and upper limbs were conducted using jump and throwing tests. The One-Legged Triple Jump (right and left leg) was performed according to the standardized protocols[19] to evaluate the explosive power of the lower extremities. The Medicine Ball Chest Throw (CHEST) in-meter test was conducted in a standing position, where participants initiated the throw with a powerful forward push of the arms while maintaining a stable base, without additional momentum or torso movement, ensuring an isolated assessment of upper body strength. The Standing Long Jump test was conducted according to the standardized protocol[18] which is widely used to evaluate the explosive strength of the lower extremities.

For the One-Legged Triple Jump (right and left leg), Medicine Ball Chest Throw (CHEST) in meters, and Standing Long Jump, measurements were taken using a centimeter tape, allowing for precise determination of the distance achieved in each test.

During measurements of all motor and functional variables, all participants were dressed as for regular training sessions. Before the measurements, 10-13 minutes of warm-up were directed by experienced coach. The measurement procedure for each variable was explained in detail, and before the measurement, if needed, the participants had up to two low-intensity trials.

Statistical analysis

All data was presented using the mean ± standard deviation. The reliability of the data was assessed using the coefficient of variation (CV)[20], average inter-item correlation (IIR), and intraclass correlation (ICC). All data were inspected for univariate outliers. The Kolmogorov-Smirnov test was applied to inspect deviations from the normal distribution. A between-subjects ANOVA was used to identify the significance of the main effect. If the main effect appeared to be significant, Bonferroni post-hoc correction was applied. Partial eta squared ((partial) η^2) was used as a measure of effect size, and it was interpreted as small if $< .06$, moderate if $\geq .06$ and $< .14$, and large if $\geq .14$. The type-I error was set at $\alpha= 5\%$. All results were calculated using the software package Statistica (Cloud Software Group, Inc. (2023) Data Science Workbench (ver. 14.1.0.8., Palo Alto, USA)

Results

The Kolmogorov-Smirnov test revealed that all variables have distribution that does not deviate significantly for normal distribution ($P> .200$). Furthermore, due to all of the data for all measured variables were inside of Mean±3×SD interval, none of the results was identified as univariate outlier. All of the applied reliability indicators of the tests for the assessment of motor-functional abilities indicate, as expected, highly reliable data (Table 1). More precisely, intraclass correlation (ICC) ranged from .809– .929, inter-item correlation (IIR) ranged from .85– .93 and coefficient of variation ranged from .02– .07 are consistently pointing to the non-existence of systematic bias within the data. Due to the significant main effect on variable *medical ball chest throw* with large effect size ($P= .032$; (partial) $\eta^2= .407$) Bonferroni post hoc correction was applied and significant differences were identified between midfield and defense line players ($P= .017$) (Table 2). Results suggests that the distinguishing factor between midfield and defense line players are upper-body strength and explosive power. This aligns with the physical demands typically associated with these roles in contemporary soccer, where midfielders may require greater upper-body power for tasks such as shielding the ball, while defenders might prioritize other physical attributes. Although

Table 1. Mean ± standard deviation (M±SD) and measures of reliability for variables observed in the entire sample (N=38).

Variables	Trial I	Trial II	Trial III	Total	ICC	IIR	CV
OneLegTJR (m)	6.24± .55	6.45± .47	6.63± .46	6.69± .40	.874	.93	.02
OneLegTJL (m)	6.24± .42	6.52± .47	6.71± .41	6.75± .40	.929	.85	.02
CHEST (m)	11.14± .86	11.54± .87	11.55±1.04	11.72± .92	.809	.88	.04
SLJ (m)	2.29± .13	2.31± .15	2.33± .15	2.35± .14	.822	.91	.03
PU30 (#)	24.44±6.21	25.31±7.11	25.92±6.03	27.39±7.87	.816	.83	.07
Yo-YoLv1 (m)	1482.38± 352.63						

Note. OneLegTJR - one-legged triple jump right leg; OneLegTJL - one-legged triple jump left leg; CHEST – medical ball chest throw; SLJ - standing long jump; PU30 - 30 sec push-ups; Yo-YoLv1 - Intermittent Recovery Test Level total distance. Intraclass correlation (ICC), average inter-item correlation (IIR), and coefficient of variation,

variables *Standing long jump* and *30-sec push-ups* have large effect size ((partial) η^2= .168; (partial) η^2= .184 respectively) main effect appeared to be not significant (*P*= .500; *P*= .445, respectively). Moreover, the lack of significance in *Standing long jump* and *30-sec push-ups* implies that lower-body explosive strength and muscular endurance, as measured by these tests, do not differ significantly across observed positions and are less critical in distinguishing between players in these roles. Consequently, both were not considered fundamental for further discussion.

Table 2. Mean±standard deviation (M±SD) together with between-subjects ANOVA.

Variables	Attack M±SD	Middlefield M±SD	Defense M±SD	F	*P*	(partial) η^2
OneLegTJR (m)	6.31± .93	6.47± .77	6.03± .41	.444	.813	.092
OneLegTJL (m)	6.21± .02	6.44± .47	6.31± .49	.152	.977	.033
CHEST (m)	11.69± .54	10.74± .22¥	11.88±1.00	3.025	.032	.407
SLJ (m)	2.34± .09	2.32± .11	2.30± .13	.898	.500	.169
PU30 (#)	24.03±5.74	25.34±6.34	25.11±5.13	.993	.445	.184
Yo-YoLv1 (m)	1476.75±311.29	1422.64±621.79	1511.23±341.02	.113	.976	.022

Note. OneLegTJR - one-legged triple jump right leg; OneLegTJL - one-legged triple jump left leg; CHEST – medical ball chest throw; SLJ - standing long jump; PU30 - 30-sec push-ups; Yo-YoLv1 - Intermittent Recovery Test Level total distance; F value (F), significance level (p), partial eta squared ((partial) η^2), ¥ denotes significant difference comparing to defense

Discussion

The fact that in the majority of variables, there were no significant differences between young soccer players, considering their positions in the game, confirms previous findings indicating that the selection of young soccer players by position is not possible through motor and functional abilities[21-23]. The findings suggest that these abilities are similarly developed across all young players, indicating that position assignments should be based on other factors rather than these measured abilities alone. However, the results that pointed to significant differences between midfielders and defenders confirmed that some practical knowledge was integrated into goalkeepers' fitness training systems[17]. Namely, the goalkeeper's physical training system, which is closely related to the needs of the game, requires athletes to perform certain complex movements through different ballistic activities.

It should be noted that contemporary soccer requires well-developed strength among players, especially at an elite level[24]. With this in mind, numerous laboratory and field tests have been prescribed for assessing soccer players' explosive power[11]. Explosive strength is one of the determinants of success in all activities that require the manifestation of maximum muscle force in the shortest possible time[25]. Therefore, explosive power is an important factor in activities in which it is necessary to give great acceleration to the mass of the body, the mass of certain parts of the body, or an external object, and this applies primarily to activities such as jumping, sprinting, throwing, and hitting[26]. Explosive strength training improves many neuromuscular qualities (maximum running speed, explosive muscle strength) in the sports performance of adults[27], but also of young athletes[28,29]. One of the tests that is most often used to assess the explosive power of soccer players is the Vertical Jump Test. The problems with this test can be the performance in field conditions or the lack of equipment, and it has been proved that this test is not correlated with players' football performance[12]. For this reason, tests such as the one-legged triple jump on the right and left legs (3-Hop Test), the long jump, and throwing a medicine ball from the chest (Medicine Ball Explosive Power Test) were used in this work. We have several methods to improve strength, and it is up to us as experts to choose the appropriate method, depending on the situation and conditions in which we find ourselves. The most commonly used method for increasing strength is plyometric training.

Plyometrics is a specific method of resistance training that uses stretch-shortening cycle exercises to maximize the mechanical output of muscles (force, work, and strength) in explosive movements. The positive effects of this training method have been proven in several studies[13,30]. In addition to plyometric training, we can raise the strength to a higher level with speed, agility, and quickness (SAQ) training[31].

Despite the lack of significant differences (*P*= .976), it is important to note that defense players performed better on the Yo-Yo Intermittent Recovery Level 1 Test than other observed players. The possible reason for this is that this position requires a higher level of endurance than other positions due to domination of specific movements patterns. Soccer is a complex sport[32], and to play it at a competitive level, a high level of aerobic (mitochondrial metabolic pathways) and anaerobic (non-mitochondrial metabolic pathways) abilities are required from players[5]. A soccer player travels an average of 11393±1016 meters during a match, with a minimum of 5696 meters and a maximum of 13746 meters[8]. Most of the activities performed at a soccer match were low intensity, such as walking and jogging[33]. Furthermore, research indicated that the submaximal level of activity predominantly burdens the aerobic energy system, whereas an anaerobic energy system is needed for high-intensity activities during a match[10]. Consequently, for a player to be able to withstand the match at a satisfactory level, he should possess certain types of endurance. We distinguish between aerobic and anaerobic endurance. Aerobic endurance depends on three important elements: maximum oxygen intake (VO_2 max), anaerobic threshold, and economy of work[34]. By general aerobic endurance, we usually mean the athlete's ability to overcome a given load as long as possible in activities involving a large number of muscles, whereby the energy required for work is obtained mainly through aerobic means. The positive effect of a high level of aerobic capacity on performance during a soccer match was investigated. It has been proved that improved maximum oxygen uptake (VO_2 max) and running economy by 5 $ml \cdot kg^{-1} \cdot min^{-1}$ and 7% significantly affected the player's technical and tactical performance during the match[35,36]. These include more involvement in handling the ball, similar technical skills at a higher intensity, an increased number of sprints, and greater running distance during the match[37]. Researchers agree that high aerobic fitness plays a key role in enabling effective recovery from high-intensity activities in soccer[38]. Although soccer is a dominantly aerobic game, the anaerobic component is of great importance for the player because it is used to perform sprints, high-intensity running, and duel play, all of which can contribute to the final result[39]. Anaerobic endurance represents a player's ability to work for as long as possible at an intensity close to maximum. Moreover, the significance of the anaerobic system during a match is clearly evidenced by a high blood lactate level (~10 $mmol \cdot L^{-1}$) accompanied by a decrease in muscle pH (~6.8)[2], a high-intensity running distance of 1.1 km at speeds over 18 $km \cdot h^{-1}$ [40], and between 150-200 intense actions during the match[2]. Considering the indicated importance of the aerobic and anaerobic energy system, many tests have been used to monitor players' training and prescribe training during a competitive season[37], and one such test is the Yo-Yo Intermittent Recovery Test Level 1, which we used in this research. Aerobic and anaerobic endurance are also important for parameters such as total distance run, total distance run at high intensity, number of sprints, total distance run at high intensity when a team has possession of the ball, and total distance run at high intensity when a team does not have possession of the ball. It is well known that different positions covered different distances[41]. Moreover, central midfielders ran the most and central defenders the least; outside defenders and outside midfielders and attackers are most likely to be less capable of sprinting in the second half. It has been concluded that each position requires an individual approach when creating a training program. Moreover, midfielders and forwards run the most at a high intensity (1049±106 m, 968±143 m; respectively) and central defenders the least (681±128 m)[10]. The highest number of sprints is done mostly by outside midfielders and forwards (260±47 and 262±63) and central defenders the least (167±53) when the team has possession of the ball. The high-intensity players also perform the highest-intensity running and forwards (505±76 m, i.e., 566±104 m), while the highest-intensity running occurs when a team does not have possession of the ball, outside defenders and central midfielders (498±71 m and 489±71 m, respectively). Doubtlessly, it can be stated that each position requires an individual approach when creating a long or short-term training program.

Practical applications

The results provide in-depth insight into the complex interactions between observed factors and can provide useful guidelines for the development and application of contemporary position-specific training systems for young soccer players. For future research, it is highly recommended to include a larger sample of participants and a larger number of specific variables, which would more precisely determine possible differences by player position. This would greatly benefit everyone involved in overall soccer development.

Conclusion

Conclusively, the results of this study indicate that, despite the specific demands of different playing positions, most motor and functional abilities of young soccer players do not show significant differences among attackers, midfielders, and defenders. The identified differences in specific manifestations of strength between midfielders and defenders suggest that some positional specificities arise from varying training loads and contemporary game requirements. The findings emphasize the importance of a holistic approach in developing young players, where technical-tactical skills, alongside motor and functional characteristics, play a key role in determining the optimal playing position. These results serve as guidelines for adapting training programs to the demands of specific positions and improving the selection process for young soccer players' development. Further research focusing on a broader range of variables would provide deeper insight into the factors contributing to player success and allow for optimizing training methodologies across different stages of their careers.

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Informed Consent Statement

Informed consent has been obtained from all subjects involved in the study.

Ethical Committee approval

Authors gathered approval no 2181-205-02-05-20-025, class 003-08/20-04/001 from Ethical committee of Faculty of Kinesiology, University of Split.

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Conflicts of interest

The authors have no conflicts of interest to declare.

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Author-s contribution

Conceptualization, F.Ž. and L.Č.; methodology, F.Ž., I.J.; software, I.J.; validation, F.Ž., L.Č., and I.J. formal analysis, F.Ž., L.Č., and I.J.; investigation, F.Ž..; resources, F.Ž. and I.J.; data curation, F.Ž., L.Č., and I.J.; writing—original draft preparation, F.Ž., I.J.; writing—review and editing, F.Ž., L.Č., and I.J..; visualization, F.Ž., L.Č., and I.J.; supervision, F.Ž..; project administration, L.Č. All authors have read and agreed to the published version of the manuscript.

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