ANATOLIA SPORT RESEARCH

ISSN: 2757-6485

2026 & 7 (2)

The Effects of Proprioceptive Training on Speed, Agility and Quickness Performance in Young Football Players

"Proprioseptif Antrenmanlarının Genç Futbolcularda Sürat, Çabukluk ve Çeviklik Performansı Üzerindeki Etkileri"

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ORGINAL ARTICLE

History
Received: 7 June 2026
Accepted: 20 August 2026
Published: 30 August 2026

DOI: http://dx.doi.org/10.29228/anatoliasr.128

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Author Contributions
All authors contributed to the conception and design of the study.

Funding
This study received no specific financial support.

Competing Interests
The authors declare that they have no conflicts of interest.

Transparency
The authors confirm that the manuscript is an honest, accurate and transparent account of the study being reported, that no vital features of the study have been ommited and that any discrepancies from the study as planned have been explained.
Ethical
This study follows all ethical practices during writing.

Citation
Kirişçi, İ., & Gök, B. (2026). The Effects of Proprioceptive Training on Speed, Agility and Quickness Performance in Young Football Players. Anatolia Sport Research. 7(2): 231-242.

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ABSTRACT

Aim: The present study was conducted with a view to evaluating the effects of proprioceptive training on the performance of speed, agility, and quickness in young soccer players.
Material and Method: The study comprised a sample of 20 licensed male athletes from the U16 category of Sarıyer Belediyespor, who were free from any health issues. Participants were randomly divided into two groups using a simple (coin-toss) randomisation procedure: the experimental group (n=10) and the control group (n=10), in a pre-test–post-test control group quasi-experimental design. The experimental group underwent proprioceptive exercises in addition to regular football training for a period of six weeks, while the control group continued with its regular three-times-per-week football training programme without any additional intervention. Performance measurements were conducted on both groups using the Illinois Test, the 505 Test, and the 30-meter Speed Test before and after the six-week training period. The data obtained were analysed using SPSS 24.0 statistical software.
Results: The experimental group showed statistically significant improvements in agility ($t=10.40$, $p<0.001$, $d=3.29$) and quickness ($t=3.61$, $p=0.006$, $d=1.14$), whereas the improvement in speed was not significant ($t=1.20$, $p=0.260$). No significant pre-post changes occurred in the control group for any parameter (all $p>0.05$). Analysis of covariance (ANCOVA), controlling for pre-test scores, confirmed that the experimental group improved significantly more than the control group in agility ($p<0.001$) and quickness ($p=0.012$), but not in speed ($p=0.296$). These findings indicate that a six-week proprioceptive training programme produces genuine, control-group-verified improvements in agility and quickness, though a longer intervention period may be required to elicit measurable improvements in linear speed.
Conclusions: A six-week proprioceptive training programme, applied in addition to regular football training, produced statistically significant improvements in agility and quickness performance in young male footballers, while speed did not improve significantly over this period. These findings suggest that proprioceptive training can be a useful short-term addition to youth football conditioning, particularly for change-of-direction qualities, whereas the development of linear speed may require longer or more speed-specific interventions.

Keywords: Agility, Football, Proprioception, Quickness, Speed.

ÖZET

Amaç: Bu çalışma, genç futbolcuların hız, çeviklik ve çabukluk performansları üzerinde proprioseptif antrenmanın etkilerini değerlendirmek amacıyla gerçekleştirilmiştir.
Materyal ve Metod: Çalışma, herhangi bir sağlık sorunu bulunmayan Sarıyer Belediyespor'un U16 kategorisinden 20 lisanslı erkek sporcudan oluşan bir örneklemden oluşmuştur. Katılımcılar rastgele iki gruba ayrılmıştır: deney grubu (n=10) ve kontrol grubu (n=10). Deney grubu, altı haftalık bir süre boyunca normal futbol antrenmanlarına ek olarak proprioseptif egzersizler yapmıştır. Buna karşılık kontrol grubu, herhangi bir ek müdahale olmaksızın standart antrenman programına devam etmiştir. Her iki grupta da altı haftalık antrenman programının öncesinde ve sonrasında Illinois Testi, 505 Çeviklik Testi ve 30 metrelik Hız Testi kullanılarak performans ölçümleri yapılmıştır. Elde edilen veriler SPSS 24.0 istatistik yazılımı kullanılarak analiz edilmiştir.
Bulgular: Deney grubunda çeviklikte ($t=10,40$, $p<0,001$, $d=3,29$) ve çabuklukta ($t=3,61$, $p=0,006$, $d=1,14$) istatistiksel olarak anlamlı gelişmeler saptanmıştır; sürat parametresindeki gelişme ise anlamlı bulunmamıştır ($t=1,20$, $p=0,260$). Kontrol grubunda hiçbir değişkende anlamlı bir ön test-son test farkı gözlenmemiştir (tüm $p>0,05$). Ön test puanları kovaryant olarak kontrol edilerek yapılan kovaryans analizi (ANCOVA), deney grubunun kontrol grubuna kıyasla çeviklikte ($p<0,001$) ve çabuklukta ($p=0,012$) anlamlı derecede daha fazla geliştiğini, ancak süratte böyle bir farkın bulunmadığını ($p=0,296$) doğrulamıştır.
Sonuç: Bu çalışmanın bulguları, altı haftalık proprioseptif antrenmanın kısa sürede çeviklik ve çabukluk gelişimini önemli ölçüde destekleyebileceğini, ancak sürat performansında anlamlı bir gelişme sağlamak için muhtemelen daha uzun bir uygulama süresinin gerektiğini göstermektedir.

Anahtar Kelimeler: Çabukluk, Çeviklik, Futbol, Hız, Propriosepsiyon.

INTRODUCTION

Football is a multifaceted team sport that demands high levels of physical, technical and cognitive performance. Throughout the game, players are required to demonstrate technical proficiency whilst executing short bursts of high-intensity running, sudden changes of direction, and acceleration and deceleration movements. Therefore, speed, agility, quickness, and neuromuscular control are key factors determining football performance (Reilly, Bangsbo, & Franks, 2000). The increasing tempo and physical demands of modern football require athletes to be highly developed not only in terms of endurance but also in terms of explosive strength and rapid reaction abilities.

In the domain of football, speed is delineated as a player's capacity to traverse brief distances at the highest possible velocity. Speed is identified as a key performance factor, particularly in game scenarios such as rapid attacks, sudden runs behind the defence, and evasive manoeuvres against opponents (Little and Williams, 2005). Research indicates that the majority of sprints undertaken during professional football matches occur within a range of 5 to 30 metres, and that an athlete's ability to accelerate over these distances is directly linked to their overall performance in a football match (Stølen et al., 2005). Consequently, emphasis is placed on the significance of short-distance sprint training and exercises that emphasise acceleration in training programmes.

Agility is defined as the ability to change direction without losing speed and to maintain control of body position (Sheppard and Young, 2006). In sports of an open nature, such as football, the capacity to demonstrate agility is related not only to physical characteristics but also to perceptual and decision-making processes. The ability of athletes to respond to their opponents' movements with maximum expediency, to select the most appropriate change of direction, and to execute this at high velocity directly influences the course of the match. Consequently, it is imperative that agility training encompasses not only change-of-direction exercises but also reaction time and cognitive processes (Sheppard & Young, 2006).

Speed is generally understood to be the capacity of athletes to respond to a stimulus and initiate movement with maximum expediency (Young, James and Montgomery, 2002). To illustrate this point, consider the example of a football match. It is evident that reacting swiftly to sudden developments, such as a change in the ball's direction, an opponent's movement, or a teammate's pass, provides a significant advantage. The primary objective of agility training is to enhance reaction time, initial step speed and short-distance acceleration skills. Another significant factor influencing performance in football is proprioception, which refers to joint position sense and body awareness. Proprioception is defined as the ability to perceive the body's position in space and to control movement via receptors located in muscles, tendons and joints (Proske and Gandevia, 2012). Proprioception is a vital aspect of athletic performance, as it enables athletes to maintain balance, execute movements in a coordinated manner, and stabilise the body during sudden changes of direction. The development of proprioceptive skills is considered important for enhancing performance and preventing injuries, particularly in contact sports such as football that require high-speed changes of direction. The extant literature suggests that proprioceptive training has the potential to enhance lower limb stability and mitigate the risk of ankle and knee injuries, as evidenced by studies conducted by Hrysomallis (2007). Proprioceptive development can be supported by a range of practices, including balance boards, single-leg stabilisation exercises and various balance activities. The integration of such exercises into football training programmes has been demonstrated to enhance athletes' movement control, thereby facilitating more efficient performance. Recent studies in the field of sports science have revealed that characteristics such as agility, speed and proprioception interact with each other and must be developed together. The

implementation of training models that support multi-faceted physical development, particularly in young footballers, is important for long-term performance development (Miller et al., 2006). In this particular context, it is asserted that holistic training approaches incorporating coordination, balance, reaction and speed components are more efficacious in developing athletes' motor skills.

In the process of devising football training programmes, it is essential to consider factors such as age, developmental level and performance level. In the case of youth athletes, the development of agility, speed, and proprioceptive abilities at an early age has been shown to facilitate the achievement of higher performance levels in later stages. Consequently, it is imperative for coaches to employ scientifically validated training methodologies and methodically cultivate athletes' motor characteristics. Recent studies have increasingly examined the concurrent development of these qualities through integrative, multi-component training models: Zhang, Mi and Liu (2023) reported that integrative neuromuscular training produces significant gains in change-of-direction performance in court-based sport athletes, while Michailidis, Kyzerakos and Metaxas (2024) demonstrated that short integrative training programmes enhance power-related performance indices in youth soccer players. However, in the majority of these studies proprioceptive stimuli are embedded within broader multi-component programmes that also include plyometric, strength and change-of-direction drills, and it therefore remains unclear how much of the observed improvement is attributable to the proprioceptive component specifically. Comparatively few controlled, pre-test–post-test experimental-control group studies have isolated proprioceptive training as a stand-alone addition to regular football training in youth male footballers. This gap is particularly relevant for youth-level coaches, who typically have limited weekly training time and need clear evidence on which specific training components yield the most efficient returns for speed, agility and quickness development. Therefore, the present study was designed to isolate and evaluate the effect of a structured six-week proprioceptive training programme, added to regular football training, on speed, agility, and quickness performance in young male footballers, using a randomised experimental-control group design. It was hypothesised that the experimental group would demonstrate significantly greater improvements than the control group, particularly in agility and quickness.

MATERIAL AND METHOD

Ethical Approval

Ethical approval for this study was obtained from the Istanbul Gelisim University Scientific Research Ethics Committee (Decision No: 2026-04, Date: March 18, 2026).

Research Group

The present research was conducted using a quantitative approach, with a pre-test – post-test control group quasi-experimental model employed in its design. The research commenced with the athletes being informed about the purpose of the study and the assessment methods that would be applied. Subsequently, the distances for the tests to be conducted were measured and the tests were prepared. The collection of data was initiated with the measurement of the athletes' body weights and heights. Subsequently, the requisite measurements for the pre-test were obtained. The study, which was conducted over a period of six weeks, involved the division of the footballers into two groups, using a simple randomisation procedure (coin toss performed individually for each athlete): 10 subjects in the experimental group and 10 subjects in the control group. The experimental group was administered proprioceptive drills in addition to their regular training programmes. The athletes in the

control group continued with their regular football training programme, which consisted of three sessions per week (matching the frequency of the experimental group), each lasting approximately 90 minutes and comprising standard technical, tactical and small-sided game components at a moderate-to-high intensity (estimated 5–7/10 session RPE); no proprioceptive, balance or stabilisation exercises were included in the control group's programme. At the end of the six-week period, the athletes' test measurements were obtained once more, and a comparison was made of the relationship between them.

Participants

The study involved twenty young football players from Sarıyer Belediyespor, who play in the U16 Football League. The players had no health problems and were licensed athletes. Parental consent forms were obtained from the players' families. The athletes met the following criteria: actively training at least three days a week, having at least two years of continuous football training experience, and not having sustained an injury within the six months prior to the study. Before the study, participants were given detailed information about the training program and the testing procedures to be applied throughout the study.

Data Collection Methodology

The participants were required to complete a personal information form, the objective of which was to gather information relevant to the study. In addition, the following measurements were taken: age, height, and weight. The experimental procedures were meticulously timed: the Illinois and 505 tests were timed manually using a stopwatch, whereas the 30-metre sprint test was timed automatically using a photocell system for higher measurement precision; course distances were measured in metres using a tape measure, and cone/marker positions were set using a funnel and plate.

Illinois Agility Test: The Illinois test is a tool that can be used to assess sprinting and change-of-direction ability in contemporary contexts. However, it is considered to lack comprehensive coverage of all components of agility due to its exclusion of cognitive factors. The test is conducted within a 5-metre-wide and 10-metre-long area. The 10-metre length is divided into three sections by cones placed at equal intervals (approximately 3.3 metres) along the centre line. The test involves a distance of approximately 40 metres of straight running and 20 metres of slalom running between the cones. The test encompasses five full rotations of approximately 180°, in addition to six supplementary incomplete rotations between the cones. The Illinois test is the longest in terms of distance covered and time taken among commonly used agility tests. At the commencement of the test, subjects are to be positioned in a prone position with their hands touching the ground at shoulder level (Hazır, 2010). The test was administered twice, with the faster (lower) of the two trials recorded for analysis. In the present study, performance on the Illinois test is reported as the "Agility" variable in Table 3.

505 Agility Test: The test is comprised of measuring the time taken to run the final 5 metres of a 15-metre course and then return. Despite its brevity and apparent simplicity, the exercise fails to provide insight into the cognitive dimensions of agility, as the movement sequence is predetermined. It provides more information about skills such as acceleration, deceleration, and changing direction. It is important to note that the time taken within the initial 10 metres from the test's starting point is not included in the final score. The temporal measurement is initiated upon the initial passage of the 5-metre distance and terminated upon the return of the subject to the initial point. This procedure is repeated twice, and the faster (lower) of the two times achieved is recorded (Draper and Lancaster,

1985; Gelder and Bartz, 2011; Hazır, 2010). In the present study, performance on the 505 test is reported as the "Quickness" variable in Table 3. The 505 test was selected as the quickness measure because, unlike the longer and more agility-oriented Illinois test, it isolates a single rapid deceleration-reacceleration action over a short distance, which more closely reflects the brief, explosive change-of-direction actions (i.e., quickness) that occur repeatedly during a football match.

30 Meter Speed Test: In the course of the study, the students were required to run at maximum speed over a distance of 30 metres, with a high start. The duration of the process was measured in seconds using a photocell. The participants performed the test twice, and the best result was recorded (Sevim, 1997).

Training Program

The training programme comprised a six-week moderate-intensity proprioceptive training programme, incorporating progressively increasing loads of proprioceptive exercises. Training intensity was monitored using the session Rating of Perceived Exertion (RPE) scale (0-10), with sessions in weeks 1-2 targeting a moderate intensity (4-6/10 RPE) and sessions in weeks 3-6 targeting a moderate-to-high intensity (6-7/10 RPE), as no heart rate monitoring device was used. The programme comprised three training sessions per week. The weekly schedule and intensity characteristics of the training programme are summarised in Table 1.

Table 1. *Training Program*

Drills	Week	Set	Rpt	Intensity	Rest Time (sec.)
Single Leg Balance Reach	1-2	2	12	*Moderate (4-6/10 RPE)*	45
Single Leg Squat	1-2	2	12	*Moderate (4-6/10 RPE)*	*45*
Touchdown	3-4	3	12	*Moderate High (6-7/10 RPE)*	*60*
Back Front Back	3-4	3	12	*Moderate High (6-7/10 RPE)*	*60*
Side To Side	5-6	3	12	*Moderate High (6-7/10 RPE)*	*60*
Single Leg Hop With Stabilization	5-6	3	12	*Moderate High (6-7/10 RPE)*	*60*

To ensure the reproducibility of the training programme, each exercise was standardised as follows. Single Leg Balance Reach: performed barefoot on a firm, flat surface, standing on one leg while reaching the free leg forward, sideways and backward in turn; repetitions were counted per direction, per leg, and both legs were trained equally within each session. Single Leg Squat: performed on a firm surface, standing on one leg with the contralateral leg held flexed in front of the body, descending to a self-selected comfortable depth; repetitions were counted per leg, with both legs trained equally. Touchdown: performed on a firm surface, standing on one leg and touching the opposite hand to the ground (or as close as mobility allowed) while maintaining single-leg balance; repetitions were counted per leg. Back Front Back: performed on a firm surface, hopping forward and backward over a marked line on a single leg while maintaining balance on landing; repetitions were counted per leg. Side To Side: performed on a firm surface, hopping laterally over a marked line on a single leg; repetitions were counted per leg. Single Leg Hop With Stabilisation: performed on a firm surface, hopping forward on a single leg and holding a stable landing position for approximately two seconds before the next repetition; repetitions were counted per leg. For all exercises, the two legs were alternated across sets so that each leg received an equal training volume, and no external balance equipment (e.g., wobble boards or foam pads) was used, in order to keep the stimulus consistent across all sessions.

Statistical Analysis

The data obtained from the speed, agility and quickness tests were analysed digitally using the SPSS 24.0 programme. The normality of the data distribution was assessed using a combination of statistical methods, including Shapiro-Wilk tests, skewness and kurtosis values, and ratios obtained by dividing skewness and kurtosis values by standard error. In the course of the assessment of the skewness and kurtosis coefficients, it was established that all scores within the ±3 range were acceptable and met the standards for normal distribution. According to Kalaycı and researchers, coefficient values within the ±3 range are considered acceptable (Büyüköztürk, 2007). Subsequent to the evaluations, in instances where the data conformed to a normal distribution, the independent samples t-test was used to compare the experimental and control groups, and the paired samples t-test was used to compare pre-test and post-test values within each group. Between-group differences in pre-post change (gain scores) were additionally examined using analysis of covariance (ANCOVA), with pre-test scores entered as the covariate to control for baseline differences between groups. Effect sizes were calculated as Cohen's d (within-group, using the paired-difference standard deviation) and as Hedges' g (between-group, using pooled gain-score standard deviations). In instances where the data did not demonstrate a normal distribution, the Mann-Whitney U test was employed as a non-parametric analysis. In the analyses performed, a statistical significance value of $p<0.05$ was accepted.

RESULTS

Table 2. *Descriptive Characteristics of the Participants*

Variables	Groups	n	Min	Max	$\bar{X}$ ± Sd
Height (cm)	Experiment	10	168	189	181,5±5,79
	Control	10	170	193	181,6±6,68
Weight (kg)	Experiment	10	63	79	71±5,47
	Control	10	57	78	70,6±6,62
Age (years)	Experiment	10	16,1	16,9	16,5±0,87
	Control	10	16,2	16,7	16,45±0,80
BMI (kg/m²)	Experiment	10	19,8	23,4	21,23±1,07
	Control	10	16,3	22,1	20,75±0,87

The mean height in the experimental group was 181.5 ± 5.79 cm, while it was 181.6 ± 6.68 cm in the control group. The average body weight was 71 ± 5.47 kg in the experimental group and 70.6 ± 6.62 kg in the control group. The average age was 16.5 ± 0.87 years in the experimental group and 16.45 ± 0.80 years in the control group. When BMI values were examined, the mean for the experimental group was 21.23 ± 1.07 kg/m², while that for the control group was 20.75 ± 0.87 kg/m². These results indicate that the two groups are quite similar in terms of their mean and standard deviation values.

Table 3. *Comparison of Pre-Test and Post-Test Performance Parameters between the Experimental and Control Groups.*

Variable	Group	Test	n	$\bar{X}$	Sd	t	p	d
Agility (sec.)	Experimental	Pre-Test	10	15,94	0,49	10,396	<0,001*	3,29
		Post-Test	10	14,79	0,35			
	Control	Pre-Test	10	16,70	0,34	0,435	0,674	0,14
		Post-Test	10	16,67	0,21			
Quickness (sec.)	Experimental	Pre-Test	10	2,62	0,14	3,607	0,006*	1,14
		Post-Test	10	2,53	0,11			

	Control	Pre-Test	10	2,63	0,20	-0,196	0,849	0,06
		Post-Test	10	2,64	0,20			
Speed (sec.)	Experimental	Pre-Test	10	4,49	0,16	1,203	0,260	0,38
		Post-Test	10	4,43	0,14			
	Control	Pre-Test	10	4,49	0,20	0,467	0,652	0,15
		Post-Test	10	4,48	0,14			

*: p < 0.05; sec: second; SD: Standard Deviation; d: Cohen's d (within-group effect size, based on the paired-difference SD). The faster (lower) of two trials was recorded as the value.

Statistically, paired-samples t-tests were used to compare each group's own pre-test and post-test scores (Table 3). In the experimental group, pre-post differences were significant for agility ($t(9)=10.396$, $p<0.001$, $d=3.29$) and for quickness ($t(9)=3.607$, $p=0.006$, $d=1.14$), corresponding to large within-group effect sizes; the change in speed was not significant ($t(9)=1.203$, $p=0.260$, $d=0.38$). In the control group, none of the three pre-post comparisons reached significance (agility: $t(9)=0.435$, $p=0.674$, $d=0.14$; quickness: $t(9)=-0.196$, $p=0.849$, $d=0.06$; speed: $t(9)=0.467$, $p=0.652$, $d=0.15$), indicating that regular football training alone did not produce a measurable within-group change over the same six-week period. Because the paired t-test in Table 3 only establishes whether each group changed over time and does not by itself compare the two groups to one another, the between-group comparison of gain scores (Group × Time interaction) is reported separately in Table 4.

Table 4. *Group × Time Interaction: Comparison of Gain (Post-Test – Pre-Test) Scores Using Analysis of Covariance (ANCOVA, with Pre-Test as Covariate).*

Variable	Experimental Gain X̄±Sd	Control Gain X̄±Sd	ANCOVA t	p	Hedges g
Agility (sec.)	-1,15 ± 0,35	-0,02 ± 0,16	12,96	<0,001*	4,15
Quickness (sec.)	-0,09 ± 0,08	+0,01 ± 0,08	2,82	0,012*	1,20
Speed (sec.)	-0,06 ± 0,14	-0,01 ± 0,07	1,08	0,296	0,38

*: p < 0.05; Gain = post-test – pre-test (negative values indicate a decrease in time, i.e., a performance improvement); ANCOVA t: group effect obtained by controlling for pre-test score as covariate; g: Hedges' g (between-group effect size, reported as an absolute value; all effects favour the experimental group).

As shown in Table 4, the ANCOVA comparing gain scores between groups, with pre-test values entered as the covariate, confirmed that the experimental group's improvement was significantly greater than the control group's for agility ($t=12.96$, $p<0.001$, $g=4.15$) and quickness ($t=2.82$, $p=0.012$, $g=1.20$), but not for speed ($t=1.08$, $p=0.296$, $g=0.38$). These results provide direct, control-group-verified evidence that the observed gains in agility and quickness are attributable to the proprioceptive training intervention rather than to regular football training alone.

DISCUSSION AND CONCLUSION

This study comprehensively investigates the impact of proprioceptive training on motor performance parameters such as speed, agility and quickness in young athletes. The findings indicate substantial enhancements in agility and quickness in the experimental group, and these improvements remained statistically significant when directly compared against the control group's change scores using ANCOVA, indicating that they are attributable to the proprioceptive intervention rather than to regular football training alone. While a favourable trend was evident in speed, this improvement did not attain statistical significance, either within the experimental group or relative to the control group.

The findings of this study demonstrate that proprioceptive training administered to young soccer players leads to a significant improvement in agility and quickness performance. Agility and quickness

are largely related to the neuromuscular system's capacity to respond rapidly to stimuli and to reorganise body position during changes of direction, and the effectiveness of proprioceptive feedback plays a decisive role in this process. It is suggested that proprioceptive training contributes to the central nervous system's ability to activate motor units more rapidly by increasing afferent signals from muscle, tendon, and joint receptors (Behm & Anderson, 2006). This mechanism may support the development of agility and quickness performance, particularly in scenarios requiring rapid changes of direction and the initiation of sudden movements. This is consistent with Moreira et al. (2017), who reported that proprioceptive and central stabilisation training improved physical fitness parameters in young soccer players, supporting the view that proprioceptive stimuli can produce measurable, sport-relevant performance gains in this population.

The high plasticity of the neuromuscular system in young athletes allows for more pronounced adaptations to proprioceptive training. It has been reported that balance- and stabilization-based exercises improve motor control, shorten reflex response times, and enhance the timing of muscle activation (Zech et al., 2010). In this context, it is believed that proprioceptive training positively influences not only postural balance but also rapid force production and reaction time, thereby contributing to agility and quickness performance.

The absence of a statistically significant improvement in speed in the present study may be explained by the fact that speed performance is a multidimensional trait and cannot be developed solely through proprioceptive training. Factors such as muscle strength, explosive power, neuromuscular coordination, and technical skill also have a significant impact on speed (Young, James, & Montgomery, 2002). Therefore, combining proprioceptive training with other performance-enhancing training methods, or extending the intervention beyond six weeks, may be necessary to elicit significant gains in speed. Future studies comparing different age groups, training durations, and protocols will contribute to a more comprehensive understanding of the effects of proprioceptive training on speed.

Integrated neuromuscular training (INT), comprising balance, plyometrics, strength and COD work, has been shown to enhance speed, COD, jumping and agility in male youth soccer players. In a study conducted by Hammami et al. (2023), it was observed that the implementation of an eight-week intensive training programme in highly trained youth male soccer players resulted in significant enhancements in various performance metrics. These enhancements included improvements in the 10-metre sprint, 30-metre sprint, and COD-related tasks. Additionally, the programme led to gains in CMJ height and balance measures. This finding is consistent with the findings of more extensive reviews indicating that a combination of balance, plyometrics, and dynamic stability with strength components results in increased NT in agility and speed-related outcomes (Akbar et al., 2022). Furthermore, meta-analytic work has demonstrated significant COD improvements following INT in a range of court-based sports, including football (Zhang et al., 2023). The findings presented herein lend support to the claim that a combination of physical training and intelligence training can enhance quickness and critical eye-dominance (COD) as part of an integrated programme (Hammami et al., 2022; Akbar et al., 2022).

Salot and Sathya (2020) A total of 90 footballers were selected at random and divided into two groups an experimental group (n=45) and a control group (n=45). The experimental group received proprioceptive training on a Bosu ball in addition to regular football training programmes, while the control group continued with conventional football training programmes. The athletes underwent a training regime that was conducted three times per week for a period of six weeks. Agility assessments were conducted before and after the training period. All subjects underwent intervention using the T-agility test. Results, The findings demonstrated a substantial discrepancy between the pre- and post-

agility values in the experimental group, with a p-value of 0.000 (< 0.05), while no such discrepancy was observed in the control group, with a p-value of 0.220 (> 0.05).

Three teams from the Iranian Youth League (second division) voluntarily participated in this study and were randomly assigned to two intervention groups (F11+; n = 29, M11+; n = 31) and one control group (n = 30). The F11+ group followed the FIFA 11+ programme, while the M11+ group performed modified exercises as a warm-up protocol three times a week before training and matches throughout a football season. The control group performed routine warm-ups, which included running, basic football drills, and static stretches. However, no injury prevention approach was implemented. The incidence of lower extremity injuries was documented, along with the duration of exposure for each player. The assessment of football-specific performance was conducted using the Illinois Agility and Slalom Dribbling tests. The analysis of the data was conducted by means of the analysis of variance (ANOVA), the Fisher-Freeman-Halton test, and the chi-squared test. Results: A significant difference in injury frequency was observed between the groups (p = 0.02, C = 0.40), with the lowest frequency documented in the M11+ group. A significant disparity was identified between the groups in terms of pre- and post-test results, as well as developmental trends over time for Illinois agility and ball dribbling speed (Asgari et al., 2022).

In younger adolescent players, the integration of brief intermittent training (INT) programmes into regular football training has been shown to enhance sprint-related speed, COD, and jumping ability, with a particular emphasis on acceleration (e.g., 10 m sprint) and COD performance (Michailidis et al., 2024). These findings suggest that even shorter INT programmes can have a positive impact on speed and agility domains in youth football. This finding aligns with the prevailing notion that the development of speed and COD in youth can be enhanced through targeted neuromuscular interventions (McBurnie & Dos'Santos, 2022).

A systematic review and meta-analysis focusing on the effects of plyometric training (PT) appropriate for the performance of adolescent footballers has been conducted. The study demonstrates that plyometric training significantly improves jumping, sprinting and change of direction (COD) performance; furthermore, depending on the protocol and age group, it yields moderate improvements in change of direction speed and lesser improvements in linear sprinting. Although not entirely proprioceptive, the plyometric component of SSC-guided PT utilises proprioceptive and neuromuscular mechanisms that underpin improvements in speed and COD. This component is frequently incorporated into proprioceptive and strength-based INT programmes (Zhou et al., 2024). The synthesis suggests that proprioceptive mechanisms originating from the plantar surface (PT) may contribute to improvements in cutting (COD) and agility performance in young footballers.

It has been demonstrated that incorporating proprioceptive training programmes—with a focus on balance exercises, agility training and coordination drills performed on an unstable surface—into football training leads to improvements in female footballers' agility parameters and ball skills. Furthermore, these training programmes can also influence physiological and technical skills. In the context of the Greek women's league, a 16-week proprioceptive-focused programme has been shown to improve ball control, shooting, passing and dribbling skills, whilst also leading to a reduction in body fat. These findings suggest that proprioceptive/coordination training may be effective in enhancing technical performance and perceptual-motor skills. Furthermore, the programme's effects may extend to indirect benefits such as increased speed and agility, which can be attributed to improvements in movement quality and efficiency (Souglis et al., 2023). Whilst the primary outcomes encompass

technical skills, the intervention was explicitly designed to target proprioceptive coordination and balance—fundamental to rapid and precise changes of direction.

It has been demonstrated that proprioceptive/neuromuscular training, particularly when integrated into a more comprehensive fitness programme incorporating plyometrics, balance, strength and change of direction (COD) exercises, improves speed and agility performance in young footballers. As demonstrated in the current literature, improvements have been observed in various parameters, such as 10-metre and 20–30-metre sprints, short sprint times, COD speed and agility measurements (Zhang et al., 2023).

To summarise, the present study has demonstrated that proprioceptive training exerts a considerable effect on agility and quickness in the short term. However, it is evident that the development of speed necessitates the implementation of longer-term, sport-specific, and comprehensive programmes. The findings demonstrate that six-week proprioceptive training programmes have varying levels of effectiveness on the motor performance of young athletes. While statistically significant improvements were observed in agility and quickness performance, a positive but statistically non-significant improvement was noted in the speed parameter.

This finding suggests that proprioceptive training enhances neuromuscular coordination in the short term, thereby reducing reaction time in sudden movements and improving body awareness. However, the study indicates that longer durations, sport-specific applications, and planning tailored to targeted motor skills are necessary for long-term and sustainable improvements. It is possible that extending the training period beyond six weeks could facilitate statistically significant enhancements in speed as well. It is acknowledged that training programmes may be enhanced by the incorporation of running technique, explosive strength and reaction training. These are considered to be skills contingent on numerous factors, including, but not limited to, the development of speed.

Limitations

This study has several limitations that should be acknowledged. First, the sample was restricted to a single club (Sarıyer Belediyespor) and a small number of male U16 athletes (n=20), which limits the generalisability of the findings to other age groups, sexes, and competition levels. Second, training intensity was monitored using the session RPE scale rather than an objective heart-rate monitoring device, which may reduce the precision of intensity control across sessions. Third, the six-week intervention period may not have been sufficiently long to elicit statistically significant improvements in linear speed, which is a multidimensional quality dependent on strength and technical factors beyond proprioceptive control. Finally, no follow-up testing was conducted after the intervention period, so the durability of the observed improvements in agility and quickness remains unknown.

Recommendations

Based on the present findings, youth football coaches seeking short-term gains in agility and quickness may consider adding a structured, six-week proprioceptive training block (comprising single-leg balance, squat, touchdown and hopping-with-stabilisation exercises) to regular training, as this addition produced significant, control-group-verified improvements in these qualities. Because linear speed did not improve significantly over the same six-week period, coaches aiming to develop speed specifically should either extend the intervention beyond six weeks or combine proprioceptive work with speed-specific and strength-based training components. Regular re-testing (e.g., every six weeks)

is recommended to monitor progress and to adjust training content according to each athlete's response, and future studies should test whether these gains are retained after the intervention ends.

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