AGE-RELATED DIFFERENCES IN PHYSICAL AND TECHNICAL PERFORMANCE: A CROSS-SECTIONAL ANALYSIS OF ELITE BULGARIAN YOUTH FOOTBALL PLAYERS (U12–U14)

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Abstract: Purpose: This study aimed to examine age-related differences in physical and technical performance among elite youth football players aged 12 to 14 years. Specifically, the research focused on sprinting ability (10m and 20m), agility, and dribbling performance to assess how these skills evolve during early adolescence. Methods: A total of 75 male youth football players from a professional academy were tested and divided into three age groups: U12 (n = 37), U13 (n = 16), and U14 (n = 22). The test battery included a 10-meter sprint, 20-meter sprint, slalom agility run, and dribbling test. Descriptive statistics (mean ± standard deviation) were calculated for each group. A one-way ANOVA assessed between-group differences, with significance set at $p < .05$. All data were collected and analyzed using SPSS v27 for macOS 14 PRO. Results: The U13 group showed the best sprint performance, with significantly faster times in both the 10m and 20m (U13: 2.11s (10m) vs. U14: 2.51s) sprints ($p < .001$) compared to the other age groups. No statistically significant differences were found for agility or dribbling performance. While sprint speed improves with age, agility, and technical ability may require more prolonged or specialized training to elicit significant progression. Conclusions: Sprint performance in youth football players improves significantly between ages 12 and 14, likely due to growth and neuromuscular development. However, agility and dribbling performance remain relatively stable, highlighting the need for targeted training strategies. Coaches should consider these developmental patterns when designing age-appropriate training programs focused on both physical and technical development.
Keywords: youth football, physical performance, agility, dribbling, motor development, U12–U14, athlete monitoring, talent development

1. INTRODUCTION

In youth football, developing fundamental motor qualities such as speed and coordination plays a critical role in shaping long-term athletic performance. These physical attributes contribute to a player's immediate effectiveness on the pitch and serve as foundations for more complex technical and tactical skills acquired in adolescence and beyond (Ford et al., 2011; Lloyd & Oliver, 2012). As players progress through key developmental stages, physiological changes—such as growth spurts, neuromuscular adaptation, and improved motor control—can significantly influence performance outcomes in sprinting, agility, and explosive power (Philippaerts et al., 2006).

Cross-sectional and longitudinal studies in youth sports have revealed age-specific performance trends, with significant improvements typically occurring during the prepubescent and pubertal periods (Vaeyens et al., 2008). Identifying when and how these changes occur can assist coaches in designing age-appropriate training interventions that optimize development and reduce the risk of overtraining or early specialization (Balyi et al., 2013).

Despite the growing body of literature on youth athletic development, there is limited data regarding speed and coordination progression in Eastern European football academies, especially for those aged 11 to 14. Understanding how performance varies among U12, U13, and U14 groups can provide valuable insight into training priorities and the effectiveness of early development programs.

The purpose of this study is to analyze and compare the short-distance speed, agility, and dribbling performance of youth football players aged 11 to 14. Using a cross-sectional dataset derived from standardized field tests—including a 10-meter sprint, 20-meter sprint, agility slalom, and a football-specific dribbling test—we aim to identify statistically significant differences across age groups and highlight developmental trends during the pre-adolescent and early adolescent phases.

2. METHODS

This study employed a cross-sectional, observational design to examine differences in speed, agility, and technical performance across three youth age groups. Data were collected through standardized field-based testing protocols commonly used in football talent development environments.

Participants were recruited from the youth academy of Olimpia Football Club – a professional football club competing in the Bulgarian youth league system. The academy follows a standardized training regimen aligned with

UEFA guidelines for player development. Testing was conducted at the club's training facility in [град], Bulgaria, during the 2023/2024 competitive season. All participants had at least 3 years of structured football training.
A total of 75 male youth football players from a professional football academy in Bulgaria participated in the study. The participants were grouped by competitive age category as follows:

- U12 (n = 37) – players born in 2012
- U13 (n = 16) – players born in 2011
- U14 (n = 22) – players born in 2010

All players were healthy, actively training, and injury-free at the time of testing. Parental consent was obtained for each participant. Testing was carried out during the in-season training period under the supervision of qualified coaches and sports scientists.
Each participant completed the following performance tests, conducted on a synthetic football field in standardized conditions:

- 10-Meter Sprint Test: Players sprinted from a standing start over 10 meters. Time was recorded using electronic timing gates. The fastest time from two trials was used.
- 20-Meter Sprint Test: Identical protocol to the 10-meter test, but with 20-meter distance.
- Agility Test (Slalom): A football-specific slalom agility course with cones was used to assess change-of-direction speed. The timing was recorded via stopwatch or gates.
- Dribbling Test: Participants completed a slalom course while dribbling a football. The best time out of two attempts was used for analysis.

All players completed a standardized dynamic warm-up before testing. At least 2 minutes of rest were allowed between trials.
Descriptive statistics (mean ± standard deviation) were calculated for each age group and test. One-way analysis of variance (ANOVA) was used to assess between-group differences, followed by Tukey's post hoc test for pairwise comparisons. Statistical significance was set at $p < 0.05$. All analyses were performed using SPSS v27 for macOS.

3. RESULTS

A total of 75 youth football players were assessed across three age groups: U12 (n = 37), U13 (n = 16), and U14 (n = 22). The results of four performance tests—10-meter sprint, 20-meter sprint, agility (slalom), and dribbling—are presented in Table 1 as mean ± standard deviation (SD).
Descriptive Results

Table 1. Descriptive statistics of performance tests by age group

Age Group	n	Sprint 10m (s)	Sprint 20m (s)	Agility (s)	Dribbling (s)
U12	37	2.15 ± 0.12	3.70 ± 0.17	8.46 ± 0.42	11.63 ± 0.96
U13	16	2.11 ± 0.08	3.63 ± 0.15	8.52 ± 0.38	10.53 ± 2.91
U14	22	2.51 ± 0.20	3.98 ± 0.29	8.51 ± 1.02	10.90 ± 3.69

Source: Authors research

As shown in Table 1, U13 players had the fastest sprint times, with an average of 2.11 s in the 10-meter sprint and 3.63 s in the 20-meter sprint. Agility scores remained relatively consistent across the age groups while dribbling performance showed slight variation.

ANOVA Results

To determine whether the observed differences were statistically significant, one-way ANOVA was conducted for each variable (Table 2). These results confirm that sprinting ability shows significant age-related progression, whereas agility and dribbling exhibit high within-group variability, limiting statistical significance.

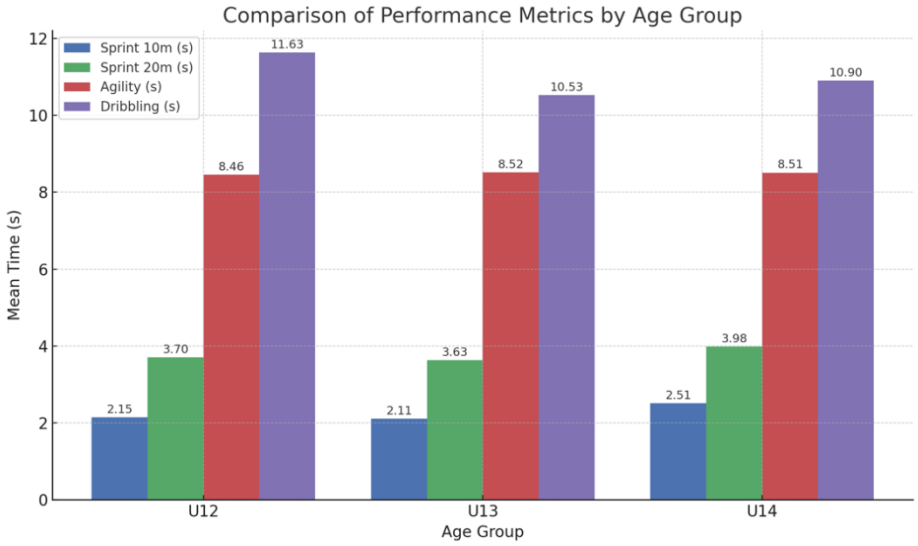
Table 2. ANOVA test analysis

Test	F-value	p-value
Sprint 10m	54.04	< .001
Sprint 20m	17.34	< .001
Agility	0.06	.9396
Dribbling	1.24	.2943

Source: Authors research

Significant differences were found for both sprint tests (10 m and 20 m), indicating that sprint performance improves with age or training exposure. No significant differences were found for agility or dribbling, suggesting that these abilities may develop more gradually or require different training stimuli to elicit clear age-related trends.
Bar charts (Figure 1) were created to visualize group-wise differences across each test. Each graph displays the average score (in seconds), with values annotated on the bars for clarity.

Figure 1. Mean 10-Meter Sprint Time by Age Group (U12–U14)



Source: Authors research

4. DISCUSSION

This study aimed to assess and compare the development of speed, agility, and dribbling performance across three age groups (U12, U13, U14) in a professional football academy setting. The results revealed statistically significant improvements in sprint performance (both 10m and 20m) with increasing age, while agility and dribbling scores showed no significant differences.

Sprint Performance and Age Progression

The significant differences observed in the 10-meter and 20-meter sprint tests ($p < .001$) support existing literature that highlights the role of maturation and neuromuscular development in speed enhancement during adolescence (Lloyd & Oliver, 2012; Philippaerts et al., 2006). The peak sprint performance observed in U13 players may also reflect an optimal balance between coordination and muscle efficiency before major growth spurts, which may temporarily impair sprint mechanics in post-peak height velocity players (Ford et al., 2011).

These findings suggest that around the age of 13, players may reach a temporary peak in neuromuscular coordination and body composition efficiency before growth-related changes begin to impact sprint mechanics. The superior sprint performance observed in U13 players compared to U14 may reflect a temporary decline in coordination and speed efficiency among older players, possibly due to early puberty-related growth spurts. Rapid increases in limb length and body mass during this phase can disrupt previously established neuromuscular patterns, leading to a transient drop in sprint performance until coordination adapts (Philippaerts et al., 2006; Ford et al., 2011).

Agility and Dribbling Stability Across Age

Contrary to the sprint results, agility and dribbling scores did not show statistically significant differences across age groups. This finding suggests that these abilities might develop more gradually and could be less influenced by biological age alone. Similar conclusions were reached by Hill-Haas et al. (2011), who emphasized the importance of skill-specific and repeated stimulus to develop agility and ball control in youth players. Moreover, since these tests require technical execution combined with physical movement, performance may also be influenced by cognitive and perceptual-motor factors that do not progress linearly with age (Gabbett, 2006). High levels of technical skill are characteristics of those players who can process information effectively before deciding on the appropriate course of action.
(Ivanov, 2021). Recent studies emphasize the value of integrated approaches in youth football training, where technical skills are developed in context-rich environments, rather than isolated drills. According to Ivanov &

Lovkov (2023), the majority of football specialists support integrated learning as more effective for long-term player development.

Training Implications

The findings suggest that training programs for youth footballers should prioritize sprint development during the early adolescent years while continuing to reinforce agility and dribbling skills through varied and progressive drills. Coaches should consider the different trajectories of motor quality development and adopt individualized approaches based on the physical and technical profiles of their athletes. These findings are consistent with previous survey-based research in Bulgarian football, where more than half of youth coaches identified technical development as the most critical component of training for 12-year-old players (Ivanov & Gadzhev, 2020). According to a national survey among 147 Bulgarian football coaches, 44.2% believed that the optimal age for early specialization in football is between 8 and 12 years, despite acknowledging the potential risks associated with early sport focus such as injuries and burnout (Tsvetkov et al., 2021).

Limitations

This study is limited by its cross-sectional design and relatively small sample size in the U13 and U14 groups. Longitudinal tracking would offer a deeper understanding of developmental changes. Additionally, contextual factors such as training background and maturation status were not controlled for.

5. CONCLUSION

This study explored the physical and technical performance characteristics of youth football players aged 11 to 14, focusing on sprinting ability, agility, and dribbling proficiency. The results demonstrated significant age-related improvements in sprint performance, with U13 players showing the fastest times over 10 and 20 meters. In contrast, agility and dribbling scores did not differ significantly between age groups, suggesting these abilities may be influenced by factors beyond chronological age, such as training exposure, coordination, and motor learning capacity.

The findings underscore the importance of integrating age-appropriate training stimuli into youth development programs. While sprinting ability appears to progress with maturation, agility, and dribbling require consistent and structured practice to yield improvements. Coaches should prioritize holistic development approaches that blend physical preparation with technical refinement and cognitive engagement. These approaches will support more individualized and developmentally appropriate coaching for youth players transitioning through key growth stages.

Future research should adopt longitudinal designs to better understand developmental trajectories over time and explore the interaction between physical growth, skill acquisition, and training methodology in youth football.

This underscores the necessity of not only age-appropriate but also skill-specific periodization training models within youth football development.

Practical Application

The results of this study offer actionable insights for football coaches, strength and conditioning professionals, and youth development coordinators. The age-related differences in sprint performance highlight the natural acceleration of speed attributes during early adolescence. Coaches working with U12 –U14 players should leverage this window of accelerated neuromuscular adaptation by incorporating sprint drills and resisted sprint work into training sessions.

The results of functional examinations of amateur futsal players suggest that even non-elite athletes can reach performance levels close to professional standards, particularly in VO_2 max and maximum speed. This highlights the importance of structured training and physical monitoring, even at the amateur level (Stoilov et al., 2023). There is a significant number of strong correlations between physical preparation indices such as speed, explosive force, and change of direction ability, and technical skills such as ball control at high speed. This interdependence highlights the importance of integrated training methodologies that address both physical and technical development simultaneously (Stoilov, 2020).

Meanwhile, the lack of significant improvement in agility and dribbling across age groups suggests that these skills require continuous and deliberate practice rather than relying solely on maturation. Incorporating small-sided games, technical slalom drills, and perceptual-motor training in early developmental stages can promote more consistent progress in agility and ball control.

Moreover, training programs should consider individual variability in growth and skill acquisition. Implementing regular monitoring protocols and adapting drills to each player's stage of development may optimize talent progression and prevent under or overexposure to physical loads.

By understanding when and how specific motor abilities evolve, coaches can create more effective, age-sensitive training strategies that align with long-term athlete development models.

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