

Article

The Impact of Core Stability Training on Neuromuscular Performance Among Young Soccer Players: A Randomized Interventional Trial

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Abstract

(1) Soccer is the world's most popular sport, with over 265 million players worldwide. The core muscles play a crucial role in supporting the body's upper and lower limbs, and training to strengthen these muscles has been shown to improve athletic performance. In 11- to 15-year-old soccer players, core training can be effectively integrated into exercises that resist body weight, improving stability and agility. (2) Our study examines the impact of core muscle training on stability and agility in this age group. (3) 22 male soccer players in an amateur league at the age of 13 ± 1.01 years, height 1.47 ± 0.06 m, weight 60.06 ± 7.44 kg were enrolled. Participants were divided into two groups: experiment (core and ball movement training) and control (ball movement training). The intervention period lasted 12 weeks and included two 15–20 min-long training sessions weekly. Pre- and post-intervention tests were conducted, including tests for agility, stability, ball kick accuracy, speed, and distance jumping. (4) Core training significantly and clearly improved agility, accuracy in ball kicking, and balance with both legs towards the back. Based on these results, and considering that no special equipment is required, we recommend the inclusion of core training in young footballers' training routine.

Keywords: soccer; agility; core drills; training; field test

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1. Introduction

Soccer is the most widely played sport globally, engaging over 265 million participants. Soccer is a physically demanding sport that requires high levels of aerobic and anaerobic endurance, muscular strength, speed, agility, reaction time, explosive power, flexibility, and optimal posture during dynamic movements such as sprinting, jumping, and kicking [1–4].

Numerous studies have examined the characteristics of successful soccer players to inform training methodologies and player development. Anthropometric and physical attributes significantly influence soccer performance. These factors, combined with strength, reaction speed, and agility contribute to athletic success [5,6]. Elite players typically exhibit superior levels of these capacities, with agility and speed identified as key differentiators between professional and sub-professional players [2,3,5,7]. One of the recent approaches

to performance enhancement is core training, which targets the musculature surrounding the trunk and spine. Core strength contributes to postural stability, balance, and dynamic control, all of which are essential for efficient movement during play [8–10]. This form of training is increasingly recognized for its role in supporting overall athletic performance in soccer.

1.1. Anatomy of the Core

The core area consists of muscle groups that require cooperation between the upper and lower body through mutual support. The core is described as a muscle cylinder with the abdomen in the front, the back muscles in the back, the diaphragm as the ceiling, and the pelvic floor and hip muscles at the bottom. A kinetic chain provides proximal stability for distal mobility for limb function. Core stability is essential to prevent injuries and improve performance in athletes [1]. Core muscles stabilize the spine and center of gravity during movements of the upper and lower limbs such as jumping, running, and throwing. Core muscle training may help improve dynamic balance and coordination between the lower and upper limbs, as they are responsible for transferring force between the lower and upper body segments [6]. Additionally, it may help reduce the risk of injury and muscle imbalance [11]. Core stability is controlled by the passive spine, active spine muscles, and the nervous system, which includes proprioceptors in tendons, ligaments, and muscles. The three systems are interdependent and interrelated to allow for dynamic activities in daily life, as well as those included in sports. Most athletic movements start with the core muscles and then move to the limbs; several muscles are attached to the core and are directly involved in throwing, kicking, and running [12,13].

1.2. Core Muscle Training in Soccer

Soccer relies heavily on lower limb power, making a strong, coordinated core essential for efficient force production. Improved balance can reduce the need for stabilizing muscles, allowing more energy to be directed toward movement [8,10]. Although a direct link between core strength and dynamic performance in soccer players is yet to be firmly established, studies suggest enhanced core stability contributes to better movement efficiency and speed. However, research findings remain mixed, particularly in relation to balance and on-field performance, and few studies have focused solely on strength-based core training [6,14,15].

1.3. Stability in Soccer

Balance is essential in soccer, particularly during one-legged actions such as kicking or dodging opponents. It involves complex coordination of the core and limbs, regulated by sensory feedback from visual, auditory, and somatosensory systems [10,12]. Due to the sport's dynamic nature, players often maintain balance during movement rather than in static positions. Research has shown that elite players demonstrate superior balance and dynamic stability compared to lower-level players, suggesting balance is a key component of soccer performance. Core strength plays a central role in postural control and movement efficiency. In Ozmen [1], it was found that core stability improved jump performance, its effect on dynamic balance was less conclusive. Training on unstable surfaces is thought to enhance core activation, although the actual transfer to performance remains debated [16]. Aslan et al. [6] found that core training improved agility and leg power, but had no significant effect on balance scores after eight weeks. In conclusion, although core training appears to enhance several key physical abilities in soccer, particularly strength, agility, and power, its direct effect on balance is still under investigation.

1.4. Core Muscle Training

As core stability increases, the power output in the arms and legs also increases. Core stability training can provide significant benefits to players and teams, and it is easy to incorporate into any training session. If players follow the above exercises, they are expected to build a solid foundation through which they can improve their physical performance and reduce injuries [6,10,12]. The impairment of core stability during athletic movements causes the antagonistic muscles to work harder and try to compensate for this deficiency, which in turn may lead to functional power deficits. In addition, core exercises consist of movements that both increase muscle range, flexibility, and body strength, resulting in improved muscular and cardiovascular endurance, and develop psychomotor skills, coordination, and balance [9]. Core stability training on unstable surfaces is commonplace. Such training improves muscle-nerve pathways, leading to stronger strength and balance. Generally, findings indicate that as instability increases, core muscle activity increases proportionally. For this reason, resistance exercises performed on unstable surfaces have been highlighted as most effective for developing core stability [16]. Many soccer coaches consider core training to be an important part of soccer training. Despite the widespread use of core training by coaches, conflicting results should be noted [6].

1.5. The Effect of Core Training on Agility Abilities in Soccer

Agility is a critical performance component in soccer, encompassing both physical and cognitive elements, such as perception and decision-making [3,5]. It is defined as the ability to rapidly change direction in response to external stimuli. This process involves shifts in the body's center of gravity, linking agility closely with balance [3,11]. Core stability plays a crucial role in maintaining postural control and efficiently transferring force during dynamic movements. Previous studies have demonstrated that improved core strength contributes not only to enhanced athletic performance but also to reduced injury risk, particularly concerning ACL injuries [17,18]. Furthermore, the principle of specificity is considered essential for optimizing performance outcomes, suggesting that training interventions should target sport-specific movement demands [7,19].

Agility, balance, and kicking accuracy are key psychomotor fitness components that reflect the integration of neuromuscular control and cognitive coordination. These abilities are particularly relevant in soccer, but they also represent fundamental performance capacities across other ball games that share similar coordinative and perceptual demands [20,21].

However, despite the growing body of research, findings regarding the relationship between core muscle function and these psychomotor abilities remain inconsistent, especially among young soccer players. There is a clear need for broader investigations examining how different aspects of core strength interact with multiple performance variables in this population. Moreover, recent studies continue to explore novel training methods aimed at advancing performance monitoring and long-term athletic development in young soccer players [17,22,23].

Therefore, the purpose of the present study was to examine the effects of core muscle strengthening exercises on agility, balance, speed, power, and kicking accuracy among young soccer players. We hypothesized that core muscle strengthening exercises would lead to improvements in agility, balance, and kicking accuracy among young soccer players.

2. Materials and Methods

This randomized interventional study included two groups: an experimental group and a control group. Twenty-two male youth soccer players (mean $\pm$ SD: age = 13.0 ± 1.01 years; height = 147.0 ± 0.06 cm; body mass = 60.06 ± 7.44 kg) voluntarily participated in the

study. Participants were randomly assigned to either the experimental group ($n = 11$) or the control group ($n = 11$). All athletes were registered members of the Male Youth Division of Hapoel Hadera Football Club and underwent a comprehensive medical screening at an accredited sports medicine testing center prior to enrollment. In addition to their regular soccer practices, the players took part in weekly supplementary sessions that included 45 min of strength training and 45 min of conditioning exercises.

The inclusion criteria for participation were (1) no musculoskeletal injuries during the two months prior to or throughout the intervention period, and (2) attendance of at least 80% of all scheduled training sessions before and during the intervention.

2.1. Procedure

All meetings between the researcher and study participants took place at stadium. In the first meeting, the research was presented to the athletes and their parents, following which, the participants and their legal guardians were asked to sign consent forms. At the end of the meeting, each participant was randomly assigned to one of two groups: the experimental group, which performed exercises based on core muscle strength (Table 1) in addition to their regular soccer training; and the control group, which continued with their regular soccer training, including 20 min of exercises (like dribbling, air technique, passing and kicking to goal) to improve individual player technique.

Table 1. 12-week intervention training plan added on top of the routine technique training program in the experimental group.

Drill	Weeks 1–3 (One Set)	Weeks 4–6 (Two Sets)	Weeks 7–9 (Two Sets)	Weeks 10–12 (Three Sets)
Plank	25 s work	30 s work 30 s rest	45 s work 45 s rest	40 s work 60 s rest
Side plank	25 s work	30 s work 30 s rest	45 s work 45 s rest	40 s work 60 s rest
Bird dog	25 s work	30 s work 30 s rest	45 s work 45 s rest	40 s work 60 s rest
Balance on one leg	25 s work	30 s work 30 s rest	45 s work 45 s rest	40 s work 60 s rest
Crunch	25 s work	30 s work 30 s rest	45 s work 45 s rest	40 s work 60 s rest
Back extension	25 s work	30 s work 30 s rest	45 s work 45 s rest	40 s work 60 s rest
Lying twist trunk	25 s work	30 s work 30 s rest	45 s work 45 s rest	40 s work 60 s rest
Mountain climber	25 s work	30 s work 30 s rest	45 s work 45 s rest	40 s work 60 s rest
Gluteus bridge	25 s work	30 s work 30 s rest	45 s work 45 s rest	40 s work 60 s rest

In the second meeting, participants from both groups underwent pre-intervention tests, including an Illinois Agility Test, a Y Balance Test, and power (distance jumping), speed, and shooting accuracy tests. At the end of the intervention period, the same tests (post-assessment) were conducted again.

The intervention period lasted 12 weeks, during which two unique training sessions were conducted each week as part of the regular six weekly sessions. The post-tests were

conducted immediately after the 12-week intervention period, and each session lasted 15 to 20 min, performed following the warm-up phase.

2.2. Tests and Tools

Illinois Agility Test: The Illinois Agility Test is a physical fitness test designed to assess agility, particularly among athletes and soccer players. It is a simple test that is easy to administer and requires minimal equipment. The test evaluates the ability to move quickly while changing direction and angles. The goal of the test is to complete the course in the shortest time possible (see diagram of the course: 10 m in length, 5 m in width).

Y Balance Test: The Y Balance Test is a test used to assess static stability and predict the risk of injury in athletes. The athlete stands on one leg while reaching the non-standing leg in three different directions: anterior, posteromedial, and posterolateral (as indicated by markings on the ground in the shape of the letter Y).

20 m sprint test: The purpose of the 20 m sprint test is to measure the ability to sprint 20 m with the highest possible speed in the shortest time possible, primarily assessing reaction speed and acceleration. In this test a straight line of 20 m is measured and marked with cones at the start and end. Athletes are instructed to start the sprint with their feet behind the starting line and to perform the sprint maximally.

Broad jump test: This test assesses the athlete's explosive power during the jump. In the test the athlete performs a horizontal jump with both feet behind a starting line, using their arms as needed. The athlete bends their knees and swings their arms to jump horizontally as far as possible. Upon landing, they must stand stably and maintain balance.

Shooting accuracy test: The purpose of this test is to assess the accuracy after a series of specific training and exercises. Shooting on goal involves a balance effect that engages the core muscles, as well as strength and activation of many major muscles. There are nine rings attached to the goal at different angles and heights, and the participant is asked to stand on the penalty spot and score into the central ring. Each participant has ten attempts to score. The scoring was as follows: scoring into the central ring = 10 points, scoring into one of the four rings adjacent to the central ring = 5 points, scoring into one of the four outermost rings (within the goal frame) = 1 point (see Figure 1).

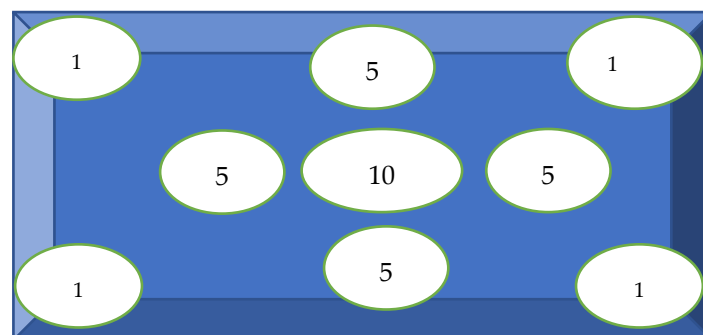


Figure 1. Shooting accuracy test.

2.3. Statistical Analysis

In this study, data were analyzed using SPSS v.26 (IBM, Inc., Armonk, NY, USA). Data processing included descriptive statistics. The normality of data distribution was verified prior to applying parametric tests using the Shapiro–Wilk test.

The statistical analysis was conducted using a Two-way mixed ANOVA test to examine the interaction effects (group $\times$ time). The results for each test are presented separately below.

3. Results

Table 2 presents the measurements of the variables before and after the intervention in the experimental and the control groups (mean $\pm$ SD). The following variables were measured before and after the intervention:

- Agility (via Illinois Agility Test)
- Y Stability for right leg forward-anterior (YANTD)
- Y Stability for right leg backward to the right-posteromedial (YPOSTRTD)
- Y Stability for right leg backward to the left-posterolateral (YPOSTLTND)
- Y Stability for left leg forward-anterior (YANTND)
- Y Stability for left leg backward to the right-posteromedial (YPOSTRTND)
- Y Stability for left leg backward to the left-posterolateral (YPOSTLTND)
- 20 m sprint (via 20 m sprint test)
- Jump (via Broad jump test)
- Shooting accuracy for the dominant foot (via the Shooting accuracy test)

Table 2. Comparison of test results before (Pre) and after (Post) the intervention by group (mean $\pm$ SD).

Group	Control		Experimental	
	n = 11		n = 11	
Test	Pre	Post	Pre	Post
Agility (Illinois Agility Test) (s)	12.68 $\pm$ 1.19	12.60 $\pm$ 1.14 *	12.97 $\pm$ 1.01	12.68 $\pm$ 0.90 *
YANTD (cm)	66.59 $\pm$ 5.22	68.22 $\pm$ 4.05 *	65.72 $\pm$ 8.22	67.54 $\pm$ 7.16 *
YPOSTRTD (cm)	99.45 $\pm$ 11.16	101.59 $\pm$ 8.90 *	93.40 $\pm$ 11.80	98.54 $\pm$ 11.54 *
YPOSTLTND (cm)	102.54 $\pm$ 9.53	104.86 $\pm$ 7.53 *	101.81 $\pm$ 9.66	103.68 $\pm$ 6.34 *
YANTND (cm)	61.68 $\pm$ 10.32	65.81 $\pm$ 10.15 *	63.22 $\pm$ 7.85	67.95 $\pm$ 8.85 *
YPOSTRTND (cm)	101.95 $\pm$ 9.12	103.09 $\pm$ 7.78 *	97.86 $\pm$ 14.35	98.63 $\pm$ 12.95 *
YPOSTLTND (cm)	102.77 $\pm$ 9.23	105.90 $\pm$ 9.28 *	98.90 $\pm$ 10.63	100.86 $\pm$ 10.09 *
20 m sprint test (s)	3.99 $\pm$ 0.13	3.96 $\pm$ 0.12	3.94 $\pm$ 0.12	3.91 $\pm$ 0.1 *
Broad jump test (m)	1.84 $\pm$ 0.75	1.87 $\pm$ 0.71	1.87 $\pm$ 0.69	1.90 $\pm$ 0.74 *
Shooting accuracy test (points)	9.27 $\pm$ 3.43	10.45 $\pm$ 3.23 *	10.54 $\pm$ 4.34	13.09 $\pm$ 3.41 *

YANTD = Y Stability Test for right leg forward-anterior; YANTND = Y Stability Test for left leg forward-anterior; YPOSTLTND = Y Stability Test for left leg backward to the left-posteromedial; YPOSTRTD = Y Stability Test for right leg backward to the left-posteromedial; YPOSTRTND = Y Stability Test for right leg backward to the right-posteromedial; YPOSTLTND = Y Stability Test for left leg backward to the right-posteromedial. * p -value < 0.05 .

As shown in Table 2, participants in the experimental group significantly improved their performance in all tests compared to their performance before the intervention. Participants in the control group significantly improved their performance in all tests with the exception of the sprint and the jump tests.

A graphical presentation of the results obtained in the individual tests is provided in Figures 2–6 and the results are discussed by test below.

Pre- versus post-intervention results in the Illinois Agility Test (Figure 2): There were statistically significant differences in this test in the time factor (effect of intervention) ($F_{1,20} = 18.324$, p -value < 0.01). The interaction (time $\times$ group) was statistically significant ($F_{1,20} = 6.213$, p -value < 0.05), indicating that the experimental group improved significantly more than the control group.

Pre- versus post-intervention results in the Y Balance Test (Figure 3):

Y-ANTD: There were statistically significant differences in the variable Y-ANTD in the time factor (effect of intervention) ($F_{1,20} = 15.781$, p -value < 0.01). However, the interaction (time $\times$ group) was not statistically significant (p -value > 0.05).

Y-POSTRTD: There were statistically significant differences in the variable Y-POSTRTD in the time factor (effect of intervention) ($F_{1,20} = 27.240$, p -value < 0.01). The interaction (time $\times$ group) was statistically significant ($F_{1,20} = 4.635$, p -value < 0.05), indicating that the experimental group improved significantly more than the control group.

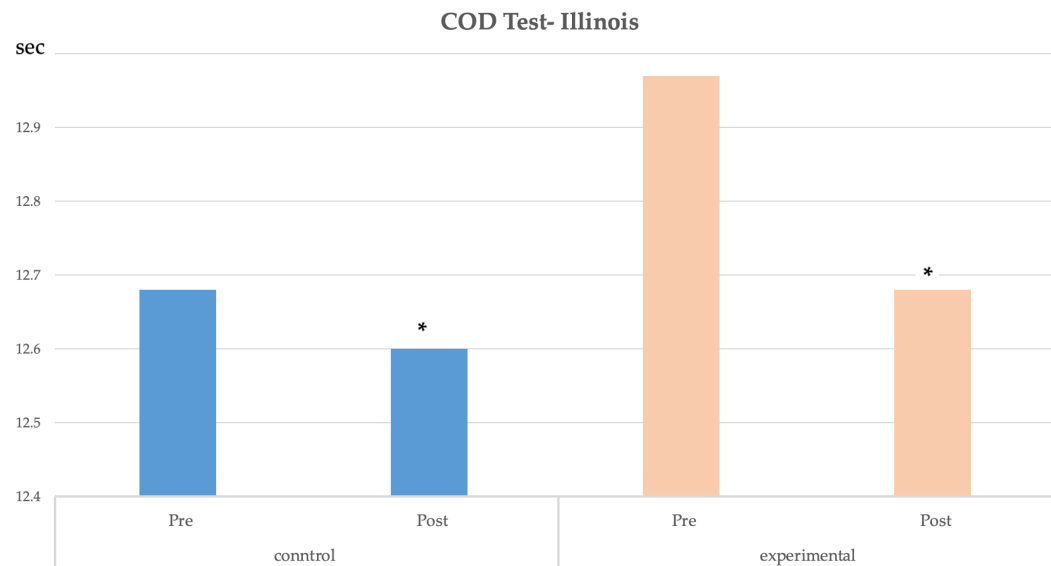


Figure 2. Pre- versus post-intervention results for agility using the Illinois Agility Test, presented by intervention group. * p -value < 0.01 .

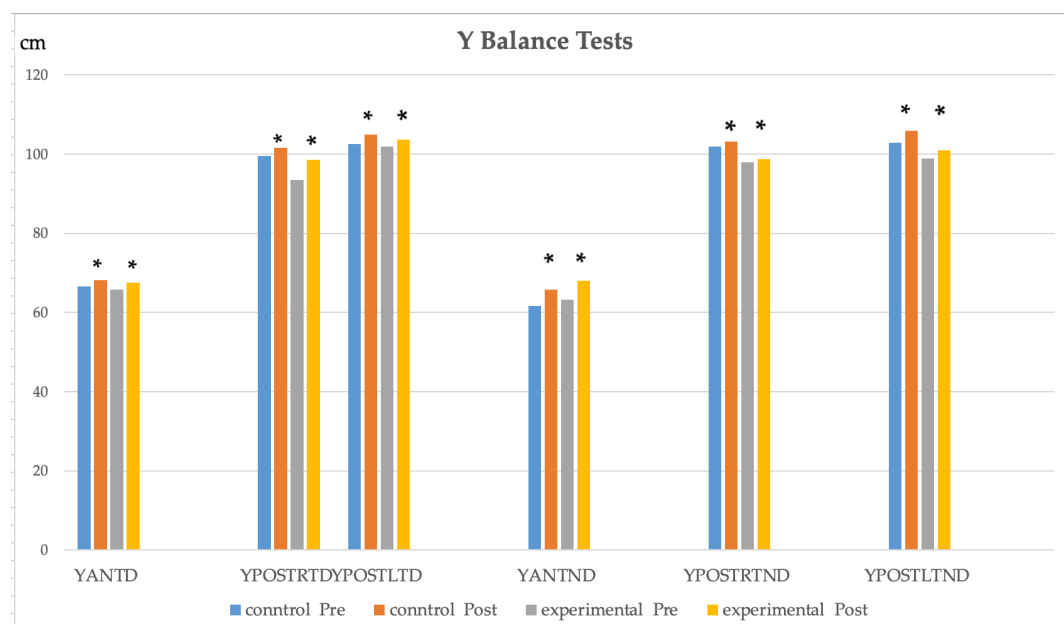


Figure 3. Pre- versus post-intervention results in the different variables included in the Y Balance Test, presented by intervention group. YANTD = Y Stability Test for right leg forward-anterior; YANTND = Y Stability Test for left leg forward-anterior; YPOSTLTD = Y Stability Test for left leg backward to the left-posteromedial; YPOSTRTD = Y Stability Test for right leg backward to the left-posteromedial; YPOSTRTND = Y Stability Test for right leg backward to the right-posteromedial; YPOSTLTND = Y Stability Test for left leg backward to the right-posteromedial. * p -value < 0.05 .

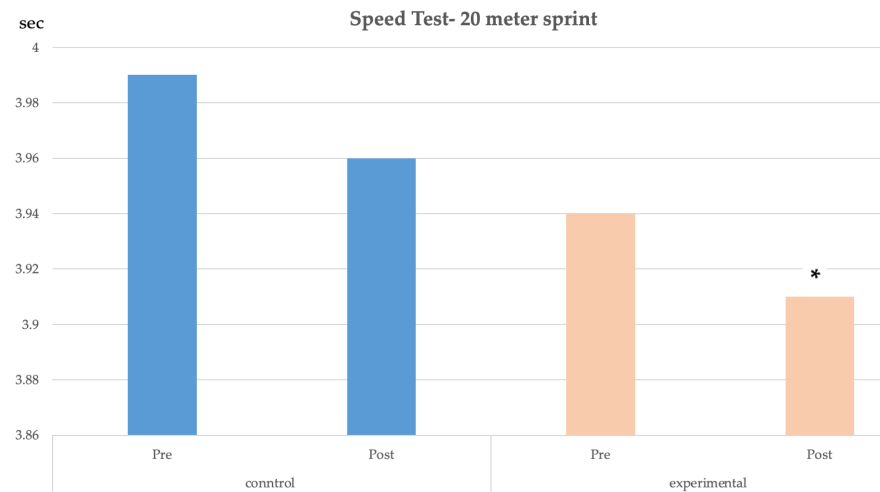


Figure 4. Pre- versus post-intervention results for speed using the 20 m speed test, presented by intervention group. * p -value < 0.01.

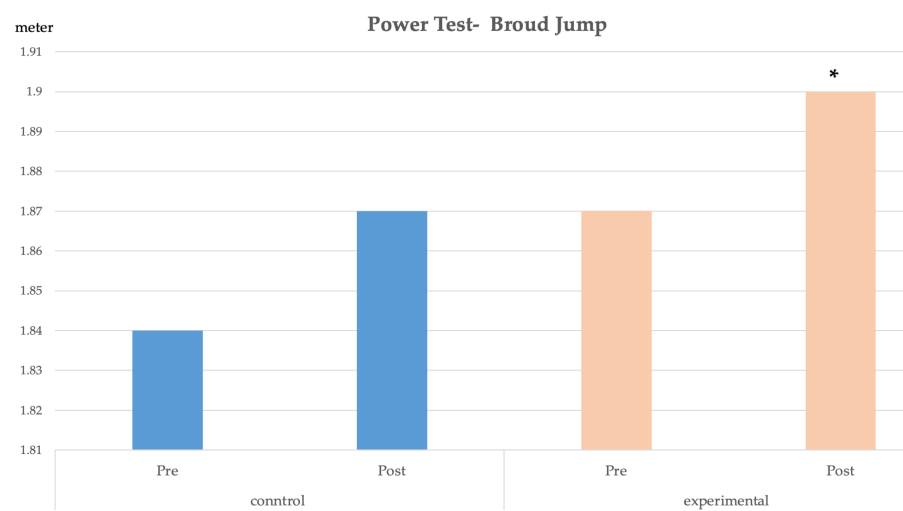


Figure 5. Pre- versus post-intervention results for distance jumping using the broad jump test, presented by intervention group. * p -value < 0.01.

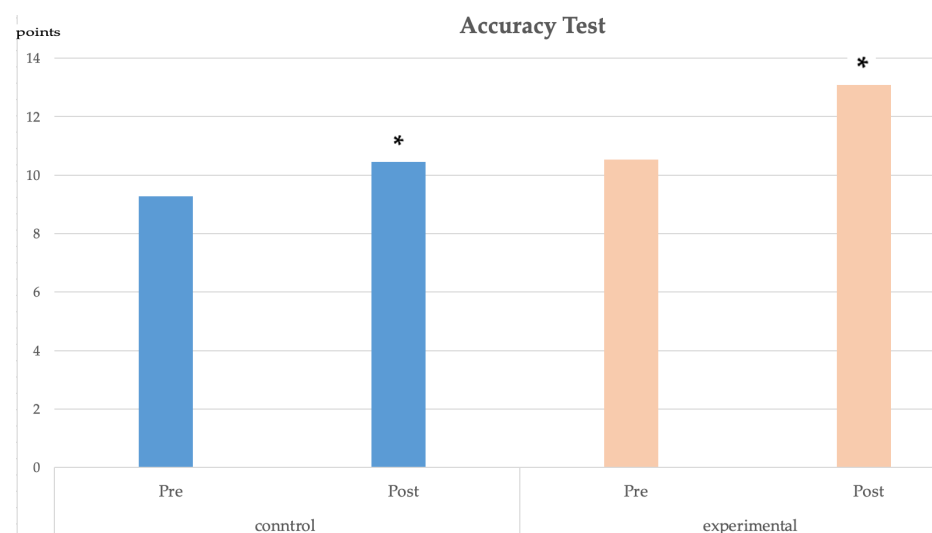


Figure 6. Pre- versus post-intervention shooting accuracy results using the shooting accuracy test, presented by intervention group. * p -value < 0.05.

Y-POSTLTD: There were statistically significant differences in the variable Y-POSTLTD in the time factor (effect of intervention) ($F_{1,20} = 4.748$, p -value < 0.01). However, the interaction (time $\times$ group) was not statistically significant (p -value > 0.05).

Y-ANTND: There were statistically significant differences in the variable Y-ANTND in the time factor (effect of intervention) ($F_{1,20} = 105.100$, p -value < 0.01). However, the interaction (time $\times$ group) was not statistically significant (p -value > 0.05).

Y-POSTRTND: There were statistically significant differences in the variable Y-POSTRTND in the time factor (effect of intervention) ($F_{1,20} = 2.634$, p -value < 0.05). However, the interaction (time $\times$ group) was not statistically significant (p -value > 0.05).

Y-POSTLTND: There were statistically significant differences in the variable Y-POSTLTND in the time factor (effect of intervention) ($F_{1,20} = 23.902$, p -value < 0.01). The interaction (time $\times$ group) was statistically significant ($F_{1,20} = 1.288$, p -value < 0.05), indicating that the experimental group improved significantly more than the control group.

Pre- versus post-intervention results in the 20-m sprint test (Figure 4): Statistically significant differences were found in the 20 m sprint test results in the time factor (intervention effect), ($F_{1,20} = 23.365$, p -value < 0.01). However, the interaction (time $\times$ group) was not found to be statistically significant (p -value > 0.05).

Pre- versus post-intervention results in the broad jump test (Figure 5): Statistically significant differences were found in the jump to distance test in the time factor (intervention effect) ($F_{1,20} = 131.515$, p -value < 0.01).

Pre- versus post-intervention results in the shooting accuracy test (Figure 6): Statistically significant differences were found in the shooting accuracy variable in the time factor (effect of intervention) ($F_{1,20} = 7.627$, p -value < 0.05). The interaction (time $\times$ group) was statistically significant ($F_{1,20} = 1.021$, p -value < 0.05), indicating that the experimental group improved significantly more than the control group.

4. Discussion

The purpose of the current study was to examine the effect of adding core muscle training on agility, balance, speed, power (jump), and kicking accuracy among young soccer players, as well as to investigate how these exercises can be incorporated into soccer training programs. The main finding of this study indicates that core strengthening exercises improved the ball kicking accuracy and agility of the participants. Although both groups in the study showed improvement in these two variables, the interaction between the group factor and the time factor was significant, indicating that the experimental group that performed core strengthening exercises improved more than the control group in agility and accuracy in ball kicking. This finding is in line with the findings of Kachanathu et al. [10], which showed that core exercises twice a week for thirty minutes significantly improved agility among soccer players. In the current study, although the control group showed significant improvement (p -value < 0.01) in agility from before to after the intervention, the experimental group showed a significantly greater improvement (p -value in this variable from before to after the intervention). These results support previous research, showing that core exercises improve agility, which may be related to the improved balance resulting from core exercises, aiding in faster and more agile performance [10,12]. Of note, these results are in contrast to a study by Sever O. [9], which examined the effect of static and dynamic core exercises on anaerobic tests such as speed and agility among soccer players. The study found that core exercises do not produce enough stimulation to improve anaerobic skills such as agility and speed and cannot be a cardinal component of soccer training programs.

Our results also showed a beneficial effect of core training on stability, albeit with some inconsistencies. The balance test showed significant improvement in both groups after the intervention. For sending the right and left leg forward, there was significant

improvement (p -value < 0.01) without interaction between the two groups. For sending the leg backward there was significant improvement (p -value < 0.001) for both right and left legs in both groups. However, the improvement for sending the right leg backward was greater in the experimental group than in the control group. In contrast to this result, for both right and left legs, there was a significant improvement (p -value < 0.01) in sending the left leg backward, but the improvement was more significant in the control group. This finding is similar to that found by Kachanathu et al. [10], who examined the effectiveness of core exercises on dynamic balance among soccer players. The results of this study showed significant improvement after two weeks of core exercises on dynamic weight bearing. Another study showed improvement in balance level in the dominant leg after core exercises [6]. The purpose of this study was to examine the effect of core exercises on functional performance among soccer players, and it showed that after eight weeks of core exercises, there was significant improvement in the functional performance of soccer players in the non-dominant leg, which may not affect functional performance in the dominant leg as seen in a study where a significantly greater improvement was found in the left leg when most players had a dominant right leg. In their study, Iacono et al. [12], presented supporting evidence for the beneficial effect of core exercises on developing strength in the lower limbs and weight-bearing balance among soccer players. Similarly, another study by Parkhouse and Ball [16], which examined the effect of static core exercises versus dynamic exercises on physical fitness tests in the field, showed significant improvement in both intervention groups, with neither of the groups showing improvement based on a dynamic field test. The findings indicate that both types of exercises improve specific measures of core stability but not sports-related skills. Core exercises consist of movements that increase body flexibility and strength, as well as enhance muscle endurance, thus aiding in the development of psychomotor skills and coordination, and improved weight distribution [1,10,12].

With respect to the ball kicking accuracy variable, our results showed that core exercises significantly improved the participants' accuracy in shooting for goal in both intervention groups. However, the interaction between the group factor and the time factor was statistically significant, indicating that participants in the experimental group improved and were more accurate in shooting for goal compared to those in the control group. Kicking accuracy is the ultimate and important goal in soccer. A study comparing between accurate and inaccurate kicks to upper and lower targets, by analyzing the actions of the muscles involved in kicking and ground reaction forces, showed that improved activation of certain muscles (TA, BF) and reduction in GAS action may help players kick more accurately. Thus, optimal and efficient activation of the kicking leg muscles represents a significant mechanism contributing to higher accuracy [24]. This finding is similar to that found by Mohamed M. [15], who examined the effect of core exercises on several physical and technical abilities in soccer. In their study, the researchers found that core exercises significantly improved some technical skills in soccer, including the level of accuracy in shooting for goal, which was reported after 10 weeks of combined core and strength training of muscles involved in shooting. Similar results were found in, a study by Cerrah et al. [25], who investigated the effect of core exercises on dynamic performance and the relationship between weight-bearing ability and kicking. In this study, after the intervention period the level of weight-bearing and kicking in both the dominant and non-dominant legs showed significant improvement, suggesting that performing core exercises three times a week may help and positively affect dynamic performance and kicking performance among soccer players.

The core is the anatomical location of the center of gravity, and its main function is to maintain the stability of the spine and balance of the pelvis. Since the core is central in

most kinetic chains in sports movements, controlling core strength, balance, and movement is expected to maximize the kinetic chains of upper and lower limb function. In soccer, balance is required when shooting at goal and standing on one foot. These two actions are complex and require specific coordination of core and leg muscles. Additionally, soccer involves heavy use of the lower limbs, and the core must be strong and coordinated to allow optimal force production and a greater amount of force. Improved balance may reduce the number of muscles involved in stabilization, allowing more muscles to contribute to the force produced in a given movement [1,8–10,12,16].

Limitations and Future Research

The results may impact adolescent soccer players, as the tests used for assessment are specific and may not easily translate to dynamic measurements during a soccer game. Skill tests may only reflect individual soccer skills and may not capture overall soccer ability.

5. Conclusions

Core muscle exercises have received significant attention in recent years and have become a key component of training programs. These exercises are recommended and preferred because they can be performed with body weight, anywhere without the need for equipment, and aim to strengthen and build a strong foundation of strength in athletes. Therefore, including static and dynamic core exercises in the training program improves and helps increase performance in soccer players.

In the future, it is suggested to examine the effect of core exercises on performance in the dynamic game itself, where the elements are more pronounced. Additionally, the effect of core exercises on explosive strength should also be investigated.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee at the authors' affiliated academic institution (Reference number: 318, 4 November 2021).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study; for participants under the age of 18, informed consent was also obtained from one of their parents. The participants were free to withdraw from the study at any time, without having to provide an explanation for this decision. Although anonymity could not be ensured due to the nature of the study, the participants and their parents were assured that the utmost confidentiality and scientific rigor would be applied throughout the study, and that the acquired data would only be used for the purpose of this research project.

Data Availability Statement: The data presented in this study are available on request from the corresponding authors (R.G. and J.C.G.). The data are not publicly available due to ethical and privacy restrictions.

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References

- Ozmen, T. Relationship between core stability, dynamic balance and jumping performance in soccer players. *Turk. J. Sport Exerc.* **2016**, *18*, 110. [\[CrossRef\]](#)
- Hoffman, J.R. Evaluation of a Reactive Agility Assessment Device in Youth Football Players. *J. Strength Cond. Res.* **2020**, *34*, 3311–3315. [\[CrossRef\]](#)
- Sheppard, J.M.; Young, W.B. Agility literature review: Classifications, training and testing. *J. Sports Sci.* **2006**, *24*, 919–932. [\[CrossRef\]](#) [\[PubMed\]](#)
- Klatt, S.; Thönnissen, L.; Fischer, T.; Sandmann, A. Alternative training methods in soccer. *Ger. J. Exerc. Sport Res.* **2025**. [\[CrossRef\]](#)
- Zouhal, H.; Abderrahman, A.B.; Dupont, G.; Truptin, P.; Le Bris, R.; Le Postec, E.; Sghaier, Z.; Brughelli, M.; Granacher, U. Effects of Neuromuscular Training on Agility Performance in Elite Soccer Players. *Front. Physiol.* **2019**, *10*, 947. [\[CrossRef\]](#)
- Aslan, A.K.; Erkmen, N.; Aktaş, S.; Güven, F. Postural Control and Functional Performance After Core Training in Young Soccer Players. *Malays. J. Mov. Health Exerc.* **2018**, *7*, 23–38. [\[CrossRef\]](#)
- Young, W.B.; McDowell, M.H.; Scarlett, B.J. Specificity of sprint and agility training methods. *J. Strength Cond. Res.* **2001**, *15*, 315–319.
- Akif Afyon, Y.; Boyaci, A. Investigation of the effects by compositely edited core-plyometric exercises in sedentary man on some physical and motoric parameters. *Int. J. Acad. Res.* **2013**, *5*, 256–261. [\[CrossRef\]](#)
- Sever, O. Comparison of static and dynamic core exercises' effects on Stork balance test in soccer players: Futbolcular statik ve dinamik core egzersizlerin Stork denge testine etkisi. *J. Hum. Sci.* **2017**, *14*, 1781. [\[CrossRef\]](#)
- Kachanathu, S.; Tyagi, P.; Anand, P.; Hameed, U.; Algarni, A. Effect of Core Stabilization Training on Dynamic Balance in Professional Soccer Players. *Phys. Med. Rehabil. Kurortmed.* **2014**, *24*, 299–304. [\[CrossRef\]](#)
- Ozmen, T.; Aydogmus, M. Effect of core strength training on dynamic balance and agility in adolescent badminton players. *J. Bodyw. Mov. Ther.* **2016**, *20*, 565–570. [\[CrossRef\]](#)
- Dello Iacono, A.; Padulo, J.; Ayalon, M. Core stability training on lower limb balance strength. *J. Sports Sci.* **2016**, *34*, 671–678. [\[CrossRef\]](#)
- Turna, B. The Effects of 6-Week Core Training on Selected Biomotor Abilities in Soccer Players. *J. Educ. Learn.* **2020**, *9*, 99. [\[CrossRef\]](#)
- Nesser, T.W.; Huxel, K.C.; Tincher, J.L.; Okada, T. The Relationship Between Core Stability and Performance in Division I Football Players. *J. Strength Cond. Res.* **2008**, *22*, 1750–1754. [\[CrossRef\]](#) [\[PubMed\]](#)
- Mahmoud, M. Effect of core training exercises on some physical and technical skill abilities in young soccer players. *Int. J. Sports Sci. Arts* **2018**, *7*, 33–44. [\[CrossRef\]](#)
- Parkhouse, K.L.; Ball, N. Influence of dynamic versus static core exercises on performance in field based fitness tests. *J. Bodyw. Mov. Ther.* **2010**, *15*, 517–524. [\[CrossRef\]](#)
- Lee, K.-J.; Seon, S.-Y.; An, K.-O. Arrangement Order Effects of Neuromuscular Training on the Physical Fitness of Youth Soccer Players. *Appl. Sci.* **2024**, *14*, 4748. [\[CrossRef\]](#)
- Weber, T.A.; Duchene, Y.; Simon, F.R.; Mornieux, G.; Gauchard, G.C. Evolution of Core Stability, Athletic Performance, and ACL Injury Risk across a Soccer Season. *Appl. Sci.* **2024**, *14*, 4116. [\[CrossRef\]](#)
- Michailidis, Y.; Venegas, P.; Metaxas, T. Effects of Combined Horizontal Plyometric and Change of Direction Training on Anaerobic Parameters in Youth Soccer Players. *Sports* **2023**, *11*, 27. [\[CrossRef\]](#)
- Shalom, A.; Levy, A.; Meckel, Y.; Calleja-Gonzalez, J.; Gottlieb, R. Integrating physical and cognitive approaches: A scoping review of advanced training methods in basketball. *Acta Gymnica* **2025**, *55*, e2025.012. [\[CrossRef\]](#)
- Shalom, A.; Gottlieb, R.; Shalom, I.; Gafni, G.; Levy, A.; Calleja-Gonzalez, J. A Pilot Study Exploring the Optimization of Warm-Up Strategies: Modern Cognitive Warm-Up with Open-Skill Demands vs. *Tradit. Closed-Ski. Warm-Up Basketball. Sens.* **2025**, *25*, 3279. [\[CrossRef\]](#)
- Boraczyński, M.; Magalhães, J.; Nowakowski, J.J.; Laskin, J.J. Short-Term Effects of Lower-Extremity Heavy Resistance versus High-Impact Plyometric Training on Neuromuscular Functional Performance of Professional Soccer Players. *Sports* **2023**, *11*, 193. [\[CrossRef\]](#)
- de Oliveira-Sousa, S.L.; León-Garzón, M.C.; Gacto-Sánchez, M.; Ibáñez-Vera, A.J.; Espejo-Antúnez, L.; León-Morillas, F. Does Inspiratory Muscle Training Affect Static Balance in Soccer Players? A Pilot Randomized Controlled Clinical Trial. *Healthcare* **2023**, *11*, 262. [\[CrossRef\]](#)

24. Katis, A.; Giannadakis, E.; Kannas, T.; Amiridis, I.; Kellis, E.; Lees, A. Mechanisms that influence accuracy of the soccer kick. *J. Electromyogr. Kinesiol.* **2013**, *23*, 125–131. [[CrossRef](#)] [[PubMed](#)]
25. Cerrah, A.O.; Bayram, İ.; Yıldız, G.; Uğurlu, O.; Şimşek, D.; Ertan, H. Fonksiyonel Denge Antrenmanının Adölesan Futbolcuların Statik ve Dinamik Denge Performansları Üzerine Etkileri. *Int. J. Sports Exerc. Train. Sci.* **2016**, *2*, 38897. [[CrossRef](#)]

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