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ASPECTS RELATING TO THE DEVELOPMENT OF MOTOR SKILLS, STRENGTH, AND BALANCE IN U16 FOOTBALL

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Abstract. *Regarding the process of development of young athletes, our primary focus is their health. It is widely recognized that a significant injury can slow down the process of development in the best-case scenario, or prematurely end an athlete's career, in the worst-case scenario. The nature of football introduces a heightened risk of injuries due to its dynamic and unpredictable characteristics. In order to optimize our efforts in the process of preventing these injuries, we believe that the best practice is to understand the pillars on which performance in football is based, and adapt our training plans and sessions to address particular weaknesses. The two pillars that need our full attention are strength and balance. To pinpoint the vulnerabilities of young athletes, we employed two devices to measure both balance and strength in each athlete. A total of two tests were conducted for each athlete, measuring maximal power in the lower body, dynamic balance from one foot to the other, limb asymmetry in terms of muscle strength, and dynamic balance. The study confirmed that neuromuscular control has a key role in the effective utilization of power by the athlete, as in the dynamic balance test, football team B used less power and recorded (at the same time) a lower limb asymmetry score than team A.*

Keywords*: strength; balance; injury prevention.*

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Introduction

”In order to create good adult athletes, it is of primary importance that attention is paid to a complete and harmonic development of motor abilities at early ages, above all concerning the specific age-related ones in each phase of the athlete's body development” (Ricotti, 2011).

The most popular sport in the world, football, is also one of the most loved sports in Romania. According to the Romanian Football Federation, in 2020 there were over 300.000 players signed up in a wide variety of organised competitions, from grassroots and amateur to professional players.

”Football is one of the sports that takes place with a very fast rhythm” according to Khuddus (2017). In order to sustain such an effort over the years, the athletes must acquire a complex set of motor skills, which will help them maintain their health and perform better in competitions.

"Physical condition is a necessary requirement in improving athlete performance, and can even be considered a basic need that cannot be postponed or negotiated," according to Hanief et al. (2017). Scheunemann (2012) has stated that "the physical condition components of football players are speed, strength, endurance, flexibility, accuracy, power, coordination, reaction, balance, agility". For this study we have chosen to talk about strength and balance, as these two are key factors in reducing the risk of injury and enhancing performance (as emphasized below).

Balance performance plays a fundamental role in many athletic activities and the ability of postural control may designate successful performance during competition (Adlerton et al., 2003). According to Jadczak et al. (2019), football players participating at a professional level (PRO group) exhibit superior balance, which may indirectly contribute to injury prevention and increased efficacy in any game-related actions.

In the context of a football match, football players frequently perform lower extremity skills such as passing, shooting, and dribbling while wearing football cleats on a grass field (Orchard, 2002). Given this, we agree that players must maintain their balance while being impeded by the opposing team and trying to secure the ball (Gerbino et al., 2007).

Postural proficiency can be considered a performance or skill criterion in specific conditions of football (Paillard et al., 2006). It requires unipedal balance to perform different technical movements such as shooting, dribbling, and passing, the balance in the supporting leg being essential to shoot as accurately as possible (Paillard et al., 2006). Football players use one leg as support when kicking the ball and being in possession of the ball (Adlerton et al., 2003; Kellis et al., 2001) and have better one-legged stance stability (Matsuda et al., 2008).

Balance performance can be developed through strength, flexibility, aerobic and anaerobic training (Judge et al., 1993; Messier et al., 2000; Shintaku et al., 2005). Over the years, authors have stated that the ability to effectively maintain balance is based on physical fitness factors such as muscular strength and anaerobic capacity (Era & Heikkinen, 1985). It has been reported that students with high muscle strength have better balance (Pant et al., 2006). The power generated during football-specific activities depends on the strength of muscles performing the movements (Reilly et al., 2000).

In football, the quadriceps plays an important role in sprinting, jumping, and ball-kicking (Lehance et al., 2009), with the hamstrings assisting the anterior cruciate ligament in preventing anterior traction forces as well as decelerating the leg prior to full extension and thus, limiting overextension of the knee (Coombs & Garbutt, 2002). The hamstring strength is extremely important in football players for joint stabilization during various tasks, notably in eccentric action. Moreover, short-sprinting execution may mirror actual game situations at high level and could be an important determinant of match-winning actions (Cometti et al., 2001).

Hamstrings and quadriceps strength deficits and asymmetries have been identified as important parameters in the prevention of knee and hamstring injuries in football (Lehnert et al., 2014, Ruas et al., 2015, Ardern et al., 2015).

Between-limb strength asymmetries are reportedly more common in high-level youth football players compared to professional players (Lehance et al., 2009). Between-limb strength asymmetries greater than 10% have been associated with increased risk of knee injury in football players (Fousekis et al., 2010; Daneshjoo et al., 2013).

Limb strength asymmetries have been found to be more common in high-level youth soccer players compared to professional players (Lehance et al., 2009). Limb strength asymmetries above 10% have been associated with an increased risk of knee injury in football players (Fousekis et al., 2010; Daneshjoo et al., 2013).

Therefore, strength and balance play a very important role in football performance and injury prevention. It is important for coaches at the juvenile level to pay enough attention to these motor skills while developing the technical and tactical aspects of the game.

Methodology

Research question

What are the dynamics of muscle strength, and the dynamic balance in football players competing in the Romanian U16 Elite League?

Participants

The study involved 38 players, selected from two different academies, and competing in the U16 Elite League, the highest competition at this level in Romania. The players were divided into 2 groups, according to their teams – Team A comprised 18 players, and Team B comprised 20 players. All the players had at least 9 years of football-playing experience, and all of them were training according to their coach's instructions. None of the players were doing any extra workout at the time of testing.

Measures

For this study we used 2 different measurement systems, namely Optojump and Desmotec, to measure maximal power in the lower body, dynamic balance from one leg to the other, limb asymmetry in terms of muscle strength, and dynamic balance.

Using the Optojump, we conducted the "Ski test," which is a dynamic balance test. This test was carried out with both legs parallel to the bars, jumping sideways from one leg to the other for 15 seconds. The test provided parameters including contact time, flight time, height of the jumps, power of each jump, limb asymmetry in terms of dynamic balance, and reactive strength index. The reactive strength index is derived from the height achieved in a depth jump and the time spent on the ground developing the forces required for that jump, according to McClymont (2008). The primary aim of this test is to measure the dynamic balance from one leg to the other, and limb asymmetry in terms of dynamic balance.

With the Desmotec, we conducted the "Max Power test," involving a series of 10 squats with a flywheel. Before the test started, each subject did an accommodating set of squads. This test quantifies, in Watts, the maximum, average and standard deviation for both concentric and eccentric power generated by the athlete. Additionally, it indicates the presence of limb asymmetry in terms of muscle strength.

Procedure

Participation in the research was voluntary, with a commitment to maintaining anonymity and adhering to international ethical recommendations regarding the absolute confidentiality of both the collected data and the participants' anonymity and security. No identification data such as name, phone number or email address were solicited. Participants could withdraw from the study at any point without facing negative consequences. The tests were conducted under the supervision of specialized professionals trained to use the equipment.

The two groups of athletes were tested on two separate days, and they all followed the same protocol: a 5-minute warmup in their training clothes, followed by the Optojump and concluding with the Desmotec. All tests were conducted in silence, thus allowing each participant to concentrate and perform optimally.

The international ethical guidelines were respected, ensuring that participants provided informed consent, and measures were taken to guarantee the anonymity and confidentiality of the collected data (Descombe, 2014; Predoiu, 2020).

Results

To have a better understanding of the results, we find it beneficial to compare the two teams, considering they had different coaches. We will refer to them as TEAM A and TEAM B.

The first test to interpret will be the Ski test, as we believe that in order to generate greater power it is important to have better balance.

Table 1. *Independent Samples t Test – Ski Test*

		Levene's Test for Equality of Variances		T-Test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Power	Equal variances assumed	.88	.354	3.70	37.00	.001	2.06	.56	.93	3.19
	Equal variances not assumed			3.69	35.26	.001	2.06	.56	.93	3.19

Table 1 presents a comparison of the average power generated in the dynamic balance test by the two teams. The statistical significance of the mean difference was analysed using the Independent Samples *t* Test. The results corresponding to $p<0.05$ indicate a significant difference between the average scores of the two teams.

Table 2. *Descriptive data for Team A - Ski Test*

Ski Test	Arithmetic mean	Standard deviation	Coefficient of variation	Minimum	Maximum
Power	9.46	1.88	19.88	6.35	13.1
Limb Asymmetry	16.43	18.48	112.5	0.1	57.7
Pace	0.97	0.21	21.98	0.74	1.63
RSI	0.13	0.04	35.9	0.06	0.25

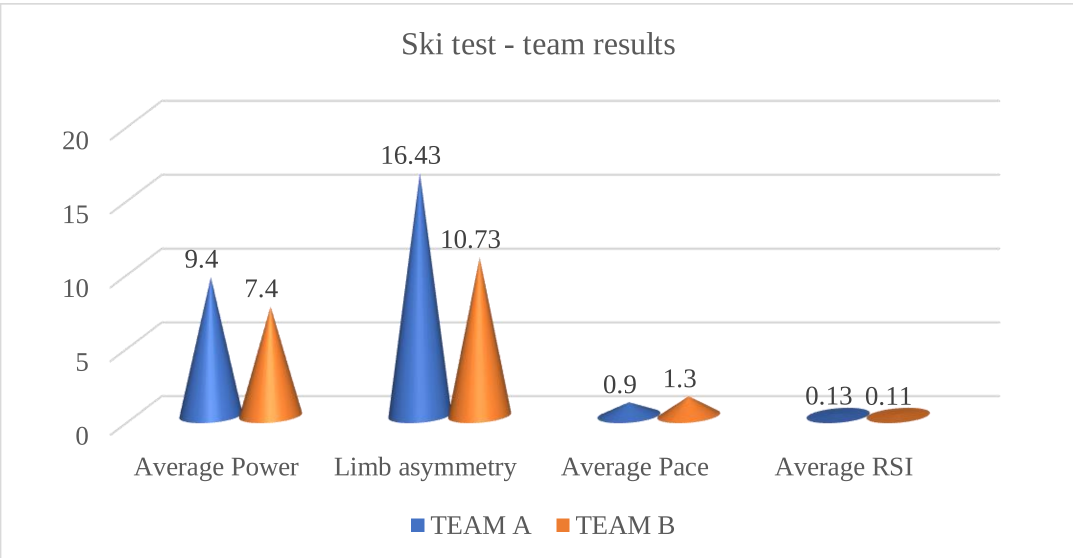
For Team A, in the Ski Test, the average power is 9.46, the average limb asymmetry is 16.43%, the average pace is 0.97 and the average RSI (reactive strength index) is 0.13.

Table 3. *Descriptive data for Team B - Ski Test*

Ski Test	Arithmetic mean	Standard deviation	Coefficient of variation	Minimum	Maximum
Power	7.4	1.58	21.4	4.45	10.63
Limb Asymmetry	10.73	11.25	104.92	0	48
Pace	1.32	0.19	14.95	1.03	1.83
RSI	0.11	0.04	35.81	0.05	0.19

For Team B, in the Ski Test the average power is 7.4, the average limb asymmetry is 10.73%, the average pace is 1.32, and the average RSI is 0.11.

Comparing the two teams in terms of power we find that the size effect is 1.19, and according to Cohen there is a very marked difference between the two teams. As we can see in Table 2 and Table 3, in average, Team A generated more power and has a slightly higher RSI score in the dynamic balance test, while Team B has a higher pace score and a lower limb asymmetry score in the Ski test. Team B has a better dynamic balance because it has a lower score in the limb asymmetry parameter and a higher score in the pace parameter, while the RSI difference is not significant statistically.



Note: RSI = reactive strength index

Figure 1. Ski test – team results

Next, we will look at the Max Power test, because we believe that the team with better balance should develop better power.

Table 4. *Independent Samples t Test – Concentric Max Power Test*

		Levene's Test for Equality of Variances		T-Test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Concentric Power	Equal variances assumed	.00	.97	-2.56	36.00	.015	-159.93	62.55	-286.79	-33.08
	Equal variances not assumed			-2.55	35.39	.015	-159.93	62.63	-287.03	-32.84

In Table 4, we compare the average concentric power obtained by both teams. The statistical significance of the mean difference was analysed using the Independent Samples *t* Test. The results corresponding to $p<0.05$ indicate a significant distinction in the average score of the two teams.

Table 5. *Independent Samples t Test – Eccentric Max Power Test*

		Levene's Test for Equality of Variances		T-Test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Eccentric Power	Equal variances assumed	1.81	.187	-2.71	36.00	.010	-155.89	57.59	-272.69	-39.09
	Equal variances not assumed			-2.73	35.91	.010	-155.89	57.10	-271.71	-40.07

In Table 5, we compare the average eccentric power obtained by the two teams. The p value = 0.010, emphasizing a significant difference between the average score of the two teams.

Table 6. *Descriptive data for Team A – Max Power Test*

Max Power Test	Arithmetic mean	Standard deviation	Coefficient of variation	Minimum	Maximum
Max Conc	518.66	194.89	37.57	160	858
Max Ecc	538.61	162.03	30.08	272	936
Avg Conc	373.55	156.62	41.92	100	647
Avg Ecc	368.83	139.54	37.83	144	670
Limb Asymmetry	5.5	3.58	65.18	0	13

Note: Max Conc = the best repetition for concentric power; Max Ecc = the best repetition for eccentric power; Avg Conc= the mean of 10 repetitions for concentric power; Avg Ecc= the mean of 10 repetitions for eccentric power.

For Team A in the Max Power Test the average Max Conc is 518.66, the average Max Ecc is 538.61, the Avg Conc is 373.55, the Avg Ecc is 368.83, while the average Limb Asymmetry is 5.5%.

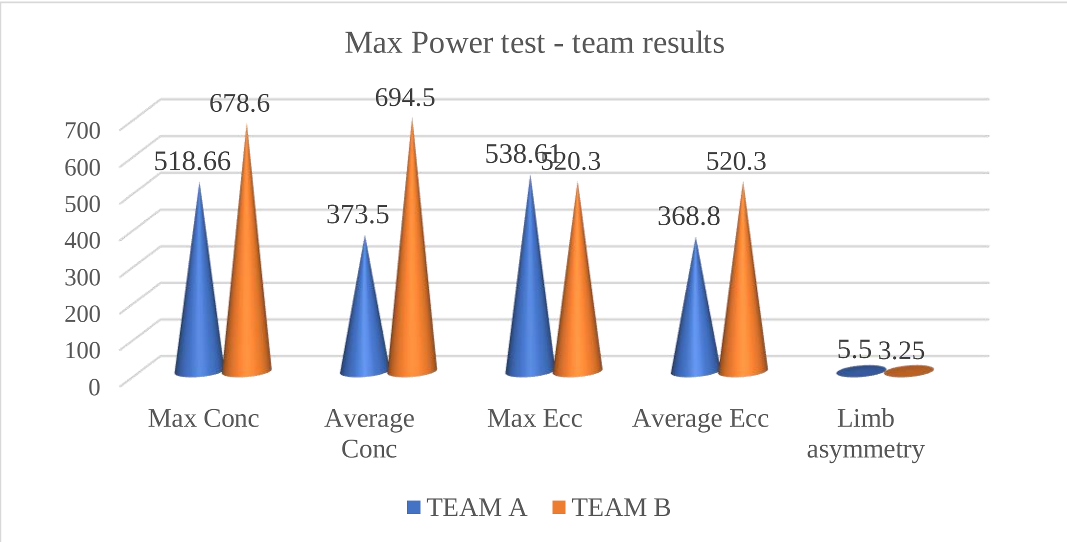
Table 7. *Descriptive data for Team B – Max Power Test*

Max Power Test	Arithmetic mean	Standard deviation	Coefficient of variation	Minimum	Maximum
Max Conc	678.6	190.37	28.05	372	1119
Max Ecc	694.5	189.85	27.33	430	1010
Avg Conc	534.4	160.02	29.94	292	894
Avg Ecc	520.35	141.96	27.28	339	781
Limb Asymmetry	3.25	1.97	60.62	0	7

Note: Max Conc = the best repetition for concentric power; Max Ecc = the best repetition for eccentric power; Avg Conc= the mean of 10 repetitions for concentric power; Avg Ecc= the mean of 10 repetitions for eccentric power.

For Team B in the Max Power Test the average Max Conc is 678.6, the average Max Ecc is 694.5, the Avg Conc is 534.4, the average Avg Ecc is 520.35, while the average Limb Asymmetry is 3.25%.

Comparing the two teams in terms of concentric power and eccentric power, we notice that the effect sizes are 0.82 and 0.87, and according to Cohen there is a significant difference between the two teams. An analysis of the data presented in Table 6 and Table 7 reveals that Team B generated more power than Team A in terms of concentric and eccentric power, and has a lower score in terms of limb asymmetry. Examining the data from the perspective of injury prevention, we observe that the values for concentric and eccentric power within the same team are very close. The concentric movement is associated to the hamstring muscles and the eccentric movement is associated with quadriceps muscles (Arsenis et al., 2021). As emphasized by the mentioned researchers, in sports performance and injury prevention it is crucial to have a balance of power between the hamstrings and the quads.



Note: Max Conc = the best repetition for concentric power; Max Ecc = the best repetition for eccentric power; Average Conc= the mean of 10 repetitions for concentric power; Average Ecc= the mean of 10 repetitions for eccentric power.

Figure 2. Max Power test – team results

In order to gain a better understanding of the quality of movement, we will analyse the Max Power test in terms of individual results. This entails assessing how many athletes from each team achieve higher results on each variable.

Table 8. *Max Power test – individual results*

Variables	Team A	Team B
Average Conc	5	6
Average Ecc	8	7
Limb Asymmetry	13	7

Table 8 presents individual results for each team, illustrating the number of players from each team who achieved results higher than the average result of the team, for each parameter. For the average conc and average ecc, a higher score means a better result, but in the case of limb asymmetry, a higher score implies poorer performance.

Upon analysing the individual results of each team, it becomes apparent that Team A has more players with limb asymmetry in terms of muscle strength compared to Team B. This limb asymmetry can indicate a heightened risk of injury as well as lower performance because the stronger leg may sustain excessive stress due to high dependence and loading, whereas the weaker leg may struggle to sustain even average loads, according to Ford et al. (2003).

Comparing these two tests (Ski test and Max Power test), we see that the common variable is the limb asymmetry, which showed better results in favour of Team B in both tests. In terms of power developed in the Max Power test, Team B had better results, while in the Ski test, Team A had better results. The difference between these two variables is that in the Max Power test we assess the maximal power developed, whereas in the Ski test we analyse the power in dynamic balance mode. In this case, higher values for the power in dynamic balance does not mean having better results. On the contrary, it may indicate reduced control over the body movement.

Discussion and Conclusion

According to Aminudin and Liskustyawati (2020) „the physical condition component of leg muscle strength, hip joint flexibility and dynamic balance greatly influence the improvement of ball shooting accuracy", which will help increasing the performance capacity in football.

According to Booysen et al. (2015,) power continues to show a significant correlation with the dynamic balance performance, particularly when evaluating the non-dominant leg as the stance leg in male football players. The ability to swiftly and forcefully engage the muscles responsible for leg extension could potentially enhance a footballer's capacity to execute optimal balance strategies. These strategies may necessitate a certain level of power to assist in managing torque demands when the player adjusts their centre of mass to maintain balance during actions such as shooting or passing.

According to Wisloff et al. (2004) „elite soccer players should focus on maximal strength training, with emphasis on maximal mobilisation of concentric movements, which may improve their sprinting and jumping performance."

In order to statistically analyse the results from both teams, we employed the Independent Samples t Test. The findings indicate a significant difference in the average scores regarding the power developed by the two teams across both tests. In the Ski test, which is a dynamic balance test, Team A registered a higher score for power than Team B, although in the Max Power test Team B registered a higher score for eccentric power than Team A. The results obtained (considering the values for limb asymmetry, too) indicate that Team B has a better neuromuscular control, which leads to better results in these tests.

Further research is necessary to explore the extent to which neuromuscular training adapted to the sport's specifics during younger ages can enhance performance and prevent injuries. Additionally, careful consideration is required regarding the timing of neuromuscular training sequence. Should it be integrated during preseason, or would a weekly schedule be more beneficial? In our vision it will benefit the teams and the athletes if we schedule a week of neuromuscular control training in the preseason, and add also neuromuscular control sequences in the warm ups at least three times a week throughout the year. These potential benefits await validation through future studies.

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Institutional Review Board Statement: The research was conducted according to the principles stated in the Declaration of Helsinki. The study was approved by the Ethics Committee of the National University of Physical Education and Sport in Bucharest, with no. 116/SG.

Informed Consent Statement: The written informed consent for the athletes to participate in this study was obtained.

Data Availability Statement: Data are available upon request to the contact author.

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

References

Adlerton, A. K., Moritz, U., & Moe-Nilssen, R. (2003). Force plate and accelerometer measures for evaluating the effect of muscle fatigue on postural control during one-legged stance. *Physiotherapy Research International, 8*, 187-199. https://doi.org/10.1002/pri.289

Aminudin, S., & Liskustyawati, H. (2020). Contribution Leg Muscle Strength, Dynamic Balance and Hip Joint Flexibility to the Accuracy of Football Shooting. *Budapest International Research and Critics in Linguistics and Education (BirLE) Journal*, *2,* 912-918. https://doi.org/10.33258/birle.v3i2.985

Ardern, C. L., Pizzari, T., Wollin, M. R., & Webster, K. E. (2015). Hamstrings strength imbalance in professional football (soccer) players in Australia. *Journal of Strength and Conditioning Research, 29*, 997-1002. https://doi.org/10.1519/JSC.0000000000000747

Arsenis, S., Gioftsidou, A., Smilios, I., Malliou, P., Chatzinikolaou, A., Ispyrlidis, I., & Beneka, A. (2021). Flywheel or free weight training for improvement of lower limbs strength? *Journal of Back and Musculoskeletal Rehabilitation, 34*(3), 477-483.

Booysen, M., Gradidge, P., & Watson, E. (2015). The relationships of eccentric strength and power with dynamic balance in male footballers. *Journal of Sports Sciences, 33*, 1-9. https://doi.org./10.1080/02640414.2015.1064152

Coombs, R., & Garbutt, G. (2002). Developments in the use of the hamstring/quadriceps ratio for the assessment of muscle balance. *Journal of Sports Science and Medicine, 1,* 56-62.

Cometti, G., Maffiuletti, N. A., Pousson, M., Chatard, J. C., & Maffulli, N. (2001). Isokinetic strenght and anaerobic power of elite, subelite and amateur French soccer players. *International Journal of Sports Medicine, 22*, 45-51. https://doi.org/10.1055/s-2001-11331

Daneshjoo, A., Rahnama, N., Mokhtar, A. H., & Yusof, A. (2013). Bilateral and unilateral asymmetries of isokinetic strength and flexibility in male young professional soccer players. *Journal of Human Kinetics, 36,* 45-53. https://doi.org/10.2478/hukin-2013-0005

Descombe, M. (2014). *The good research guide: For small-scale social researchprojects. (5th ed.).* Open University Press.

Era, P., & Heikkinen, E. (1985). Postural sway during standing and unexpected disturbance of balance in random samples of men of different ages. *Journal of Gerontology, 40,* 287-295. https://doi.org/10.1093/geronj/40.3.287

Ford, K. R., Myer, G. D., & Hewett, T. E. (2003). Valgus knee motion during landing in high school female and male basketball players. *Medicine & Science in Sports & Exercise, 35,* 1745-1750. https://doi.org/10.1249/01.MSS.0000089346.85744.D9

Fousekis, K., Tsepis, E., Poulmedis, P., Athanasopoulos, S., & Vagenas, G. (2010). Intrinsic risk factors of non-contact quadriceps and hamstring strains in soccer: a prospective study of 100 professional players. *British Journal of Sports Medicine, 45:* 77560. https://doi.org/10.1136/bjsm.2010.077560

Gerbino, G. P., Griffin, E. D., & Zurakowski, D. (2007). Comparison of standiing balance between female collegiate dancers and soccer players. *Gait & Posture, 26*(4), 501-507. https://doi.org/10.1016/j.gaitpost.2006.11.205

Hanief, Y. N., Puspodari, P., & Sugito, S. (2017). Profile of physical conditions of Taekwondo Junior Athletes Pusklatkot (Training center) Kediri city year 2016 to compete in 2017 East Java Regional Competition. *International Journal of Physiology, Nutrition and Physical Education, 2*(2), 262-265.

Jadczakk, Ł., Grygorowicz, M., Dzudziński, W., & Śliwowski, R. (2019). Comparison of static and dynamic balance at different levels of sport competition in professional and junior elite soccer players. *Journal of Strength and Conditioning Research, 33*(12), 3384-3391. https://doi.org/10.1519/JSC.000000000002476

Judge, J. O., Lindsey, C., Underwood, M., & Winsemius, D. (1993). Balance improvements in older women: effects of execise training. *Physical Therapy and Rehabilitation Journal, 73,* 245-265. https://doi.org/10.1093/ptj/73.4.254

Kellis, S., Gerodimos, V., Kellis, E., & Manou, V. (2001). Bilateral isokinetic concentric and eccentric strength profiles of the knee extensors and flexors in young soccer players. *Isokinetic and Exercise Science, 9,* 31-39.

Khuddus, L. A. (2017). Eating Disorders and Protein Energy Adequacy Levels on Physical Fitness of Football Players. *Journal of Learning Research*, *3*(1), 44-54.

Lehance, C., Binet, J., Bury, T., & Croisier, J. L. (2009). Muscular strength, functional performances and injury risk in professional and junior elite soccer players. *Scandinavian Journal of Medicine and Science in Sports, 19,* 243-251. https://doi.org/10.1111/j.1600-0838.2008.00780.x

Lehnert, M., Xaverova, Z., & De Ste Croix, M. (2014). Changes in muscle strength in u19 soccer players during an annual training cycle. *Journal of Human Kinetics, 42,* 175-185. https://doi.org/10.2478/hukin-2014-0072

Matsuda, S., Demura, S., & Uchiyama, M. (2008). Centre of pressure sway characteristics during static one-legged stance of athletes from different sports. *Journal of Sports Science, 26*(7), 775-779. https:/doi.org/10.1080/02640410701824099

McClymont, D. (2008). The use of the reactive strength index as an indicator of plyometric training conditions. In: T. Reilly, J. Ccabri & D. Araújo (Eds.), *Science and Football V: The Proceedings of the Fifth World Congress on Sports Science and Football* (pp. 408-416). Routledge.

Messier, S. P., Royer, T. D., Craven, T. E., O'Toole, M. L., Burns, R., & Ettinger, W. H. (2000). Long-term exercise and its effect on balance in older, osteoarthritic adults: results from the fitness, arthritis, and seniors trial (FAST). *Journal of American Geriatrics Society, 48,* 131–138. https://doi.org/10.1111/j.1532-5415.2000.tb03903.x

Orchard, J. (2002). Is there a relationship between ground and climatic conditions and injuries in football? *Sports Medicine, 3,* 419-432. https://doi.org/10.2165/00007256-200232070-00002

Paillard, T., Noe, F., Riviere, T., Marion, V., Montoya, R., & Dupui, P. (2006). Postural performance and strategy in the unipedal stance of soccer players at different levels of competition. *Journal of Athletic Training, 41*(2), 172-176.

Pant, H., Sukumar, K., Sharma, H., Pandey, A. K., & Goel, S. N. (2006). Correlation between muscles strength in relation to dorsiflexion, plantarflexion, eversion and inversion strength with body balance. *Journal of Sports Science & Medicine, 39*(Suppl. 1): 557.

Predoiu, A. (2020). *Metodologia cercetării științifice. Aplicații practice și elemente de statistică neparametrică* [Scientific research methodology. Practical applications and elements of non-parametric statistics]. Discobolul.

Reilly, T., Bangsbo, J., & Franks, A. (2000). Anthropometric and physiological predispositions for elite soccer. *Journal of Sport Science*, *18*(9), 669-683. https://doi.org/10.1080/02640410050120050

Ricotti, L. (2011). Static and dynamic balance in young athletes. *Journal of Human Sport and Exercise*, *6*(4), 616-628. https://doi.org/10.4100/jhse.2011.64.05

Romanian Football Federation. (2020). https://www.frfotbal.ro/index.php?competition_id=11&season=639&serie_id=2741

Ruas, C., Minozzo, F., Pinto, M. D., Brown, L. E., & Pinto, R. S. (2015). Lower-extremity strength ratios of professional soccer players according to field position. *Journal of Strength and Conditioning research*, *29,* 1220-12206. https://doi.org/10.1519/JSC.0000000000000766

Scheunemann, T. (2012). *Indonesian football curriculum for Early Childhood (u5-u12), (u13-u20) & Senior*. PSSI.

Shintaku, Y., Ohkuwa, T., & Yabe, K. (2005). Effects of physical fitness level on postural sway in young children. *Anthropological Science, 113,* 237–244. https://doi.org/10.1537/ase.040129

Wisloff, U., Castagna, C., Helgerud, J., Jones, R., & Hoff, J. (2004). Strong correlation of maximal squat strength with sprint performance and vertical jump height in elite soccer players. *British Journal of Sports Medicine, 38,* 285-288. https://doi.org/10.1136/bjsm.2002.002071