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THE CORRELATION OF STRENGTH WITH ENDURANCE, SPRINT, AND REPEATED SPRINT IN YOUNG SOCCER PLAYERS

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Abstract

The purpose of this study was to determine the relationships between lower and upper extremity muscle strength and endurance, speed, and repeated sprint ability (RSA) in young soccer players. Twenty-two young soccer players (age: 16.20±.77 years) participated in the study. The player's strength, endurance, speed, and RSA were measured. Correlations between variables were performed with Pearson product-moment correlation analysis. A significant moderate negative correlation (MNC) was found between right leg extension strength (LES) and 10m and 30m sprint performances (SP). A moderate MNC was determined between left LES and 30m SP. A moderate MNC was determined between shoulder press strength and 10m, and 30m sprint, and the best result of repeated SP. A significant MNC was determined between squat strength and 30m SP. The MNC between muscle strength and SP showed that any increase in quadriceps and hamstring muscle strength in young soccer players would positively affect SP.

Keywords: Young soccer, motor performance, strength, endurance, sprint, and repeated ability.

INTRODUCTION

Shephard (1999) defines football (soccer) as a sport that involves long periods of low-intensity activities interspersed with a short time of high-intensity activities. Considering the duration of the game, the size of the playing area, and the involved movements (running, sprinting, jumping, striking the ball, changing direction, etc.), this definition is one of the most accurate descriptions of soccer in physiological terms. Additionally, due to its physiological requirements, soccer demands speed, explosiveness, and effective repetitive sprinting ability (Dragijsky, Maly, Zahalka, Kunzmann, & Hank, 2017; Meckel, Machnai, & Eliakim, 2009; Shephard, 1999).

In modern soccer, the importance of the distance covered during the game has increased (Al Haddad, Méndez-Villanueva, Torreño, Munguía-Izquierdo, & Suárez-Arrones, 2018; Penas, Rey, Ballesteros, Casais, & Domínguez, 2009; Mallo, Mena, Nevado, & Paredes, 2015). During a match, players engage in activities such as standing (0-0.6 km/h), walking (0.7-7.1 km/h), jogging (7.2-14.3 km/h), running (14.4-19.7 km/h), high-speed running (19.8-25 km/h), and sprinting (>25 km/h) (Bradley et al., 2013). The total distance covered resulting from these activities has been reported as 11720 ± 524 m (Rampinini, Coutts, Castagna, Sassi, & Impellizzeri, 2007) and 12,027 ± 625 m (Di Salvo et al., 2007) in different studies. Additionally, the average running distance of teams in the 2010 World Cup was reported as 104.58 km (Arslan et al., 2012). In the 2014 World Cup, teams covered an average distance of 107.51 ± 5.42 km in the group stage, 105.98 ± 7.46 km in the knockout stage, and 107.00 ± 5.74 km in the third-place playoff (Chmura et al., 2014). It can be understood from these high distances covered that soccer players are expected to have good aerobic endurance along with effective anaerobic power.

The number of meters of activities such as sprints, change of direction runs, walking, jogging, etc., during the game reflects the quality of the distance covered. High-speed running (sprints) or skills such as jumping and leaping demonstrate players' anaerobic power. To outperform the opponent and establish an advantage in soccer, players need to be better than their opponents. To be athletically superior to the opponent, players are expected to run more, make explosive movements, and be able to apply effective technical-tactical skills while doing all of these (Chmura et al., 2014). In addition to technical-tactical skills, players are expected to have developed strength, endurance, and speed abilities, as these motor skills are necessary for achieving success. Therefore, understanding the relationship between these skills is important for accurate sport-specific training planning (Gouveia et al., 2023). In soccer, where there are numerous positional changes and movements according to the opponent's actions, the speed and accuracy of these movements affect performance outcomes. This highlights the importance of players having good speed and agility. An effective speed and agility performance also depends on well-developed strength (Gouveia et al., 2023). Additionally, players' lower extremity muscle strength plays a crucial role in soccer-specific movements such as speed, change of direction, repeated sprints, jumping, agility, passing, and shooting (Pääsuke, Ereline, & Gapeyeva, 2001). And players are expected to have good aerobic endurance to effectively showcase their skills throughout the process of achieving success. Being able to perform at the same level from the first minute to the last minute of a match requires an increased capacity for work from players, leading to effective and efficient performance outcomes. Therefore, a player's lower and upper extremity strength can enable them to display their other motor skills. In this regard, this study aimed to examine the relationship between the lower and upper extremity strength of young soccer players and their endurance, speed, and repeated sprint performance.

METHOD

Participants

A total of 22 healthy young male soccer players (age: 16.20±0.77 years) who regularly trained four days a week and played one day a week in matches, and had not experienced any sports-related injuries in the last six months, voluntarily participated in the study. Anthropometric measurements were taken before the performance assessments. Height was measured using the Holtain Stadiometer, and body weight was measured using InBody Bioelectrical Impedance (model: InBody 120) (Height: 174.70±5.08 cm, body mass: 68.02±9.95 kg, respectively).

Fundamental Motor Skill Tests

Sprint: Participants' 10m and 30m sprint performance was measured using a telemetric photoelectric chronometer. A 1 m distance area was marked behind the designated starting line as the starting zone. When ready, participants sprinted the 10m and 30m distances at maximum speed. Each distance was performed twice, and the lowest time was recorded as the participant's maximum performance result.

Repeated Sprint: Bongsbo's (1994) 7x35m repeated change-of-direction sprint test was used to assess participants' repeated sprint performance. Before the test, participants were introduced to the test area depicted in Figure 1 and provided with information about the test procedure. Subsequently, participants ran at maximum speed, changing direction to the right and left in the designated area, and returned towards the starting line at a jogging pace during the 25-second rest period before starting the next sprint. Each sprint time was recorded using a telemetric photoelectric chronometer, and the test was concluded after the 7th repetition. From the recorded times, the best sprint time, average times for all repetitions, and fatigue index were calculated.

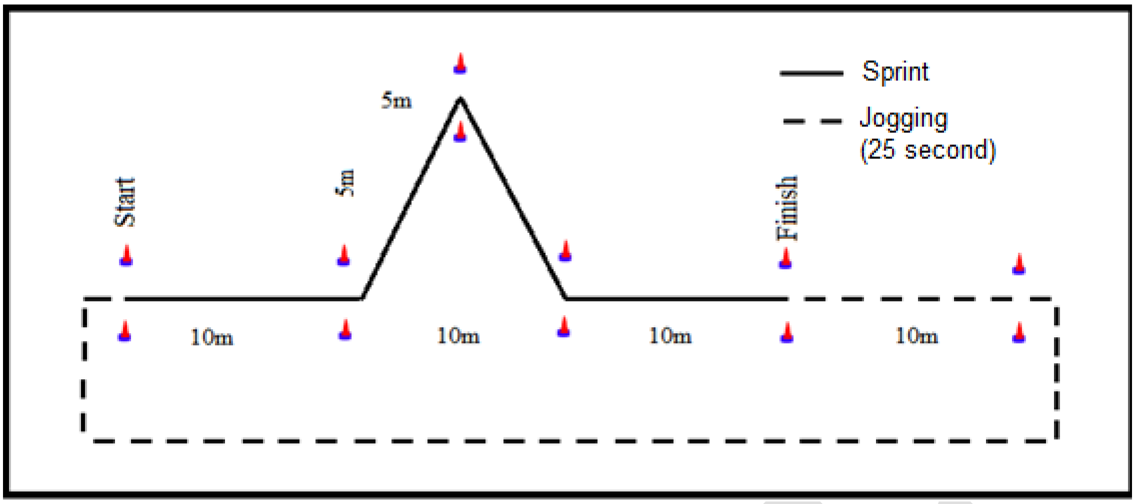

Figure 1. 7 Repeated Sprint Test (Bongsbo 1994)

Formula: FI (%) = (TTST - (BPTS * 7)) / (BPTS * 7) * 100
FI = Fatigue Index
TTST: Total Corrected Test Scores
BPTS: Best Performance Time in Sprint

To calculate the Corrected Test Scores (CTS), for each sprint repetition, if the time recorded in seconds is shorter than the previous sprint time, the next repetition's time is calculated as the average of the previous and subsequent sprint times. Here's an example:

Example:
4th repetition: 7 seconds
5th repetition: 6.90 seconds
6th repetition: 7.10 seconds
For the 5th repetition, the CTS is calculated as follows:
CTS = (7 + 7.10) / 2 = 7.05 seconds

Endurance: To assess participants' endurance performance, the Yo-Yo Intermittent Recovery Test Level 1 (Yo-Yo IR1) depicted in Figure 2 was utilized (Krustrup et al., 2003). The test area was introduced to each participant, and information about the test was provided. Before the test, a Polar (M400, Finland) brand watch and a chest strap with a heart rate sensor were worn to determine participants' maximum heart rates (HRmax). Subsequently, participants engaged in a 10-minute general warm-up before initiating the test. Once ready, participants were instructed to perform the test until exhaustion. The distance covered and maximum heart rate values were recorded for participants who discontinued the test. Relative aerobic capacity was calculated using the appropriate formula.

Formula: VO2max (ml/kg/min) = Running Distance * 0.00084 - 36.4
Strength: The maximum strength values of the participants were determined using the 10-repetition maximum (10-RM) method. In the study, exercises such as leg extension, leg curl, bench press, shoulder press, squat, and lat pulldown were performed to determine the maximum strength that can be generated in major muscle groups. The order of exercises was adjusted according to the muscle group being targeted. To determine the maximum strength values of the participants, the following sequence was followed: (1) leg extension, (2) bench press, (3) leg curl, (4) shoulder press, (5) squat, and (6) lat pulldown. For the measurement of strength in the right and left legs, the leg extension and leg curl exercises were performed separately for each leg. After measuring the maximum strength of the right leg, the participants were given a 3-minute rest before measuring the maximum strength of the left leg. Each participant performed warm-up for a 10-minute and stretching exercise under the guidance of a coach before the test. In the measurements, the participants performed warm-up sets at 50% of their previously known maximum weight for 10 repetitions to warm up for the measurements in the specified exercises. Then, they were asked to lift the weight at progressive stages (1st stage: 90%, 2nd stage:

100%, 3rd stage: 110%, and 4th stage: 120% of the known maximum weight) for 10 repetitions. The participant was instructed to perform 10 repetitions at each stage. After completing 10 repetitions in the respective stage, the participant was given a 3-minute rest period before moving on to the next stage. If the participant could not complete 10 repetitions in the respective stage, the number of repetitions performed was recorded, and the maximum strength value was calculated. For the calculation, the weight lifted by the participant in the respective stage was reduced by 2.5 kg, multiplied by the 10-RM determination coefficient of 1.36, and the participant's new maximum strength value was determined.

Statistical Analysis

The variables were presented in terms of mean and standard deviation. The relationships between the variables were examined using Pearson's correlation analysis.

RESULTS

The means and standard deviations of the results obtained from the measurements are presented in Table 1.

Table 1. Results of Motor Skill Tests

Endurance	Mean±Std.Dev.	Strength	Mean±Std.Dev.
Running Distance (m)	1224±394.57	Right Leg Extension (kg)	84.08±10.82
VO_{2max} (ml/kg/min)	46.68±3.31	Left Leg Extension (kg)	85.44±10.26
HR_{max} (beats/min)	201.5±7.61	Right Leg Curl (kg)	56.78±17.79
Sprint		Left Leg Curl (kg)	56.95±18.05
10m (sec)	1.73±0.09	Front Pull Down (kg)	64.6±11.56
30m (sec)	4.31±0.22	Bench Press (kg)	62.9±10.89
Repeated Sprint		Shoulder Press (kg)	62.39±9.18
Best score (sec)	6.70±0.22	Squat (kg)	118.15±29.16
Mean score (sec)	6.95±0.29		
Fatigue Index (FI) (%)	3.77±2.63		

There was a significant moderate negative correlation between right leg extension strength and 10m and 30m sprint performance (r=-.444, p<.05 and r=-.532, p<.05, respectively). A significant moderate negative correlation was found between left leg extension strength and 30m sprint performance (r=-.473, p<.05). There was a significant moderate negative correlation between shoulder press strength and 10m, 30m sprint, and best time in repeated sprint performance (r=-.502, p<.05; r=-.598, p<.05; r=-.485, p<.05, respectively). A significant moderate negative correlation was found between squat strength and 30m speed performance (r=-.473, p<.05).

Table 2. Results of Pearson Correlation Coefficient (*r*)

	Yo-Yo Distance (m)	Yo-Yo VO_{2maks} (ml/kg/min)	Yo-Yo HR_{maks} (beats/min)	10m (sec)	30m (sec)	Repeated Sprint Best Score (sec)	Fatigue Index (%)
Leg Curl (Right Leg) (kg)	-.116	-.116	-.143	-,245	-.260	-.179	.170
Leg Curl (Left Leg) (kg)	.062	.062	-.106	-.308	-.355	-.386	.174
Leg Extension (Right Leg) (kg)	.320	.320	-.045	-.444*	-.532*	-.407	-.031
Leg Extension (Left Leg) (kg)	.267	.267	-.085	-.387	-.473*	-.305	-.022
Front Pull Down (kg)	.162	.162	-.109	-.132	-.383	-.304	.170
Bench press (kg)	.187	.187	-.198	-.097	-.355	-.272	,244
Shoulder press (kg)	.225	.225	.142	-.502*	-.598*	-.485*	.081
Squat (kg)	.235	.235	-.070	-.444*	-.438	-.389	-.006

*p<.05

DISCUSSION, CONCLUSION, and SUGGESTIONS

This study aimed to examine the relationship between lower and upper extremity strength and endurance speed and repeated sprint performance in young soccer players. The results of the study showed a negative correlation between muscle strength and speed performance, indicating that an increase in quadriceps and hamstring muscle strength in the lower extremities of young soccer players would positively affect speed performance.

Josef, Brünn, Martin, and Ratko (2018) reported a statistically moderate relationship between active and passive jumping using the YO-YO intermittent recovery (Level 1) test. Active and passive jumping performance is determined by elastic and explosive strength. In this study, maximum strength determination methods were used to determine lower extremity strength and only the strength of the major muscle groups in that region was measured using weight machines. Although jumping performance is predominantly performed with the lower extremities, it is also accomplished with the synergistic involvement of core muscles and upper body muscles. This difference between the findings of this study and the results reported by Josef et al. (2018) can be explained by this fact. Additionally, it is noted in this study that training interventions aimed at improving explosive strength have been shown to increase active jumping height, depending on the content of the training unit (Buchheit, Mendez-Villanueva, Delhomel, Brughelli, & Ahmaidi, 2010). In the same study, it was reported that both repeated sprint and explosive strength training significantly increased maximum sprint speed. Styles, Mattheyews, and Comfort (2016) compared short-distance sprint performance (5m, 10m, 20m) with low-volume strength training (squat) applied twice a week for 6 weeks. Styles et al. (2016) stated that strength training in young soccer players positively influenced short-distance sprint performance and that low-volume strength training not only improved maximal strength but also enhanced short-distance sprint performance. In another study, Hammami, Negra, Shephard, and Chelly (2017) examined the effects of standard and contrast (different from standard training practices) strength training interventions on jumping, change of direction repeated sprint, and speed characteristics in young soccer players. They examined the effects of two different strength training methods applied to two different groups twice a week for 2 months. Although both groups showed an increase in performance results, the contrast strength training performed during the competitive season improved performance outcomes more than standard strength training. These studies and others in the literature indicate that training interventions specific to the desired skill positively improve performance outcomes.

Effective speed and agility performance are primarily a result of well-developed strength (Gouveia et al., 2023). In this study, it was found that the speed performance exhibited by participants was moderately inversely related to the maximum forces generated during the push and pull of the right and left legs, as well as during squat and shoulder press movements. Similarly, Boraczyński, Boraczyński, Podstawski, Wójcik, and Gronek (2020) reported that lower extremity strength was statistically inversely and highly related to 5m and 30m speed performance. In the same study, Boraczyński et al. (2020) also indicated a strong inverse relationship between active jumping and half squat, active jumping and 30m speed, and active jumping and maximum voluntary contraction strength. Taking into account the results from both studies, it can be concluded that improvements in lower extremity strength contribute to increased performance in situations where leg strength plays a significant role, especially in skills requiring speed and power such as sprinting, jumping, and change of direction in soccer. Consistent with these findings, various studies in the literature have reported a moderate to high correlation between lower extremity strength and speed and jumping performance (Ishid et al., 2020; Ishida, Travis, & Stone, 2021; Kabacinski et al., 2022).

In addition to these findings, Kabacinski et al. (2022) reported that 180°/s peak torque performance results in isokinetic strength were significantly correlated with active jumping, passive jumping, and 30m speed performances. They also mentioned that 60°/s and 300°/s torque performance results were statistically significantly related to agility test results involving a change of direction (T-Test). However, it should be noted that there may be differences in performance due to developmental variations, especially in young athletes, and it is important for coaches to understand these differences. Gouveia et al. (2023) stated in their study examining the jump and strength values of soccer players in different age groups and levels that as age increases, they displayed better performance results in terms of isokinetic power, vertical jump, static power, and average power values compared to young players. They also emphasized the necessity of specific strength planning in training units. In line with Gouveia et al. (2023) study, Itoh and Hirose (2020) stated that biological maturation is effective not only in the physical and physiological development but also specifically in muscle strength in elite young soccer players. Therefore, it is evident that efficient training during the maturation process is important and necessary for improving strength performance. However, there is a widespread belief among coaches that strength training negatively affects athletes' performance in speed and agility-related tasks. Contrary to this common misconception among coaches, the research in the literature indicates that strength training positively affects speed, agility, and other performance parameters (Gouveia et al., 2023; Hammami et al., 2017; Kabacinski et al., 2022; Ishid et al., 2020; Ishida et al., 2021; Itoh & Hirose, 2020). In light of this information, it is crucial for coaches to accurately adjust strength planning for young soccer players in small age groups.

Success in soccer can be achieved by demonstrating a more effective performance than the opponent. In addition to low-intensity activities, high-intensity activities such as jumping, sprinting, changing direction, etc. require the maximum display of skills (Chmura et al., 2014; Shephard, 1999). In other words, the key determinant of success involves the development of sport-specific skills in a complex manner. This highlights the importance of the practices carried out during training sessions. Turner and Stewart (2014) stated that effective and structured training programs should be designed for the development of power and conditioning in soccer players. When the findings of this study are supported by the literature including Turner and Stewart (2014), Bunchheit et al. (2010), Kabacinski et al. (2022), Ishida et al. (2021), it can be said that in the game of soccer, which involves the effective and efficient display of many fundamental motor skills together, coaches should pay attention to planning the training of sport-specific skills. Furthermore, athletic performance development should be facilitated through programs supported by measurements conducted for training planning and performance monitoring (Castagna, Manzi, Impellizzeri, Weston, & Barbero Alvarez, 2010).

Suggestions

Maintaining acceleration is important in soccer. In future studies, the relationship between acceleration and lower extremity strength can be determined by examining between accelerations of every 10m and lower extremity strength in the 30m sprint test. The effect of bilateral lower extremity asymmetry on acceleration performance can be examined. The relationship between strength properties can be examined with the 30-35 IFT test.

Ethics and Conflict of Interest

This study was presented as summary in 8th International Congress on Social Sciences on October 20-23, 2022, in Tekirdağ. The author acted in accordance with the ethical rules in the research.

REFERENCES

Al Haddad, H., Méndez-Villanueva, A., Torreño, N., Munguía-Izquierdo, D., & Suárez-Arrones, L. (2018). Variability of GPS-derived running performance during official matches in elite professional soccer players. *Journal of Sports Medicine and Physical Fitness*, *58*(10),1439-1445.

Arslan, A., Açıkada, C., Güvenç, A., Gören, H., Hazır, T., & Özkara, A. (2012). Metabolic demands of the match performance in young soccer players. *Journal of Sports Science and Medicine*, *11*, 170-179.

Bangsbo, J. (1994). *Fitness training in football: A scientific approach*. Bagsvaerd, Denmark: HO+Storm.

Boraczyński, M., Boraczyński, T., Podstawski, R., Wójcik, Z., & Gronek, P. (2020). Relationships between measures of functional and isometric lower body strength, aerobic capacity, anaerobic power, sprint and countermovement jump performance in professional soccer players. *Journal of Human Kinetics*, *75*, 161-175.

Buchheit, M., Mendez-Villanueva, A., Delhomel, G., Brughelli, M., & Ahmaidi, S. (2010). Improving repeated sprint ability in young elite soccer players: Repeated shuttle sprints vs. explosive strength training. *Journal of Strength and Conditioning Research*, *24*(10), 2715-2722

Castagna, C., Manzi, V., Impellizzeri, F., Weston, M., & Barbero Alvarez, J. C. (2010). Relationship between endurance field tests and match performance in young soccer players. *Journal of Strength and Conditioning Research*, *24*(12), 3227–3233.

Chmura, P., Golinski, D., Andrzejewski, M., Mroczek, D., Kawczynski, A., Rokita, A., & Chumra, J. (2014). Endurance capacity and selected technical-tactical skills of soccer players participating in the group stage of the 2014 FIFA World Cup. *Trends in Sport Sciences. 3*(21), 153-160.

Di Salvo, V., Baron, R., Tschan, H., Calderón Montero, F. J., Bachl, N., & Pigozzi F (2007). Performance characteristics according to playing position in elite soccer. *International Journal of Sports Medicine*, *28*, 222-227.

Dragijsky, M., Maly, T., Zahalka, F., Kunzmann, E., & Hank, M. (2017). Seasonal variation of agility, speed and endurance performance in young elite soccer players. *Sports*, *5*(12), 2-8.

Gouveia, J. N., França, C., Martins, F., Henriques, R., Nascimento, M. M., Ihle, A., Sarmento, H., Przednowek, K., Martinho, D., & Gouveia, É. R. (2023). Characterization of Static Strength, Vertical Jumping, and Isokinetic Strength in Soccer Players According to Age, Competitive Level, and Field Position. *International journal of environmental research and public health, 20*(3), 1799.

Hammami, M., Negra, Y., Shephard, R. J., & Chelly, M. S. (2017). The effect of standard strength vs. contrast strength training on the development of sprint, agility, repeated change of direction, and jump in junior male soccer players. *Journal of Strength and Conditioning Research*, *31*(4), 901-912.

Ishida, A., Rochau, K., Findlay, K. P., Devero, B., Duca, M., & Stone, M. H. (2020). Effects of an ınitial muscle strength level on sports performance changes in collegiate soccer players. *Sports (Basel, Switzerland), 8*(9), 127.

Ishida, A., Travis, S. K., & Stone, M. H. (2021). Short-term periodized programming May improve strength, power, jump kinetics, and sprint efficiency in soccer. J*ournal of Functional Morphology and Kinesiology*, *6*(2), 45.

Itoh, R., & Hirose, N. (2020). Relationship among biological maturation, physical characteristics, and motor abilities in youth elite soccer players. *Journal of Strength and Conditioning Research*, *34*(2), 382–388.

Josef, S., Brünn, D., Martin, P., & Ratko, P. (2018). Is there any connection between endurance, explosive strength, and speed performance? *Journal of Physical Education and Sport. 1*(49), 363-365.

Kabacinski, J., Szozda, P. M., Mackala, K., Murawa, M., Rzepnicka, A., Szewczyk, P., & Dworak, L. B. (2022). Relationship between isokinetic knee strength and speed, agility, and explosive power in elite soccer players. *International Journal of Environmental Research and Public Health*, *19*(2), 671.

Krustrup, P., Mohr, M., Amstrup, T., Rysgaard, T., Johansen, J., Steensberg, A., Redersen, P, K., & Bangsbo, J. (2003). The Yo-Yo intermittent recovery test. Physiological response, reliability, and validity. *Medicine & Science in Sports & Exercise. 35*(4), 697-705.

Mallo, J., Mena, E., Nevado, F., & Paredes, V. (2015). Physical demands of top-class soccer-friendly matches in relation to a playing position using a global positioning system. Technology. *Journal of Human Kinetics*, *14*, 179-188.

Meckel, Y., Machnai, O., & Eliakim, A. (2009). Relationship among repeated sprint tests, aerobic fitness, and anaerobic fitness in elite adolescent soccer players. *Journal of Strength and Conditioning Research*, *23*(1), 163-169.

Pääsuke, M., Ereline, J., & Gapeyeva, H. (2001). Knee extension strength and vertical jumping performance in Nordic combine athletes. *Journal of Sports Medicine and Physical Fitness*, *41*, 354-361.

Paul, S., Bradley, Lago-Peñas, C., Ezequiel, R., & Diaz, A. G. (2013). The effect of high and low percentage ball possession on physical and technical profiles in English FA Premier League soccer matches. *Journal of Sports Sciences*, *31*(12), 1261-1270.

Penas, C. L., Rey, E., Ballesteros, J. L., Casais, L., & Domínguez, E. (2009). Analysis of work-rate in soccer according to playing positions. *International Journal of Performance Analysis in Sport*, *9*, 218-227.

Rampinini, E., Coutts, A. J., Castagna, C., Sassi, R., & Impellizzeri, F. M. (2007). Variation in top level soccer match performance. *International Journal of Sports Medicine*, *28*, 1018-1024.

Shephard R. J. (1999). Biology and medicine of soccer, an update. *Journal of Sports Sciences*, *17*, 757-786.

Styles, W. J., Matthews, M. J., & Comfort, P. (2016). Effects of strength training on squat and sprint performance in soccer players. *Journal of strength and conditioning research, 30*(6), 1534-1539.

Tunçel, A., Harbili, E., & Arı, Y. (2019, Ekim). Genç futbolcularda çeviklik test protokolleri ve tekrarlı sprint performansı arasındaki ilişkinin incelenmesi. *3rd union of Thrace universities international health science proceedings book.* Çanakkale, Turkey, 579-583.

Turner, A., & Stewart P. (2014). Strength and conditioning for soccer players. *Strength and Conditioning Journal*, *36*(4), 1-13.