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The Impact of 8-Week Deceleration Training on Dynamic Balance Skills of Young Soccer Players

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Abstract

The objective of this study is to assess the impact of deceleration training method on improving dynamic balance skills of young soccer players in comparison with the conventional training methods. This study included 26 young soccer players (mean age: 13.54±1.48, height: 154.98±12.44, weight: 46.16±11.06, Body Mass Index 18.96±2.21 kg/m^2, fat percentile 18.22%±3.22). Thirteen players participated in the deceleration training group (DTG) group and thirteen players participated in the conventional training group (CTG). The training programs were executed on three nonconsecutive days in a week for a total of eight weeks. Y-balance tests were conducted both before and after the eight week training programs. The differences between the averages were analyzed with Wilcoxon, comparison between the groups were analyzed with Mann-Whitney-U post hoc analyses. There was no difference in left-right balance variation ($p > 0.05$) performance measurements between DTG and CTG before the exercise program. However, after the 8 week training programs, the performance measurements between DTG and CTG were significantly different ($p < 0.05$) and the dynamic balance skill development of the DTG were more advanced. Based on these results, the deceleration training method seems to be a more effective method in developing dynamic balance skills than conventional training methods.

Keywords: Deceleration training, Balance, Athletic performance, Young soccer player

1. Introduction

Soccer is a game that demands multiple skills such as strength, speed, agility, balance, stability, flexibility, and endurance (Bloomfield et al., 2007; Gorostiaga et al., 2004; Helgerud et al., 2001; Krustrup et al., 2005).

Even though studies of different training methods on mature soccer players have gained importance in more recent years, there is a lack of research on the athletic performance of young soccer players. Dynamic balance, which is a fundamental movement skill, needs to be improved by the age of 11 in every sport (Camliguney, 2013). Improving dynamic balance contributes to young soccer players ability to perform their sport-specific movement skills more readily when their age of specialization comes (Bruhn et al., 2006).

Dynamic balance is defined as the skill to remain in a stable position and this skill plays a crucial role in many sports. Soccer is a sport that often requires dynamic balance skills during shooting, cutting and passing (Pau et al., 2015; Teixeira et al., 2011). Furthermore, correlations between single-leg balance and kicking have been identified (Chew-Bullock et al., 2012). On the other hand, soccer players with dynamic balance asymmetries are more likely to sustain a lower limb musculoskeletal injury (Gonell et al., 2015; Onofrei et al., 2019) causing lack of training and competition, therefore decreasing soccer team performance.

Deceleration is defined as the act of athletes slow down their movement, eventually stopping and assuming a desired body position. Deceleration is required after any sprint performance to slow the athlete's center of gravity, regardless of the relative speed of the run (Hewit et al., 2011). The deceleration aspects of speed have not been widely analyzed, however there is a coaching theory (Lees, 2002; Kovacs et al., 2008, Kovacs et al., 2015) stating that the 4 major components of deceleration are power, reactive strength, dynamic balance or stability, and eccentric strength (Kovacs, 2006). It is important to note that speed must not be considered as a single concept. In fact, acceleration, maximum speed and deceleration phases must be taken into account in order to better understand speed performance (Jeffreys, 2013). Due to the nature of team sports such as soccer that require repetitive sprinting, the deceleration ability plays an important role in the movements of players during games and also while training (Lakomy & Haydon, 2004). Acceleration and deceleration are the two most frequent movements in soccer games. Acceleration and deceleration skills of athletes have been reported to affect their overall competence, dribbling and goal scoring capabilities (Izzo et al., 2015).

The objectives of this study are to (1) examine the effect of deceleration training development skills on dynamic balance performance in young soccer players, and (2) determine whether an 8 week training program is sufficient to improve dynamic balance.

2. Method

2.1 Research Model

Participants were randomly divided into two groups as deceleration training group (DTG) and conventional training group (CTG). In addition to routine soccer training, DTG and CTG participated in DTG and CTG speed training programs, respectively. The only difference in linear speed training between the two groups was the addition of a deceleration zone at the end of the speed drill of the DTG. While the DTG players tried to stop at shortest distance within the determined deceleration zone after the sprint, CTG players tried to stop slowly. Both groups performed dynamic balance tests before and after the implementation.

2.1.1 Subjects

Twenty-six healthy young male soccer players (mean age: 13.54±1.48, height: 154.98±12.44, weight: 46.16±11.06, Body Mass Index 18.96±2.21 kg/m^2, fat percentile 18.22%±3.22) participated voluntarily in our study. All participants in the training groups had active soccer licenses for the past two years and none had any disability. The participants were required not to do any extra training during the 8 weeks of the study. After the pre-training tests, the participants were randomly divided into two groups as DTG (n = 13) and CTG (n = 13). All subjects were informed about the potential risks and benefits of the research in accordance with the 1964 Declaration of Helsinki of the World Medical Organization (WHO) (1996) before participating in the study. In addition, written consent was obtained from the families of the participants. The subjects were asked not to exercise the day before the tests. Our research was approved by the Marmara University Clinical Research Ethics Committee Number: 09.2018.487.

2.1.2 Procedure

Both groups were informed about the research before the 8 week training started. During the first training, players were expected to adapt to the research procedures. The technique for stopping after the speed run were explained to the groups in detail. Workouts were practiced 3 times a week in non-consecutive days for 8 weeks. There was no disability at the end of 8 weeks. The training contained warm-up (20 minutes of running, dynamic and static stretching and exits), speed training (10-15 minutes), technical-tactical exercises (25-30 minutes of shooting, passing, defense and attack) and cooling (10 minutes). Speed training was done immediately after warm up. Speed distances were applied as 5 m, 10 m, 20 m and 30 m in line with the demands of the soccer game. Drills were applied only in the linear plane. For speed training, 1:6 rests between reps and 4 minutes between sets were applied. The conventional group was asked to stop slowly after the sprint. The participants of deceleration group were asked to stop safely in the shortest possible distance. The research examined the comparative impact of slow stopping versus stopping within the shortest distance on dynamic balance.

Deceleration training group (DTG) applied the stopping within the shortest distance technique in linear speed training. The soccer players tried to safely stop within the shortest distance possible after passing the determined distances in the shortest time. Participants were motivated not to drop speed during the training without completing the speed distance (Table 1).

Table 1. Eight week sprint training program including deceleration zone

	Intense	Distance (m)	Deceleration Zone (m)	Reps	Sets	Rest Between Reps	Rest Between Sets
Week 1	Maximum	5	5	10	2	1:6	4 min.
Week 2	Maximum	10	5	8	2	1:6	4 min.
Week 3	Maximum	20	5	6	2	1:6	4 min.
Week 4	Maximum	30	5	4	2	1:6	4 min.
Week 5	Maximum	5-10-20-30	5	5-4-3-2	2	1:6	4 min.
Week 6	Maximum	5-10-20-30	5	5-4-3-2	2	1:6	4 min.
Week 7	Maximum	5-10-20-30	5	5-4-3-2	2	1:6	4 min.
Week 8	Maximum	5-10-20-30	5	5-4-3-2	2	1:6	4 min.

Conventional training group (CTG) applied the technique of stopping slowly in speed exercises. The athletes tried to stop slowly after passing the set distances as soon as possible. The participants were motivated not to slow down during the training without completing the speed distance (Table 2).

Table 2. Eight week conventional sprint training program

	Intense	Distance	Reps	Sets	Rest Between Reps	Rest Between Sets
Week 1	Maximum	5	10	2	1:6	4 min.
Week 2	Maximum	10	8	2	1:6	4 min.
Week 3	Maximum	20	6	2	1:6	4 min.
Week 4	Maximum	30	4	2	1:6	4 min.
Week 5	Maximum	5-10-20-30	5-4-3-2	2	1:6	4 min.
Week 6	Maximum	5-10-20-30	5-4-3-2	2	1:6	4 min.
Week 7	Maximum	5-10-20-30	5-4-3-2	2	1:6	4 min.
Week 8	Maximum	5-10-20-30	5-4-3-2	2	1:6	4 min.

2.2 Purpose of Research

In conventional soccer speed training, players either stop slowly or do not receive any command from their coach about how to stop. We believe that the slowing down stopping technique or lack of any technique are inadequate to prepare young soccer players for competition conditions. Our research goal was to determine the impact of introducing deceleration zone to linear speed training on dynamic balance. Our hypothesis is that the introducing deceleration zone in linear speed training will improve the dynamic balance of young soccer players. Question of the study is "should the deceleration zone be introduced to soccer linear speed training?''

2.3 Data Collection Tool

Height was measured with Seca 220 brand, height measuring device in a vertical and facing view. Electronic Tanita MC-780MA model segmental body composition device was used to determine the body weights, body fat analyses and body mass indices of the participants. Leg length was measured with tape measure. Dynamic balance measurements of the participants were made with the Y-balance test (Gonell et al., 2015; Plisky et al., 2009).

2.3.1 Y Balance Test

The test sequence was performed as right anterior, left anterior, right posterio-medial, left posterio-medial, right posterio-lateral and left posterio-lateral. The highest reach value in application directions was recorded to evaluate its performance across the entire test (Plisky et al., 2009). For the right and left foot values in the anterior, posterio-medial and posterio-lateral directions, the reach distance was divided by the leg length multiplied by 100. To find the composite balance value, the total reach distance in three access directions was divided by three times the leg length and multiplied by 100 (Gonell et al., 2015).

2.3.2 Lower Limb Length

On a mat table with the subject supine, the subject lifted the hips off the table and returned them to starting position. Then the examiner passively straightened the legs to equalize the pelvis. The subject's right limb length was then measured in centimeters from the anterior superior iliac spine to the most distant portion of the medial malleolus with a cloth tape measure.

2.3.3 Data Analysis

The data were analyzed for each subject for the right limb in the anterior, posterio-medial, and posterio-lateral reach directions. Means and standard deviations were calculated for the reach distance in each direction and limb length. Wilcoxon test was used to determine if there was a difference between the performance of the right and left limb. Since reach distance is related to limb length, reach distance was normalized to limb length to allow future comparison among studies. To express reach distance as a percent- age of limb length, the normalized value was calculated as reach distance divided by limb length then multiplied by 100. Composite reach distance was the sum of the three reach directions divided by three times limb length, and then multiplied by 100 (Plisky et al., 2009).

2.4 Statistical Analysis

Data were analyzed using SPSS Version 22.0 software. Descriptive statistics (Mean ± SD) were calculated for all variables. Statistical significance was set at $p \leq 0.05$. Data from Y-balance test was different from non-normally distributed, so non-parametric tests have been performed for post hoc analyses. Pre- and post-training test analyses were performed using the dependent non-parametric Wilcoxon signed-rank test. Differences between groups (DTG and CTG) were tested using Mann-Whitney-U test.

3. Results

Table 3. The physical characteristics of soccer players

	N	Age (Year)	Height (cm)	Weight (kg)	BMI (kg/m^2)
CTG	13	13.61±1.45 (11-16)	157.25±11.64	47.09±10.44	18.86±2.13
DTG	13	13.46±1.56 (12-16)	152.72±13.26	45.22±11.99	19.06±2.26

Note. Deceleration training group (DTG), Conventional training group (CTG).

Table 3. presents the descriptive information of the soccer players. The DTG height of the players is 157.25±11.83 cm, body weight is 47.09±10.44 kg, body mass index is 18.86±2.13 kg/m^2. The CTG height of the players is 152.72±13.26 cm, body weight is 45.22±11.99 kg, body mass index is 19.06±2.26 kg/m^2.

Table 4. The leg length of soccer players

	DTG	CTG
Pre-training right limb length	84.15±8.15 (70-102)	82.31±8.24 (70-98)
Post-training right leg length	86±8.58 (70-104)	83.92±8.14 (70-98)
Pre-training left limb length	84.77±8.23 (70-103)	82.38±8.21 (70-98)
Post-training left limb length	86.08±8.62 (70-104)	83.85±8.07 (70-98)

Note. Deceleration training group (DTG), Conventional training group (CTG).

Table 4. presents the descriptive limb length of the soccer players. The DTG pre-test limb length is 84.15±8.15 cm, post-test right limb length is 86±8.58 cm, pre-test left limb length is 84.77±8.23 cm, post-test left limb length is 86.08±8.62 cm. The CTG pre-test right limb length is 82.31±8.24 cm, post-test right limb length is 83.92±8.14 cm, pre-test left limb length is 82.38±8.21 cm, post-test left limb length is 83.85±8.07 cm.

Table 5. Right leg Y-Balance tests comparison

Right Leg		DTG		CTG	
		Mean±Std.Deviation (Min.Max.)	**p**	**Mean±Std.Deviation (Min.Max.)**	**p**
Anterior	**Pre-training**	63.88±9.99 (54-85)	.001*	59.19±10.4 (42-74.5)	.002*
	Post-training	82.15±7.01 (70.50-93)		76.88±9.15 (63-101)	
Posterio-Medial	**Pre-training**	77.23±6.77 (68.50-90)	.054	72.23±12.44 (55-91)	.401
	Post-training	82.31±6.72 (72-95)		68.88±8.78 (55-85)	
Posterio-Lateral	**Pre-training**	72.73±14.32 (56-99)	.043*	72.92±11.70 (52-92)	.054
	Post-training	88.19±9 (75.5-108)		83.81±9.69 (68-107)	

Note. Deceleration training group (DTG), Conventional training group (CTG).

In Table 5, In DTG there was a statistically significant difference between pre-training and post-training right leg anterior, posterio-lateral ($p < 0.05$) and in CTG there was a statistically significant difference between pre-training and post-training left leg anterior balance ($p < 0.05$). In DTG, no difference was found pre-training and post-training right leg posterio-medial, in CTG, no difference was found pre-training and post-training right leg posterio-medial and posterio-lateral balance measurements ($p > 0.05$).

Table 6. Left leg Y-Balance tests comparison

Left Leg		DTG		CTG	
		Mean±Std.Deviation (Min.-Max.)	**p**	**Mean±Std.Deviation (Min.-Max.)**	**p**
Anterior	**Pre-training**	60.12±11.80 (45-85)	.001*	57.04±9.45 (43-74)	.001*
	Post-training	81.42±7.3 (72-95)		76.62±8.22 (64-100)	
Posterio-Medial	**Pre-training**	69±12.88 (47-99)	.017*	65.19±11.56 (52-84)	.005*
	Post-training	81.27±7.13 (67.5-81.27)		82.5±8.21 (69-95)	
Posterio-Lateral	**Pre-training**	71.11±13.94 (52-93)	.013*	69.92±10.96 (51-88.5)	.014*
	Post-training	85.27±7.97 (74.50-98)		83.54±8.57 (65-95)	

Note. Deceleration training group (DTG), Conventional training group (CTG).

In Table 6, In DTG and CTG there were statistically significant differences in left leg anterior, posterio-medial and posterio-lateral balance measurements comparisons pre-training and post-training ($p < 0.05$).

Table 7. Composite Y-Balance tests comparison

		DTG		CTG	
		Mean±Std.Deviation (Min.-Max.)	**p**	**Mean±Std.Deviation (Min.-Max.)**	**p**
Right Composite Balance	**Pre-training**	79.47±16.59 (49.84-103)	.011*	78.52±13.76 (63.27-99.05)	.003*
	Post-training	95.17±7.95 (76.92-113.08)		96.99±9.88 (75.36-114.05)	
Left Composite Balance	**Pre-training**	84.22±16.91 (57.11-110.85)	.033*	86.51±17.84 (66.44-116.67)	.064
	Post-training	98.09±6.4 (85.26-110.13)		97.09±9.46 (75-110.24)	
Right-Left Composite Balance Difference	**Pre-training**	4.75±8.16 ((-7.20)-22.15)	.861	7.99±5.75 ((-1.85)-17.62)	.006*
	Post-training	2.92±5.40 ((-2.95)-16.67)		0.1±3.26 ((-3.92)±6.17)	

Note. Deceleration training group (DTG), conventional training group (CTG).

In Table 7, In DTG there was a statistically significant difference between pre-training and post-training right leg composite balance and left leg composite balance measurements ($p < 0.05$) but no significant difference was found between pre-training and post-training for right-left composite balance measurements ($p > 0.05$). In CTG there was a statistically significant difference between pre-training and post-training ($p < 0.05$) right leg composite balance and right-left composite balance measurements but no significant difference was found between pre-training and post-training for left leg composite balance ($p > 0.05$).

4. Discussion

The objective of this study is to assess the impact of deceleration training method on improving dynamic balance skills of young soccer players in comparison with the conventional training methods. This training method emphasized deceleration by enforcing stopping within the shortest distance at the end of sprint drills. The result of this research is that deceleration training improved dynamic balance in young soccer players.

One study investigated the effects of a conventional speed and agility training program, versus a program that emphasized deceleration by enforcing stopping at the end of drills in team sport athletes. The effects of speed and agility training on dynamic stability as measured by 3 excursion distances from a Star Excursion Balance Test (SEBT) (posteromedial, medial, anteromedial reaches; dynamic stability), and isokinetic unilateral strength of the knee extensors and flexors, were also investigated. The results reinforced that a well-designed speed and agility training program can improve multidirectional speed and power. Dynamic stability, as measured by functional reaching, can also be improved by this type of training. Generally, there were few between-group differences in adaptations induced by the interventions. There are, however, some important issues for strength and conditioning coaches to consider whether they should wish to implement enforced stopping during drills in an attempt to train deceleration, especially with regard to leg strength (Lockie et al., 2014).

There are certain limitations of this study. No control group was used, although this is in line with previous research (Lockie et al., 2012; Lockie et al., 2014). It seems that both traditional speed and agility training program and training with enforced stopping can improve aspects of performance relating to multidirectional speed, complete confirmation of this could be aided by using a control group. Introducing stopping distance technique as part of deceleration training was based on repeat-sprint research (Lakomy et al., 2004), rather than speed and agility training research. The loading associated with stopping within certain distances needs to be investigated further. This information could not only be used to prescribe training but also to avoid injury risk when using this type of protocol. Nonetheless, this research still provides valuable information about how drills that enforce stopping can affect multidirectional speed. Our research into sprint training included enforced stopping drills. Our results showed that deceleration training which is involved in stopping drills improved dynamic balance in young soccer players.

Dynamic balance is the ability of the athlete to maintain a stable center of gravity while the athlete is moving (Kovacs et al., 2015). Dynamic balance is especially crucial in tennis, specifically during the deceleration movement phase before or after the player makes contact with the ball. Having a stable center of gravity is vital for the prevention of injuries during practice and competition especially for tennis players. Dynamic stability is stated to be an essential component of change-of-direction ability and multidirectional speed (Bressel et al., 2007, Kovacs et al., 2008). The SEBT is often used to assess dynamic stability through functional reaching, and the posteromedial, medial, and anteromedial directions best represent the challenges posed by this test (Hertel et al., 2000). A modified version of the SEBT has been used to analyze this capacity in relation to multidirectional speed in male team sport athletes and it was found that faster athletes could reach further in the posteromedial and medial directions (Lockie et al., 2011). This investigation suggests that speed and agility training, either conventionally focused or with an emphasis on deceleration, can improve dynamic stability as measured by selected reaches from an SEBT. These adaptations would likely contribute to the multidirectional speed improvements for both groups. Our findings supported our hypothesis which is that introducing deceleration zone in linear speed training will improve the dynamic balance of young soccer players.

5. Conclusions

According to these results, the deceleration training program is contributing to the development of dynamic balance performance of young soccer players more than the conventional training program. Based on this, we suggest deceleration zone to be included in the speed trainings of young soccer players. The effect of speed training including deceleration zone on various motor skills may be examined.

References

Bloomfield, J., Polman, R., O'Donoghue, P., & McNaughton, L. A. R. S. (2007). Effective speed and agility conditioning methodology for random intermittent dynamic type sports. *Journal of Strength and Conditioning Research*, *21*(4), 1093. https://doi.org/10.1519/00124278-200711000-00020

Bressel, E., Yonker, J. C., Kras, J., & Heath, E. M. (2007). Comparison of static and dynamic balance in female collegiate soccer, basketball, and gymnastics athletes. *Journal of Athletic Training, 42*(1), 42–46.

Bruhn, S., Kullmann, N., & Gollhofer, A. (2006). Combinatory effects of high-intensity-strength training and sensorimotor training on muscle strength. *International Journal of Sports Medicine, 27*(05), 401-406. https://doi.org/10.1055/s-2005-865750

Camliguney, A. F. (2013). The effects of short-term ski trainings on dynamic balance performance and vertical jump in adolescents. *Educational Research and Reviews, 8*(10), 568-572. https://doi.org/10.5897/ERR2013.1430

Chew-Bullock, T. S. Y., Anderson, D. I., Hamel, K. A., Gorelick, M. L., Wallace, S. A., & Sidaway, B. (2012). Kicking performance in relation to balance ability over the support leg. *Human Movement Science, 31*(6), 1615-1623. https://doi.org/10.1016/j.humov.2012.07.001

Gonell, A. C., Romero, J. A. P., & Soler, L. M. (2015). Relationship between the Y balance test scores and soft tis-sue injury incidence in a soccer team. *International Journal of Sports Physical Therapy, 10*(7), 955-966.

Gorostiaga, E. M., Izquierdo, M., Ruesta, M., Iribarren, J., Gonzalez-Badillo, J. J., & Ibanez, J. (2004). Strength training effects on physical performance and serum hormones in young soccer players. *European Journal of Applied Physiology, 91*(5-6), 698-707. https://doi.org/10.1007/s00421-003-1032-y

Helgerud, J., Engen, L. C., Wisløff, U., & Hoff, J. (2001). Aerobic endurance training improves soccer performance. *Medicine & Science in Sports & Exercise, 33*(11), 1925-1931. https://doi.org/10.1097/00005768-200111000-00019

Hertel, J., Miller, S. J., & Denegar, C. R. (2000). Intratester and intertester reliability during the Star Excursion Balance Tests. *Journal of Sport Rehabilitation*, *9*(2), 104-116. http://doi.org/10.1123/jsr.9.2.104

Hewit, J., Cronin, J., Button, C., & Hume, P. (2011). Understanding deceleration in sport. *Strength & Conditioning Journal*, *33*(1), 47-52. https://doi.org/10.1519/SSC.0b013e3181fbd62c

Izzo, R., Castro, L. L., & Riccardo, I. C. (2015). The study of acceleration and deceleration capacity decrease in repeated sprints in soccer. *International Journal of Physical Education, Sports and Health, 269*(22), 250-259.

Jeffreys, I. (2013). Developing speed. *Human Kinetics* (Corpus ID: 54667233).

Kovacs, M. S. (2006). Applied physiology of tennis performance. *British Journal of Sports Medicine, 40*(5), 381-386. https://doi.org/10.1136/bjsm.2005.023309

Kovacs, M. S., Roetert, E. P., & Ellenbecker, T. S. (2008). Efficient deceleration: The forgotten factor in tennis-specific training. *Strength & Conditioning Journal*, *30*(6), 58-69. https://doi.org/10.1519/SSC.0b013e31818e5fbc

Kovacs, M. S., Roetert, E. P., & Ellenbecker, T. S. (2015). Efficient deceleration: The forgotten factor in tennis-specific training. *Strength & Conditioning Journal*, *37*(2), 92-103. https://doi.org/10.1519/SSC.0000000000000140

Krustrup, P., Mohr, M., Ellingsgaard, H. E. L. G. A., & Bangsbo, J. (2005). Physical demands during an elite female soccer game: Importance of training status. *Medicine & Science in Sports & Exercise, 37*(7), 1242-1248. https://doi.org/10.1249/01.mss.0000170062.73981.94

Lakomy, J., & Haydon, D. T. (2004). The effects of enforced, rapid deceleration on performance in a multiple sprint test. *The Journal of Strength & Conditioning Research, 18*(3), 579-583. https://doi.org/10.1519/1533-4287(2004)18<579;TEOERD>2.0.CO;2

Lees, A. (2002). Technique analysis in sports: A critical review. *Journal of Sports Sciences, 20*(10), 813-828. https://doi.org/10.1080/026404102320675657

Lockie, R. G., Murphy, A. J., Knight, T. J., & de Jonge, X. A. J. (2011). Factors that differentiate acceleration ability in field sport athletes. *The Journal of Strength & Conditioning Research, 25*(10), 2704-2714. https://doi.org/10.1519/JSC.0b013e31820d9f17

Lockie, R. G., Schultz, A. B., Callaghan, S. J., & Jeffriess, M. D. (2014). The effects of traditional and enforced stopping speed and agility training on multidirectional speed and athletic function. *The Journal of Strength & Conditioning Research, 28*(6), 1538-1551. https://doi.org/10.1519/JSC.0000000000000309

Lockie, R. G., Schultz, A. B., Jeffriess, M. D., & Callaghan, S. J. (2012). The relationship between bilateral differences of knee flexor and extensor isokinetic strength and multi-directional speed. *Isokinetics and Exercise Science, 20*(3), 211-219. https://doi.org/10.3233/IES-2012-0461

Onofrei, R., Amaricai, E., Petroman, R., Surducan, D., & Suciu, O. (2019). Preseason Dynamic Balance Performance in Healthy Elite Male Soccer Players. *American Journal of Men's Health, 13*(1), 1-7. https://doi.org/10.1177/1557988319831920

Pau, M., Arippa, F., Leban, B., Corona, F., Ibba, G., Todde, F., & Scorcu, M. (2015). Relationship between static and dynamic balance abilities in Italian professional and youth league soccer players. *Physical Therapy in Sport, 16*(3), 236–241. https://doi.org/10.1016/j.ptsp.2014.12.003

Plisky, P. J., Gorman, P. P., Butler, R. J., Kiesel, K. B., Underwood, F. B., & Elkins, B. (2009). The reliability of an instrumented device for measuring components of the star excursion balance test. *North American Journal of Sports Physical Therapy, 4*(2), 92.

Teixeira, L. A., de Oliveira, D. L., Romano, R. G., & Correa, S. C. (2011). Leg preference and interlateral asymmetry of balance stability in soccer players. *Research Quarterly for Exercise and Sport, 82*(1), 21-27. https://doi.org/10.1080/02701367.2011.10599718