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Original Article

Proprioception and balance training can improve amateur soccer players' technical skills.

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Abstract
Soccer is a sport requiring a plethora of technical skills as well as static, semi-dynamic and dynamic balance. Most of these skills, such as passing, juggling the ball in the air, dribbling or receiving the ball, are achieved through standing on one foot. Therefore, the aim of the present research was to investigate the effect of a 10 week Proprioception and Balance training program on the improvement of amateur soccer players' specific techniques.
29 amateur soccer players comprised the sample of the present research. 15 soccer players aged 16.83±0.24 comprised the experimental group, while the control group was made up of 14 soccer players aged 16.60±0.22 years old. To evaluate the program efficiency, a series of technical skills tests was run prior to and following the program implementation. The data were statistically processed with the SPSS 15 statistics program, and there was variance analysis with repeated measures by two factors. The statistically significant differences were checked at significance level a=0.05 or 5%.
Statistically significant improvements were found regarding juggling the ball in the air 'jug 200' (p-value = 0.002 < 0.05), 'jug body 1' (p-value = 0.005 < 0.05), 'jug body 2' (p-value = 0.005 < 0.05) as well as short (p-value = 0.009 < 0.05) and long (p-value = 0.022 < 0.05) passing.
It seems that Proprioception and Balance training can lead amateur soccer players to higher levels of technical ability, and therefore, its efficiency through the implementation of routines with different characteristics (frequency, quantity, types of stimuli) merits further investigation.
Key words: proprioception, balance, soccer, technical skills.

Introduction.

Balance is considered to be one of the most basic synarmostikes abilities in everyday life and sports (Martin et al 1991). Balance control includes a complex network of neuronal links and centers as well as central and peripheral feedback mechanisms (Gayton 1991). The sources of sensory stimuli to the posture control system originate from the optical, the vestibular and the somatosensory systems (Nashner 1982). In bibliography, the terms 'somatosensory', 'proprioception' and 'kinesthesis' are used as synonyms. However, 'somatosensory', as a more general term, refers to the sense of the movement of the joint (kinesthesis) as well as to the position of the joint, while 'proprioception' is described as the conscious and unconscious estimation of the joint's position.

Soccer is regarded as the most ideal sport that can improve the balance in healthy and untrained individuals since it is the most effective exercise of all traditional workout methods (Jakobsen et al 2010), while soccer players have been proved to surpass basketball players in static and dynamic balance and do not differ from gymnasts (Bressel et al 2007). It is also noteworthy that in many balance tests, footballers can compete with, if not outstrip, dancers (Gebrino 2007).

Many studies have shown the advantageous effect proprioception training can have on soccer players (and generally athletes) injury prevention and reduction (Malliou et al 2004), while poor balance has been correlated to increased risk of injury in athletes (McLeod et al 2009). Good balance seems to be effective in neuromuscular control performance (Zech et al 2010), while being a distinctive characteristic of high levelsoccer players at thesame time (Paillard et al 2006).

Soccer is a sport requiring a plethora of technical skills as well as static, semi-dynamic and dynamic balance. Most of these skills, such as passing, juggling the ball in the air, dribbling or receiving the ball, are achieved through standing on one leg. Balance plays a pivotal role in the harsh conditions, such as pushing opponents, slippery grass, changes to the ball's orbit, moving, etc facing footballers during a football game.

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Therefore, the successful and effective execution of any technical skill largely depends on thesoccer players' ability to control their balance and to adapt better and faster to their ever changing bodily postures and positions in the pitch. The industrial analysis of soccer technical skills regarding the positioning and the movements of the torso and legs, the speed of execution etc have been analyzed in many studies aiming to perfect the performance technique (Assai et al 2002, Nuonome et al 2002, Shinkai et al 2009).

Nevertheless, no other study has investigated the effect of Proprioception and Balance training on technical football skills improvement. Therefore, the aim of the present research was to investigate the effect of a Proprioception and Balance training program on the improvement of amateursoccer players' specific techniques.

Material and methods.

29 amateur soccer players comprised the sample of the present research. 15 soccer players aged 16.83±0.24 comprised the experimental group, while the control group was made up of 14 soccer players aged 16.60±0.22 years old.

Table 1: Anthropometric characteristics of the experimental and control groups (mean and standard error of the mean regarding age, weight, height).

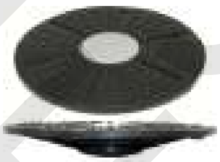
Groups	Age	Height	Weight
Experimental Group (n=15)	16,83±0,24	171,79±1,46	64,40±2,36
Control Group (n=14)	16,60±0,22	172,95±2,45	66,57±3,00

Devices used for the implementation of the Proprioception and Balance training program.

1.Balance disc: Unstable balance platform of circular shape standing on a small global base, which stimulates reflexive muscular activation (pictures 1, 2).

Picture 1

picture.2



2.Bosu (Both Sides Up balance trainer): This is a device designed for balance training. It is made up of a solid plastic base and a blown rubber surface resembling half a big ball. It was used for the athletes' support and balance in an upright position because of its unstable surface that causes difficulties in maintaining the balance (Yaggie et al 2006) (pictures 3, 4).

picture 3

picture 4

3.Togu (pictures 5, 6) : Double unstable rubber surface (Togu DynairSenso Ball Cushion). It is also alternatively called Dynadisc (Prentice et al 2004).

picture5

picture.6

4.Trampoline: A small, individual trampoline was used for progressively more difficult and more specialized reflexive neuromuscular activation exercises (picture 7).

picture 7.

Technical skills evaluation tests to which the soccer players were subjected before and after the program.
To evaluate the program's effectiveness the following tests were used (Rosch et al. 2000, Vale et al. 2009).

Test 1 (Jug 200).
In this test, the soccer player has 2 attempts to jug the ball in the air. In each attempt he tries to achieve 100 jugs without the ball falling on the ground. The maximum score for this juggling test is 200 (100 for each attempt) (Vale et al. 2009)

Test 2.
Tackling the ball with different parts of the body (pictures 9, 10, 11). The tester throws the ball to the soccer player from a distance of 5m. and the latter tries to tackle it in the following order.
Chest – right foot – head. **("jug body 1")**
Head – left foot – right foot.("jug body 2")
1. **Foot – chest – head.("jug body 3")**

The tester measures a total of 3 attempts for each exercise. Every complete, successful attempt is awarded 1 point.

Test 3.
Speed dribbling. This test allows the assessment of the dribbling skill under time pressure as well as the speed. With the word 'Go!' the soccer player starts with the ball behind the line. After 5 meters, he dribbles to the right around the first triangle. Following the test sequence, he dribbles around the remaining triangles. After 10 meters, he dribbles around an obstacle. After 8 meters, he passes the ball around an obstacle and runs from the opposite side to pick it. Next, he speeds through a gate and stops the ball by putting his foot on it. The tester measures the time from 'Go!' till the soccer player stops the ball. The measurement is done with a stopwatch in 1-second units (0.1s). (picture 12).

Test 4.
Long passing. This test assesses passing accuracy and the shooting force in long distance. The soccer player passes the ball from stand-by position behind the line to a circle (radius 2m, distance 36m.). The soccer player has one trial attempt at the beginning. The tester measures a total of 5 attempts. The scoring system is: 3 points if the ball lands inside the circle, and 1 point if it lands anywhere else within the 10 meter square around the circle.

Test 5.
Short passing: This test allows an estimate of the accuracy and the skill displayed in passing while moving. The soccer player dribbles with the ball within a marked square on a line, and from there he accurately passes the ball in a small goal 11 meters far. The tester measures a total of 5 attempts, awarding 3 points if the ball enters the goal, and 1 point if it hits the horizontal or vertical goalpost.

Test 6.
Shooting without momentum. (Shooting with the right leg, Shooting with the left leg).
This test allows an estimate of the accuracy and the skill in shooting from a stable position. A ball is positioned 16 meters away from the middle of a goal. The soccer player shoots towards the goal, which is divided into 6 sections. First he aims at the top right section and then at the top left section. The tester measures a total of 3 attempts in each section (top right, top left). 3 points if the soccer playershoots in the right spot, 1 point if he shoots into the top middle section, 1 point if he hits the goalpost in that part of the goal, 0 points if he shoots below the middle. The test was administered separately for each foot. (Shooting with the right leg, Shooting with the left leg). (picture 15)

Statistical analysis.
The data were statistically processed by means of the SPSS 15 statistical program, and there was variance analysis with repeated measures by one wayanova (one way anova –repeated measures). Statistically significant discrepancies were checked at a significance level of a = 0.05.

Results
There were statistically significant finds in the following tests:
1."Jug 200"

There are statistically significant discrepancies (p-value = 0.002 < 0.05 = a) between the groups regarding the 'Jug 200' variable. In the experimental group the performance increased by 48.73%, while in the control group there was an increase in performance by 10.40% (Figure1).

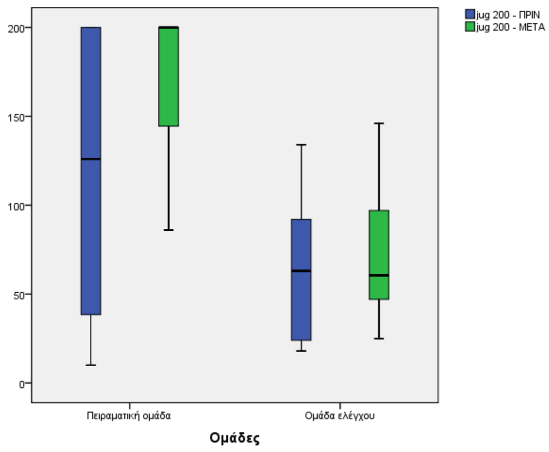


Figure 1: There were statistically significant discrepancies between the groups in the ‘Jug 200’ variable, with p-value = 0.002 < 0.05 =a.
Blue : performance before the program.
Green: performance after the program.
Left column (blue, green): experimental group.
Right column (blue, green): control group

2.“Jug body 1”
Statistically significant discrepancies (p-value = 0.005 < 0.05 = a) appear between the groups with respect to the ‘Jug body 1’ variable. The experimental group increased their performance by 189.23%, while the control group saw an 80% increase (Figure 2).

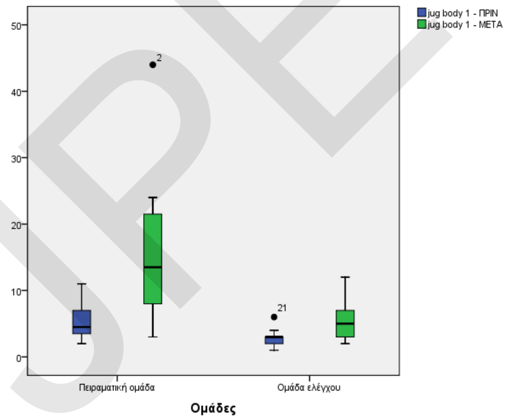


Figure 2: There were statistically significant discrepancies between the groups in the ‘Jug body 1’ variable, with p-value = 0.005< 0.05 =a.
Blue : performance before the program.
Green: performance after the program.
Left column (blue, green): experimental group.
Right column (blue, green): control group

3.“Jug body 2”
Statistically significant discrepancies (p-value = 0.009 < 0.05 = a) appear between the groups with respect to the ‘Jug body 2’ variable. The experimental group increased their performance by 157.46%, while the control group saw a 65.22% increase (Figure 3).

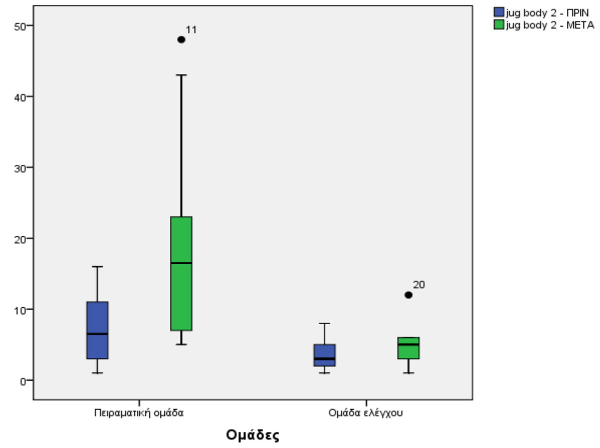


Figure 3: There were statistically significant discrepancies between the groups in the ‘Jug body 2’ variable, with p-value = 0.009 < 0.05 =a.
Blue : performance before the program.
Green: performance after the program.
Left column (blue, green): experimental group.
Right column (blue, green): control group

4.Long passing

Statistically significant discrepancies (p-value = 0.022 < 0.05 = a) occur between the groups regarding the long passing variable. The experimental group increased their performance by 30.00%, while the control group saw a 29.73% increase (Figure 4).

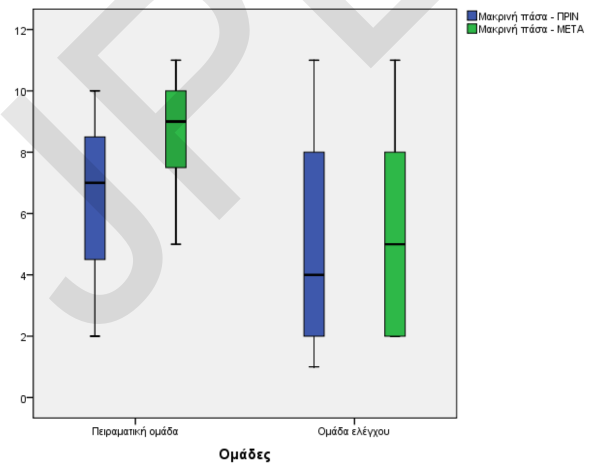


Figure 4: There were statistically significant discrepancies between the groups in the long passing variable, with p-value = 0.022< 0.05 =a.
Blue : performance before the program.
Green: performance after the program.
Left column (blue, green): experimental group.
Right column (blue, green): control group

5. Short passing

Statistically significant discrepancies (p-value = 0.009 < 0.05 = a) occur between the groups regarding the short passing variable. The experimental group increased their performance by 27.56%, while the control group saw no changes at all (Figure 5).

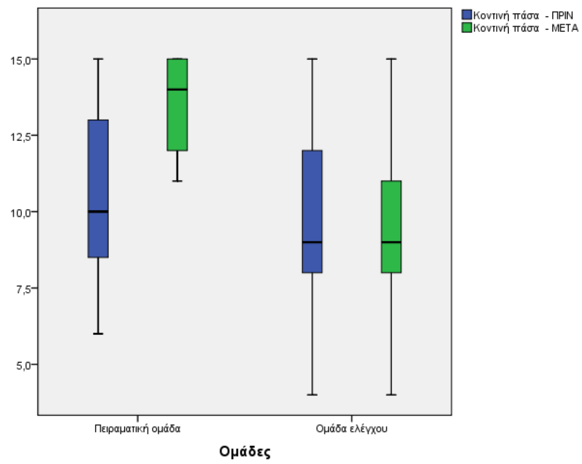


Figure 5: There were statistically significant discrepancies between the groups in the short passing variable, with p-value = 0.009 < 0.05 =a.
Blue : performance before the program.
Green: performance after the program.
Left column (blue, green): experimental group.
Right column (blue, green): control group

5. Variables without statistically significant discrepancies.

There were no statistically significant discrepancies between the groups in the following variables:

1.“Jug body 3” (p-value = 0.071 > 0.05). In the experimental group there was an increase in performance by 38.98%, while in the control group the increase was 41.18%.

2.“dribbling” (p-value = 0.273 > 0.05). In the experimental group there was a reduction by 2.95%, while in the control group the reduction in time was 2.53%.

3.“Shooting with the right foot” (p-value = 0.875 > 0.05). In the experimental group there was an increase by 29.41%, while in the control group the increase was 112.50%.

4.“Shooting with the left foot” (p-value = 0.099 > 0.05). In the experimental group there was an increase by 6.12%, while in the control group the increase was 15.00%.

Table 2. Mean and standard error of the mean of the variables without statistically significant discrepancies.

	Control group		**Experimental group**	
Variables	**BEFORE**	**AFTER**	**BEFORE**	**AFTER**
jug body 3	2,13±0,44	3,OO±0,53	4,92±1,37	6,83±1,61
dribbling	20,2±0,29	19,69±0,38	19,56±0,39	18,98±0,32
Shoot (right)	2 ±0,82	4,25±0,62	2,83±0,46	3,67±0,50
Shoot (left)	2,5±1,04	2,88±0,74	4,08±0,81	4,33±0,53

Discussion

According to the current research results, the implementation of the proprioception and balance training program resulted in the statistically significant improvement of jug skills, ‘jug 200’, jug body 1’ and ‘jug body 2’ as well as in passing skills, namely long and short passing. The improvement in jug skills (jug 200, jug body 1, jug body 2) is most probably attributable to the increase in the level of balance, somatosensory and proprioception of the standing leg. The aim of the balance training facilitated neuromuscular ability, readiness and reaction, while unconscious proprioception regulated muscular function and triggered reflexive stabilization. Thus, the stabilization ability of the standing leg alone, both during preparation and execution, resulted in enhanced performance, since the shooting with the tarsus of the contact leg does not have a large degree of difficulty.

Moreover, there was statistically significant improvement of the short and long passing (p-value = 0.009 < 0.05 and p-value = 0.022 < 0.05 respectively). This is probably attributable to the additional dynamic balance exercises (except for those mentioned before), which were done on the Togu device, simulating those particular skills with accuracy and a large degree of difficulty. Besides, balance includes dynamic reactions and inadvertent senses and thrusts which help maintain an upright position and are instrumental in most functional movements (Frank et al 1990, Horak et al 1990). Many of these require movements to the side, forwards and backwards, during which the weight center is at the edge of the support base (Lephart 1997). The proper function of the active muscles and the speed at which these forces are applied are decisive. In the present research, the dynamic exercises were controlled, without special intensification regarding speed and rigor (Irrgang et al 1994) on account of the mediocre level of the subjects. To interpret sensory information and movement co-ordination, two mechanisms played a pivotal role. That of prior feedback, which refers to the design of the movements based on sensory information derived from previous experience, and that of feedback, which regulates muscular activity through reflexive routes (Dunn et al 1986). Thus, the balance control system functioned as a control circuit of the feedback of the brain and the muscular-skeletal tract. As a direct consequence of the above, the improvement in proprioception and balance achieved through the appropriate and controlled position of the support leg joints in long and short passing resulted in more favorable somatosensory circumstances and assisted in the higher accuracy of the shoot with the instep and the inner inetatarsus respectively.

As far as 'jug body 3' skill is concerned, there was no statistically significant improvement, as the effort to move the ball from the chest to the head during the test is a factor requiring good tackling of the ball with those parts of the body and is independent of the subject's balance ability. According to the results, both groups saw an improvement in the 'dribbling' skill. However, the statistically insignificant alteration in dribbling between the two groups could be ascribed to factors such as their speed, the quality and composition of the intervention program in static, semi-dynamic and dynamic balance exercises, the technical ability of the contact leg with the ball etc. Regarding the shooting skill, there was not statistically significant improvement. It is believed that this is due to the fact that the execution with the contact leg (shooting of the ball) is done with the tarsus, that is with a small contact surface, and therefore, even the slightest mistake in the positioning of the foot on the ball or the movement of the ankle as well as the force that must be applied at the same time affect the accuracy of that skill to a large extent. So it seems that training with a ball, or the ordinary functional training, targeting the contact leg plays a more important role in the effectiveness of this skill than the previous ones. Nevertheless, longer proprioception and balance training or implementation of more specialized exercises may probablybe required.

In devising and implementing the program, thesoccer players' level and the particularity of soccer performance were taken into consideration (Soderman 2000). A large percentage of the program exercises aimed at improving the static and semi-dynamic balance through the implementation of simple proprioception exercises so that the conscious and unconscious ability of controlling the positioning of the ankle as well as the knee joint were better developed, given that the subjects had never participated in a specialized balance-improvement program. To maintain static balance, of course, the soccer player had to execute many remedial movements in the ankle, the hip, the torso, the upper limbs or the head. Thus, emphasis was laid on ensuring the balance in the basic positions on stable surfaces, and after that, the more difficult exercises on unstable surfaces using appropriate equipment made up of special unstable-surface devices, such as the Bosu Balance Trainer, Togu, balance disc, trampoline, which made maintaining balance more difficult, took place so as to ensure a satisfactory level of static balance. Implementing training on an unstable surface for balance training, Yaggie (2006) observed improvement in individual skills, such as retrograde running, time on the ball, vertical jump, forward – backward moving etc, while Cressey et al (2007), investigated the difference between training on stable and unstable surfaces in college soccer players regarding effectiveness in fitness skills (jumping, sprinting etc). All these exercises, which challenge the athlete's balance ability through thrust or other actions that alter the balance position on stable or unstable surfaces, improve the weight center position awareness under challenging circumstances and contribute to the increase in ankle strength in the closed kinetic chain. This training can increase muscular fuselage sensitivity, and in turn, the proprioception stimuli towards the spinal cord, something that can offset the alteration of the sensory information from the joint (Lephart 1993). Static and semi-dynamic balance exercises are important for the improvement of proprioceptive awareness, reflexive stabilization and posture orientation. Any attempt to adopt functional postures (soccer or other) during the execution of static balance exercises sets different requirements on the muscular-skeletal structures around the joints of the ankle, the knee and the hip (Prentice 2004). Exercises with bending, stretching, abduction and adduction (closure) movements of the hip of the other leg, with or without contact with the ball were applied because they simulate functional movements (soccer), such as kicking, ball control in the air, reception of the ball etc, and when they become progressively more difficult by being executed on foamy and unstable surfaces, they become more demanding and more effective since they further activate the somatosensory tract (Swanik et al 1997).

This study is original, since there are no similar ones investigating the effect of a proprioception and balance training program onsoccer players' technical skills improvement.

The training program that was used in this study, was always used before the established soccer players' training. Gioftsidou et al (2006), who investigated the effect of such a balance training program before and after the established training, observed an improvement in the soccer players balance ability, with greater improvement achieved after the ordinary training. Consequently, the effectiveness of a proprioception and balance training program before and after the ordinary training should be further investigated, with a view to determining which one could better improve technical skills.

We must all agree that in soccer, good balance is a high performance index and plays an important role in the soccer players's movements in the game. On the one hand, without the ball, in changing direction, in the right support – positioning to receive, pass the ball and shoot, more often than not under the opponent's pressure, and on the other hand, with the ball, in leading and change of direction with the ball as well as in many dribbling kinds in which the ball holder must be in a position to alter his body weight and appropriately fool an opponent in such a way that he can both avoid him and maintain ball control simultaneously. It is also noteworthy that even the shoes worn in different conditions of the pitch surface affect the soccer player's balance (Orchard et al 2002). So, it could be said that soccer balance can be expressed as the soccer player's ability to move, support himself, and faster and better react to unforeseen circumstances and unstable surfaces in the pitch, which are caused by the weather, field and game conditions (ball orbit, opponent pressure), which are ever re-adapted to the ever changing requirements of the game, aiming at achieving maximum effectiveness. Balance training programs must therefore target both legs, since only this way will the soccer player be assisted in better technical performance with the 'weaker' leg too, which very often gives invaluable solutions in the game. Moreover, it is characteristic that balance ability is not different between the two legs, according to Gstottnet et al (2009).

The results of this survey show that soccer players' technical ability increases when their balance and proprioception improve and denote that higher ability in this is a distinctive feature of top-notch soccer players. This positive correlation between technical performance and balance ability was indirectly approached by Paillard et al (2006), who mention that international soccer players (who are highly technically skilled) have higher levels of orthostatic balance as well as better visual information when compared to local leagues soccer players, whose technical skill is low or mediocre.

The above realizations clearly display the need for technical skills improvement in two ways that will both form a common resultant. One way (the first component) refers to the improvement of the proprioceptive ability of the support leg (support phase) and generally somatosensory, and the other way(second component) is the classical way, which emphasizes the application of technique on the leg which contacts the ball. Besides these, a combinatory training program is recommended. This program should include balance training on the support leg and functional soccer movements with the ball, which will lead to a technique improvement in a multifarious way. Of course, such a program is more appropriate for top-notch soccer players, for a more well-rounded approach to developing high technique.

Conclusions

In conclusion, the present study notes the importance of the existence of diverse as well as complementary proprioception and balance training programs in contemporary soccer training and the investigation of the duration of such programs in scheduling and devising soccer training. Additionally, it believes that the specific synarmostikes ability should be developed in many ways from childhood, aiming at performance maximization in adulthood.

It is also suggested that further investigation of the effect of proprioception and balance training in different and more complex ways that will set more specialized requirements on the soccer players' changing sensory information (visual, vestibular and somatosensory) should take place. It appears that proprioception and balance training can improve amateur soccer players' technical skills, and it is necessary to further investigate its effectiveness through the implementation of programs with different characteristics (frequency, quantity, kinds of stimuli) at all ages and levels of competition.

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