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The Effect of 32-Week Football Training on Body Mass Index and Motor Performances of Male Children Aged 8-10

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Abstract

This study examined the effects of a 32-week football training program on body mass index (BMI) and motor performances, including sprinting, vertical jump, and flexibility, in male children aged 8-10. The study, modeled according to the survey design, utilized convenience sampling. The study included 55 children (aged 9.03±0.81 years) divided into three groups based on age: 8 years (n=17, BMI=17.55±1.09), 9 years (n=9, BMI=17.96±1.62), and 10 years (n=19, BMI=18.04±1.52). Data were collected in three phases: pre-test, mid-test (after 16 weeks), and post-test (after 32 weeks), using BMI, 20-m sprint, vertical jump, and sit and reach flexibility tests. A Mixed-Model ANOVA was used for repeated measures, and Post-hoc Tukey tests were employed to analyze differences between measurements. The results showed no significant differences between age groups in BMI, flexibility, and vertical jump (p>.05), except for a significant difference in sprint times between the 8- and 9-year-olds (p<.05). Within-group analyses revealed significant improvements in all motor performances across the training period for all age groups, except for BMI in the 9-year-olds (p<.05). In conclusion, it can be suggested that long-term football training programs based on scientific methods not only enhance physical attributes but also improve motor performances in children during the specialized movement phase. Moreover, it is recommended that opportunities be provided for children to participate in football training, and that football academies conduct regular tests to assess and measure the motor performances of their students.

Keywords: *anthropometric measurement, children, motor abilities, soccer training*

Introduction

Football is an immensely popular sport with over 270 million participants worldwide (Gardasevic, Bjelica, Vasiljevic, & Masanovic, 2020). It is characterized not only by technical and tactical skills but also by motor performance parameters such as body composition (Gardasevic et al., 2020; Zalai et al., 2015), body mass index (BMI) (Lesinski, Prieske, Helm, & Granacher, 2017; Masanovic, Milosevic & Bjelica, 2019), sprint, vertical jump, and flexibility (França et al., 2023; García-Pinillos, Ruiz-Ariza, Moreno del Castillo & Latorre-Román, 2015; Luo et al., 2023; Paryadi Huda, Yudhistira, Sulistiyono & Virama, 2023). During a match, motor performance parameters such as BMI, sprint, vertical jump, and flexibility directly impact a player's efficiency and effectiveness on the field. For instance, footballers with a BMI within the normal reference range tend to exhibit faster recovery times, better endurance, and sprint, leading to increased efficiency (Gardasevic et al., 2020). Additionally, optimizing BMI can reduce injury risks, allowing players to remain active throughout the game. A meta-analysis has shown that young athletes with sport-related injuries generally have a higher BMI, while those with bone stress injuries tend to have a lower BMI compared to non-injured players (Toomey et al., 2022). Recent research indicates that BMI is crucial for players' performance, and its significance varies depending on the

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position played (Gardasevic et al., 2020; Lesinski et al., 2017; Masanovic et al., 2019). A study involving 121 young U17 football players found that their BMI ranged from 18.5 to 24.9, with goalkeepers having the highest BMI, height, and weight, while midfielders had the lowest BMI. While height provides an advantage for goalkeepers, its impact on performance in other positions remains uncertain (Miçooğulları, 2024).

The development of motor performance plays a significant role in helping players surpass their opponents during both ball and non-ball activities in a match (Luo et al., 2023). For instance, sprint enables players to move quickly with or without the ball (García-Pinillos et al., 2015), and sprint performance is closely linked to a player's developmental stage. Young players show faster progress in sprinting when participating in sprint training (Aloui et al., 2022). Vertical jump performance is closely related to sprint and strength development in children. Studies on young football players, particularly those aged 8-10, have shown a strong correlation between vertical jump performance and sprint capacity. Vertical jump is a significant indicator of sprint performance over short distances in this age group. During this developmental stage, children's central nervous system is stabilizing, which makes sprinting and jumping abilities directly linked to muscle strength and endurance (Aloui et al., 2022; Chanel, Babault & Cometti, 2024). Furthermore, vertical jump ability plays a crucial role in success during aerial duels. Players who can jump higher are more likely to reach the ball in set-piece situations like corner kicks and crosses, thus improving their chances of scoring or defending effectively (García-Pinillos et al., 2015). Flexibility also plays a crucial role in football performance as it helps players develop football-specific motor skills, such as dribbling, shooting, and other technical maneuvers. A flexible body allows players to move more efficiently, change direction quickly, and execute high-impact movements more accurately. Moreover, maintaining good flexibility helps prevent muscle strains and joint injuries commonly associated with high-intensity sports like football (Alesi et al., 2015; Tsai, Kao, Huang, Lin & Kuo, 2017). Regular stretching and flexibility exercises have been shown to improve balance, agility, and overall athleticism while reducing the risk of injuries, particularly in the lower extremities, which are highly stressed in football (Daneshjoo, Hosseini, Heshmati, Sahebozamani & Behm, 2024; Donti, Konrad, Panidi, Dinas & Bogdanis, 2022).

Regular participation in football training allows children to demonstrate marked enhancements in motor performance, making them more dynamic and effective during games, alongside the development of their technical and tactical abilities. A study found that football-trained children achieved better results in sprint and vertical jump performance compared to their non-sporting peers (Alesi et al., 2015). Another study showed that football players had better coordination between their legs compared to their sedentary counterparts, suggesting that football training enhances coordination and control of the non-dominant leg (Akpinar, 2022). Other studies have demonstrated that football training is effective in improving motor performance aspects such as vertical jump, sprint (Aloui et al., 2022), balance (Tsai et al., 2017), flexibility (Daneshjoo et al., 2024; Donti et al., 2022), coordination (Akpinar, 2022), and explosive power (Alesi et al., 2015).

Although some studies have shown positive effects of football training, a longitudinal study analyzing the effects of football training over a longer period on anthropometry and motor performance in children is still lacking. In this regard, the study aimed to investigate the effects of a 32-week football training program on BMI, sprint, vertical jump, and flexibility in male children aged 8-10. It is hypothesized that the applied training program will improve the children's BMI and enhance their motor performance.

Methods

This research employed a survey model, aiming to describe a current or past situation as it exists without attempting to alter or influence variables. A convenience sampling method was used, consisting of individuals who were readily accessible and voluntarily participated from the immediate environment.

Participants

At the beginning of the study, 70 male children aged 8 to 10, registered in a private football academy in Nevşehir, participated. Later, 15 children were excluded from the study due to a deviance rate of less than 90% in training attendance. The study included 55 children (aged 9.03±0.81 years) divided into three groups based on age: 8 years (n=17, BMI=17.55±1.09), 9 years (n=9, BMI=17.96±1.62), and 10 years (n=19, BMI=18.04±1.52). Participation criteria included being male, aged 8-10, parental signing of the pediatric informed consent form, and maintaining at least 90% attendance in training. Exclusion criteria were severe injury and voluntary withdrawal. Parental consent was obtained from all participants, and the study was approved by the Nevşehir Hacı Bektaş Veli University Institutional Review Board (# 2024.05.04) in accordance with the Declaration of Helsinki (World Medical Association, 2013).

Data Collection

Pre-test data were collected for height, weight, 20-meter sprint, vertical jump, and sit and reach flexibility tests, Mid-test data were collected four months later, followed by post-test data another four months after that.

Measurements

Anthropometric characteristics

The participants' height (m) and weight (kg) were measured using a bioelectrical impedance device (SECA 220, SECA, Hamburg, Germany). Measurements were conducted in an anatomical standing position, with participants barefoot and dressed in shorts and t-shirts. Body Mass Index (BMI) was calculated using the formula BMI (kg/m^2)=Weight/Height^2, based on their height (cm) and weight (kg) data (WHO, 2010).

Motor Performance Assessment

20-Meter Sprint Test

The sprint measurement consisted of a 20-meter test course, with photocells (Microgate, Bolzano, Italy) placed at the start and finish lines. Participants were instructed to run the course at a maximum sprint when ready. They performed two trials with a 3-minute rest interval between each, and the best time was recorded in seconds (Lockie, Schultz, Callaghan, Jeffriess & Berry, 2013).

Vertical Jump Test

The test was conducted using the OptoJump device (Microgate, Bolzano, Italy). Participants stood shoulder-width apart between two long bars fixed to the ground. After receiving a visual demonstration, they waited in a ready position until the command "jump" was given, then performed a vertical jump from a semi-squat position. Sensors on the bars communicated the time in the air to the computer, which automatically recorded the jump height in centimeters. Each participant completed three trials, with 45 seconds of passive recovery between attempts, and the highest jump distance was recorded (Sattler, Hadžic, Dervišević & Markovic, 2015).

Sit and Reach Flexibility Test

Participants removed their shoes, sat on the floor, and placed their feet flat against the sit and reach box (Baseline Sit and Reach Trunk, China). They extended their bodies forward without bending their knees, pushing the ruler with both hands to the furthest point, holding this position for 2 seconds. The measurement was repeated twice, with the highest value recorded in centimeters (Sermaxhaj, Arifi, Havolli, Luta & Isufi, 2021)

Football Training Protocol

The four training contents shown in Table 1 (movement training, ball mastery, motor performance, and game) were planned and implemented with age-appropriate levels, twice a week for 1.5 hours per session, totaling 96 hours over 32 weeks, from July to February, by the football academy.

Table 1. Football training content

Movement Training	Ball Mastery	Motor Performance	Game	Level
Body awareness (body parts)	Control	Flexibility	Educational	Fundamental
Field awareness (direction, level)	Kick	Balance	Match	Intermediate
Effort awareness (fast, slow)	Turn	Sprint	Small-sided	Advanced
		Agility	Large-sided	
Relationship awareness (obejct, individual, group)		Reaction		
		Coordination		

Data Analysis

The dataset for all variables was analyzed using the Shapiro-Wilk test, confirming a normal distribution ($p<.05$). The Shapiro-Wilk test results indicated that the data followed a normal distribution ($p>.05$). A Mixed Model ANOVA for Repeated Measures was conducted with a 3 (Age: 8, 9, 10) x 3 (Test: pre-test, mid-test, post-test) design. Post-hoc Tukey tests were performed to identify specific differences when applicable. Statistical analyses were conducted using JMP 17 Pro statistical software (SAS Company, North Carolina, USA), with significance set at $p<.05$.

Results

Height and Weight

According to Table 2, the pre-test average height of the 8-year-old group was 1.25 m, increasing by 3 cm to 1.28 m in the post-test. The 9-year-old group showed an increase of 5 cm, from 1.33 m in the pre-test to 1.38 m in the post-test. Similarly, the 10-year-old group exhibited an increase of 4 cm, from 1.37 m in the pre-test to 1.41 m in the post-test.

Table 2. Distribution of height, weight and body mass index pre-test, mid-test, and post-test values by age groups.

Variables	Test	Age 8 (n=17)		Age 9 (n=19)		Age 10 (n=19)	
		Mean	Std. D.	Mean	Std. D.	Mean	Std. D.
Height (m)	Pre-test	1.25	0.44	1.33	0.06	1.37	0.09
	Mid-test	1.26	0.04	1.36	0.06	1.39	0.10
	Post-test	1.28	0.04	1.38	0.06	1.41	0.10
Weight (kg)	Pre-test	26.61	3.58	32.12	4.74	33.61	7.46
	Mid-test	28.16	2.79	33.35	4.95	35.14	7.21
	Post-test	29.65	2.75	34.46	4.93	37.02	6.98
BMI (kg/m2)	Pre-test	17.02	1.31	17.84	1.65	17.64	1.80
	Mid-test	17.60	0.86	18.04	1.65	17.99	1.46
	Post-test	18.02	0.83	18.01	1.65	18.50	1.19

When examining the children's weight averages, the pre-test average weight of the 8-year-old group was 26.61 kg, increasing by 3 kg to 29.65 kg in the post-test. The 9-year-old group showed an increase of 2 kg, from 32.12 kg in the pre-test to 34.46 kg in the post-test. Similarly, the 10-year-old group exhibited an increase of 3.5 kg, from 33.61 kg in the pre-test to 37.02 kg in the post-test.

When examining the children's body mass index (BMI) averages according to Table 2, it was found that the 8- and 9-year-old groups had averages below 18.5, while the 10-year-old group reached an average of 18.5 in the post-test. Therefore, it can be said that the 8- and 9-year-old groups are in the underweight category, while the 10-year-old group has a normal BMI average.

Body Mass Index (BMI)

According to the results of the two-way ANOVA, a significant interaction was found between age and test factors ($F(4,104)=3.20$; $p=.02$, $\eta^2=.11$). A significant difference was also observed in the test factor ($F(2,104)=19.96$; $p=.001$, $\eta^2=.28$). However, no significant difference was found in the age factor ($F(2,52)=0.66$; $p=.52$, $\eta^2=.03$).

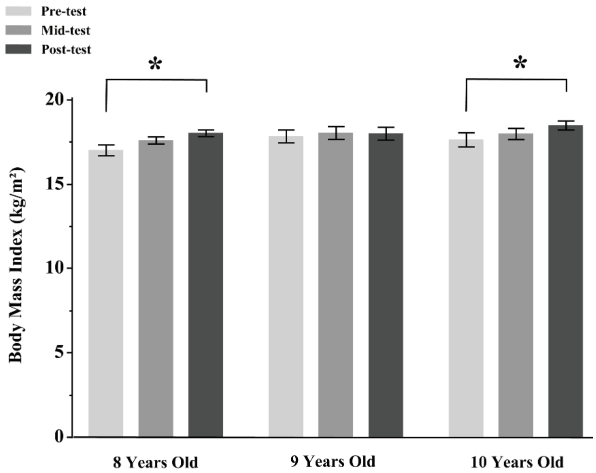

FIGURE 1. Distribution of body mass index pre-test, mid-test, and post-test values by age groups.

The Post-hoc Tukey analysis results indicate a significant difference between the pre-test and post-test mean values of the 8- and 10-year-old groups (p=.001), while no difference was found for the 9-year-old group (p=1). Comparisons between the groups revealed no significant differences in pre-tests among the 8- and 9-year-olds (p=.73), 8- and 10-year-olds (p=.93), and 9- and 10-year-olds (p=1). Similarly, mid-tests showed no significant differences between the 8- and 9-year-olds (p=.99), 8- and 10-year-olds (p=.99), and 9- and 10-year-olds (p=1). In post-tests, no significant differences were observed between the 8- and 9-year-olds (p=1), 8- and 10-year-olds (p=.99), and 9- and 10-year-olds (p=.98).

20 m Sprint Test

According to the results of the two-way ANOVA, a significant difference was found in the interaction between age and test factors (F(4,104)=4.54; p=.002, η^2=.15). While a significant difference was observed in the test factor (F(2,104)=199.93; p=.001, η^2=.79), no significant difference was found in the age factor (F(2,52)=2.99; p=.07, η^2=.09).

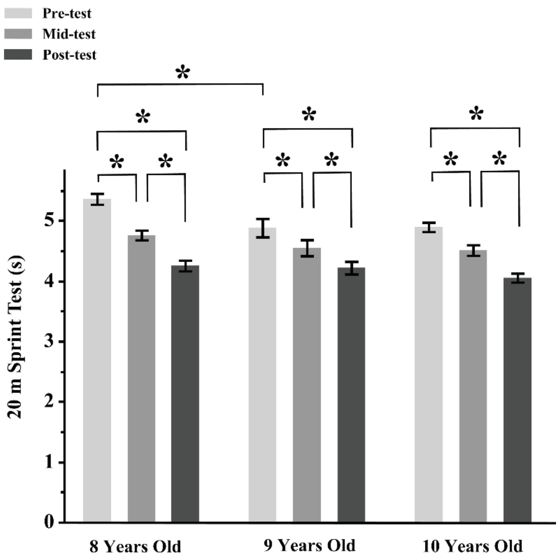

FIGURE 2. Distribution of 20-m sprint pre-test, mid-test, and post-test values by age groups.

The Post-hoc Tukey analysis (Figure 2) showed significant differences among the pre-, mid-, and post-test scores within each age group (8-, 9-, and 10-year-olds) (p=.001). In inter-group comparisons, a significant difference was found between the pre-test scores of the 8 and 9-year-old groups (p=.04), but not between the 8 and 10-year-olds (p=.05) or the 9 and 10-year-olds (p=1). For the mid-tests, no significant differences were noted between the sprint test scores of the 8 and 9-year-olds (p=.88), 8 and 10-year-olds (p=.74), and 9 and 10-year-olds (p=1). Similarly, post-tests showed no significant differences between the averages of the 8 and 9-year-olds (p=1), 8 and 10-year-olds (p=.91), and 9 and 10-year-olds (p=.96).

Vertical Jump Test

According to the results of the two-way ANOVA, a significant difference was found in the interaction between age and test factors (F(4,104)=3.03; p=.02, η^2=.10). Furthermore, significant differences were observed in both the test factor (F(2,104)=69.06; p=.001, η^2=.57) and the age factor (F(2,52 =3.18; p=.04, η^2=.11).

The Post-hoc Tukey analysis (Figure 3) shows significant differences between the pre-test and post-test mean scores within all age groups (p=.001). When examining within-group differences for the mid-tests, significant differences were found between the pre-test and mid-test for the 9-year-olds (p=.007), as well as between the mid-test

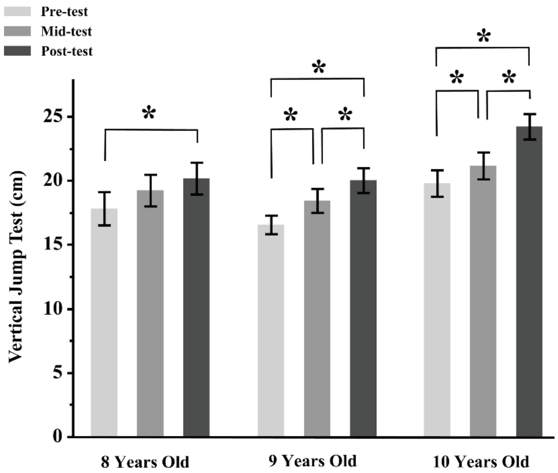

FIGURE 3. Distribution of vertical jump pre-test, mid-test, and post-test values by age groups.

and post-test for both the 9-year-olds (p=.04) and 10-year-olds (p=.001). When examining the between-group vertical jump averages, no significant differences were found among the pre-test, mid-test, and post-test scores of all age groups (p>.05).

Sit and Reach Flexibility Test

According to the results of the two-way ANOVA, no significant difference was found in the interaction between age and test factors (F(4,104)=0.69; p=.60, η^2=.03). While a significant difference was observed in the test factor (F(2,104)=53.93; p=.001, η^2=.51), no significant difference was found in the age factor (F(2,52)=0.81; p=.45, η^2=.03).

According to the within-group results of the Post-hoc Tukey analysis shown in Figure 4, significant differences were found between the pre-test and post-test scores of the 8-year-old group (p=.001), the pre-test and post-test scores of the 9-year-old group (p=.001), as well as between the mid-test and post-test scores (p=.004). For the 10-year-old group, significant differences were found between the pre-test and post-test scores (p=.001) and between the mid-test and post-test scores (p=.009). When examining inter-group comparisons, no significant differences were found among the pre-test, mid-test, and post-test scores of all age groups (p>.05).

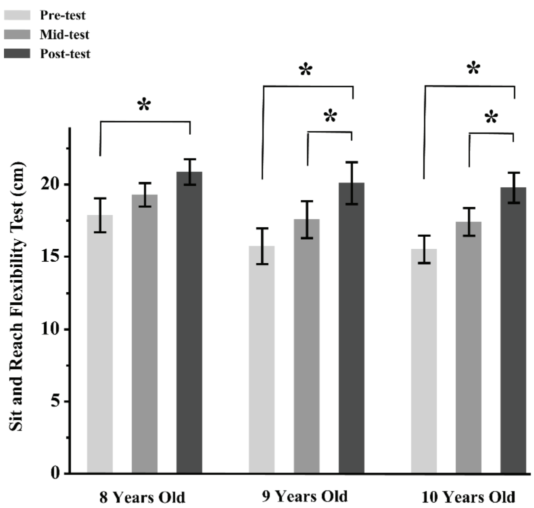

FIGURE 4. Distribution of sit and reach flexibility pre-test, mid-test, and post-test values by age groups.

Discussion

This study examined the effects of a 32-week football training program on BMI, sprint, vertical jump, and flexibility in male children aged 8 to 10 years. Although there was an increase in height and weight across all age groups, the BMI of the 8- and 9-year-old groups remained low, while the BMI of the 10-year-old group reached normal levels. In terms of sprint performance, improvements were observed in all groups, with the 9-year-old group achieving better results in the pre-tests. Flexibility increased in all groups, but no significant differences were found between the groups. Vertical jump performance improved across all groups, but no significant differences were observed between them, with the 10-year-old group demonstrating the highest performance.

BMI results may be attributed to regular football training and age-related growth positively impacting BMI. Previous studies also indicate that football training improves BMI in children, such as a 10-week program by Miranda, Antunes, Pauli, Puggina, and da Silva (2013) showing significant improvements, and a study of 50 child footballers indicating that training helped their BMI approach the normal range (İnan & Dağlıoğlu, 2013). Overall, structured physical activities like football lead to significant improvements in BMI.

Sprint results can be attributed to the development of muscle strength, which is crucial for quick movements in football, such as overtaking or stopping an opponent (Eniseler, 2010).

Research indicates that strength training positively impacts sprint performance, with systematic reviews showing that it can lead to better sprint times than power training, particularly in youth athletes (Behm et al., 2017). Sprint is a vital motor performance in football, influenced by genetic factors, but can be enhanced through proper training (Eniseler, 2010). Studies support the notion that lower-body strength training improves sprinting ability by increasing muscle power, force production, and coordination. For instance, Chelly et al. (2010) showed significant improvements in sprint performance among junior soccer players after a strength training program focused on leg power. A meta-analysis by Behringer, Heede, Matthews, and Mester (2011) also confirmed that resistance training enhances motor performance, including sprints, in youth athletes. Overall, the 32-week football training program in this study likely increased lower-body muscle strength in children, contributing positively to their sprint development.

Based on findings of vertical jump, it can be said that the primary factor influencing the improvement in vertical jump performance is neuromuscular adaptations. These adaptations include changes in the mechanical properties of muscles and tendons, increased neural drive to agonist muscles, and improvements in muscle activation strategies (Maffiuletti, Dugnani, Folz, Di Pierno & Mauro, 2002; de Villarreal, Kellis, Kraemer & Izquierdo, 2009). The increase in vertical jump performance following a 4-week plyometric training program applied to ten volleyball players has been attributed to an enhanced ability of the neuromuscular system to produce concentric force rapidly (Maffiuletti et al., 2002). In other words, it can be stated that the plyometric movement patterns, which are exhibited during the control or striking of high balls in matches and training, were applied in a 32-week football training program for children aged 8-10, who are in a period of rapid muscle and nerve development. According to de Villarreal et al. (2009), plyometric training requires optimum levels of joint coordination and muscle strength. Although neuromuscular adaptation was not investigated in this study, the jump ability exhibited during football training and matches may have influenced the development of muscle and nerve coordination.

The increase in flexibility is attributed to the stretching exercises included in football training. Although it is recommended that flexibility training start during childhood (ages 6-11) to optimize joint range of motion, evidence supporting this remains limited (Sands et al., 2016). Flexibility develops most rapidly between ages 4 and 12, when muscles and connective tissues become more elastic. Consistent stretching and physical activities during these years significantly enhance flexibility, making early childhood a critical period for its development (Donti et al., 2022). Researches show that regular stretching, such as that found in football, effectively improves flexibility. For instance, the study by Amiri-Khorasani et al. (2016) investigates the impact of both static and dynamic stretching on lower extremity flexibility, specifically in collegiate soccer players. It highlights that dynamic stretching, as part of a warm-up routine, can significantly enhance flexibility and improve movement efficiency during activities such as kicking, contributing to both performance enhancement and injury prevention. Therefore, incorporating both dynamic and static stretching exercises into football training for players aged 8-10 is effective in enhancing flexibility development.

Limitations

The study was limited to a total of 96 hours of training over 32 weeks, with 1.5-hour sessions held twice a week at a private football academy, and participants were restricted to male children aged 8 to 10. The main limitation of the study is that motor performance was assessed using only three tests.

Conclusion

Although the 32-week football training program implemented in this study positively influenced the physical and motor performance development of children, no significant changes were observed between the age groups. As a practical implication, it is recommended that football academies implement age-appropriate training programs and tests to improve players' motor performance. Training programs should be customized according to children's developmental levels, focusing on physical fitness, motor performance parameters, ball mastery, movement training, and game abilities. Additionally, conducting regular motor performance tests will allow for the evaluation of training effectiveness and enable updates to the plans when necessary. This approach will help football academies maximize the performance of young football players. For future research, the effects of the duration and intensity of the training program on such studies could be explored. Additionally, it is recommended that a broader set of motor performance tests be used in future studies. This would allow for a more comprehensive assessment of children's motor development.

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Conflicts of interest

The authors declare that there are no conflict of interest.

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