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RESEARCH ARTICLE

AGE-RELATED DIFFERENCES IN FUNCTIONAL CAPACITY AND TECHNICAL PERFORMANCE IN YOUTH SOCCER PLAYERS WITH SIMILAR TRAINING AGES

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ABSTRACT

Purpose: Chronological age is the most straightforward method for classifying youth soccer players based on their date of birth. However, results concerning the effect of chronological age on functional capacity and technical performance are controversial in youth soccer. Therefore, the aim of the present study was to determine the differences in physical and soccer technical performance between U12 and U14 male soccer players with similar training ages. For this purpose, 84 soccer players were grouped according to their soccer age category (U12 and U14).
Material and Methods: Body weight, body mass index and body composition were measured by using a bioelectrical impedance analysis. Flexibility, static balance, and vertical jump performances were measured using the sit-and-reach test, Flamingo balance test, and vertical jump test, respectively. Moreover, soccer technical performance was evaluated using Mor-Christian passing test.
Results: The mean training ages of the U12 (4.28 ± 2.14 years) and U14 (5.00 ± 2.55 years) groups were similar ($p = 0.15$), whereas their chronological ages differed significantly (U12: 10.46 ± 0.78 years; U14: 12.09 ± 0.28 years; $p < 0.05$). Anthropometric measurements (height, weight and fat free mass), flexibility, static balance, vertical jump, and passing results were significantly higher in U14 compared to U12 soccer players ($p<0.05$).
Conclusion: U14 soccer players demonstrated superior physical and technical performance compared to U12 players, despite similar training ages. These findings suggest that age-related developmental factors play a key role in performance and highlight the need to consider individual maturity and physical characteristics in youth training and classification.

Keywords: Youth soccer, chronological age, training age, technical performance, functional capacity.

INTRODUCTION

Soccer, the world's most popular sport, has become even more popular according to Fédération Internationale de Football Association's (FIFA) Big Count that counts 265 million players across different levels, genders, and ages (1,2). It also has largest number of youth players, totalling 22 million (2). Given the vast range of participants globally, it becomes important for standard frameworks to guarantee fair competition and support structured player development. Consequently, youth soccer age group classifications, determined by national and international soccer associations, follow FIFA's overarching guidelines and are based on chronological age (CA) (3).

The age range commonly used to define young athletes spans from 6 to 18 years, encompassing both prepubescent athletes (under the age of 12) and adolescent athletes (generally between 12 and 18 years). This range is commonly divided into subgroups such as U10, U12, U14, U16, and U18, based on birth year (4,5). CA has been identified as a key factor influencing both technical performance and functional capacity in youth soccer players (6,7). However, relying solely on CA may be insufficient to account for the great variability in biological maturation and training experience among youth soccer players. Differences in physical growth, motor skill acquisition, and athletic development can lead to considerable discrepancies in functional capacity and technical performance among players of the same CA. Therefore, investigating the effects of CA while controlling for training age is crucial for better understanding developmental pathways and optimize talent identification in youth soccer.

Soccer players require a high level of functional capacity, including various components such as explosive power, maximal strength, and aerobic endurance to perform successfully during matches (8). Although aerobic metabolism predominates over the course of a match, decisive actions such as short sprints, jumps, tackles, and one-on-one duels rely on anaerobic energy systems, and often distinguish successful teams from unsuccessful ones (9,10). These high-intensity actions, which have a critical influence on match results, must be developed from an early age (11). In addition to CA, functional capacity in youth players is influenced by both training age (12–15) and biological maturation (4). During puberty, increased secretion of growth hormone, testosterone, and insulin-like growth factor-1 (IGF-1) promotes muscle development, neuromuscular coordination, and energy metabolism. However, muscle mass and strength are not yet fully develop in younger athletes, resulting in gradual improvements in strength, power, and anaerobic performance with age (4).

Strength is a key determinant of soccer performance, particularly as adolescent players progress through developmental stages. Strength, which has been shown to have a strong correlation with CA, critically influences technical skill acquisition during the first two decades of life (16–18). Functional tests such as short sprints, vertical jumps (VJ), and squats effectively mirror soccer-specific strength capacities. Many studies have shown that CA positively impacts VJ performance in adolescent soccer players (6,19–21). However, biological maturation may act as a confounding variable, making it challenging to separate age-related and maturation-dependent effects (4,22,23).

Flexibility also plays an important role in soccer performance, as it underpins mobility, coordination, and technical execution (24,25). Yet, the influence of CA on flexibility in youth soccer players remains inconclusive; some studies report no significant age-related impact, while others note a decline in flexibility with increasing age in both athletes and non-athletes (18,26–28). This discordance may be due to differences in biological maturation, which complicate the interpretation of CA's impact.

Enhanced proprioception and balance are associated with improved technical and tactical soccer skills (29,30). Although balance is a crucial component of soccer performance, limited research has examined the specific influence of CA on balance development in youth players. As with strength and flexibility, biological maturity would likely play a crucial concerting role in the development of balance (4,22,23).

Finally, technical skills such as passing, shooting, dribbling, and ball control are essential to soccer success, as proficiency in these skills directly enhances a team's ability to score goals and win (31). Existing evidence indicates that CA plays a significant role in the development of these skills during adolescence (6,22,32), although this process may also be influenced by training content, biological maturation, and individual variability (6,32–34).

In summary, while CA remains the most straightforward method for classifying youth soccer players based on their date of birth (5), studies investigating its impact on functional capacity and technical performance are limited and inconsistent. Moreover, although CA offers a simple way to classify, it does not account for differences in training age. Studying players of similar training backgrounds may alow for a more accurate assessment of CA's effect on performance parameters. Thus, the aim of the present study was to determine the differences in technical performance and functional capacity between U12 and U14 male soccer players with comparable training ages. The study was based on two hypotheses:

I. Older players, despite having similar training ages, would demonstrate higher functional capacity due to physiological and motor development advantages associated with aging.

II. Older players, despite having similar training ages, would exhibit higher technical performance as a result of age-related developmental factors.

MATERIALS AND METHODS

Subjects

A total of 84 registered male youth soccer players participated in the study. Players belonged to the U12 (n = 50) and U14 (n = 34) age groups, which are among the most commonly used categories in youth soccer (6). All players belonged to a local youth soccer club, which was training them under professional coaches.

A post hoc power analysis with $\alpha = 0.05$ was conducted using G*Power 3.1.9.2 to evaluate whether the sample sizes were sufficient to detect significant differences in the study outcomes. Given the inclusion criteria and natural availability of participants at the time of data collection, group sizes were unequal (U12 = 50, U14 = 34), reflecting the actual distribution of players actively registered in the local youth soccer program. Despite this imbalance, post hoc power analysis using the Wilcoxon-Mann-Whitney test (A.R.E. method) indicated acceptable statistical power for both primary outcomes. For flexibility, an effect size of $d = 0.623$ yielded a power of 0.86 (noncentrality parameter $\delta = 2.74$, df = 78.21, one-tailed). For VJ, an effect size of $d = 0.575$ resulted in a power of 0.81 ($\delta = 2.53$, df = 78.21, one-tailed).

Training 3 sessions per week with a training experience of at least 2 years were the inclusion criteria of the study. On the other hand, players who had any musculoskeletal injuries over the last 6 months were excluded from the study.

This study followed a cross-sectional comparative design, with data collected from independent groups of players at a single time point.

Written and verbal information about the study was provided to all players and their families, and written informed consent was obtained prior to participation. The players were aware of the potential risks and benefits of the study. Ethical approval for the current study was given by the Eastern Mediterranean University Health Subcommittee, located in Famagusta, in February 2020 (approval number:2020/0050).

Procedures

Players' assessments were conducted over two consecutive training days, with a minimum 24-hour rest period between them to minimize fatigue and ensure recovery.

Day 1: All demographic and anthropometric data were collected. CA and training age were calculated as the difference between the current date and the player's date of birth or training start date, respectively (5). Body height was measured with a tape measure. Weight, body mass index (BMI) and body composition were measured by using a bioelectrical impedance analysis (Tanita SC 330). Subsequently, players completed flexibility, balance and VJ tests in that order. Prior to testing, all participants were warmed up in the same standardized way: 5-minutes of jogging at their own comfortable pace, at sub-maximal exertion, before 8-minutes of dynamic stretching on their lower extremities (lunging walks, hip circles, leg swings) (32). To minimize fatigue and ensure test reliability, a standardized rest period of 5 minutes was provided between each test. Tests were conducted indoors in the laboratory of the university, which allowed more consistent climate and testing surfaces, in the same order at the same time of day (2:00 PM) to avoid fluctuations in physiological responses due to differences in circadian rhythm.

Day 2: Soccer technical performance test was conducted. The same warm-up protocol from day 1 was repeated. The passing test was performed on an artificial turf soccer pitch, with players first receiving a familiarization trial. Measurements were performed by three physiotherapists and two sports scientists, with standardized verbal encouragement to ensure maximal effort.

Assessments- Physical Fitness Tests

Sit-and-Reach Test (SRT): SRT was used to assess flexibility of lower back and hamstring muscle groups. This test has been validated and demonstrated high reliability when standardized procedures are applied (35). Athletes sat on the floor with their knees straight, legs together, and soles of the feet positioned flat against a SRT standardized box. Once in that position, athletes were requested to extend their arms with palms down and lightly touch the index fingers together. Then, athletes bent forward slowly and reached as far forward as possible while keeping the knees extended. Three attempts were performed and the mean is recorded in cm to reduce variability due to single outlier efforts and increase measurement reliability, as recommended in previous flexibility assessment protocols (36,37).

Static Balance Test: Flamingo Balance Test was used to assess static balance, which reflects the strength and neuromuscular control of the leg, pelvic, and trunk muscle. A balance board with a 50 cm length, 4 cm in height, and 3 cm width was used. Players were asked to stand on the long axis of the board, on their dominant foot, lift the non-dominant leg, and hold it with the hand on the same side. Athletes kept their balance by holding the instructor's hand then the stopwatch started when athletes were ready to maintain their balance on their own. The stopwatch stopped each time the players lost their balance (either by falling off the beam or by moving the held leg). The number of falls within one minute was recorded. If more than 15 falls occurred in the first 30 seconds, the test was over and a score of zero was given (38). The test was performed three times for both the dominant and non-dominant legs to evaluate possible asymmetries in static balance and postural control. The mean number of falls for each leg was calculated and used for further analysis.

Vertical Jump (VJ) test: The standing VJ test was used to evaluate lower-body muscular strength and power, following the protocol described by Salles et al. (39). The test was performed indoors on a flat surface. Athletes stood flat-footed and performed a countermovement jump with arm swing, aiming to achieve the highest possible jump. Each athlete completed three trials with a 60-second rest between repetitions. Jump height was measured using the wall and chalk method, where participants marked the wall at the peak of their jump after applying chalk to their fingertips. The difference between the standing reach height and the jump mark was recorded in cm. The best of the three trials was retained for analysis. To ensure standardization, the same observer gave standardized verbal encouragement during all trials.

Soccer ability skill test: The soccer ability skill test developed by Mor-Christian evaluates technical performance such as passing, dribbling and shooting performance (40). The present study used only the passing component of the test, as it has high test-retest reliability (r=0.96) and acceptable validity (r=0.78) (41). Passing was selected due to its critical role in maintaining possession and organizing team play in soccer (31). The test was conducted on an artificial turf soccer pitch, suitable for the soccer skill evaluation. A goal of 91 cm wide and 46 cm high was made by placing 91 cm apart two cones of 45 cm high. A rope of 1.22 meters was put on the top of the two cones parallel to the ground to form the crossbar of the goal. Three cones were placed at a distance of 14 meters from the goal. The first cone was in the left and made a 45-degree angle with the goal line. The second cone was in the center and made a 90-degree angle with the goal line. The third cone was in the right and made a 45-degree angle with the goal line. The players made 5 passes with the dominant leg from each cones. The first pass from each cone was a trial and was not taken into account. The other 12 passes were taken into account (4 passes from each cone). If the ball passed between the goal posts or touched them, the pass was considered successful. 1 point was given for each successful pass and 0 point was accorded for unsuccessful passes. The highest possible score obtainable from this test was 12 points on condition that all the passes were successful (40).

Statistical analysis

The data obtained in the study were analyzed using the Statistical Package for Social Sciences (SPSS v24.0, IBM, Chicago, IL, USA). Shapiro-Wilk test was used to determine if the data were normally distributed. Non-parametric statistical tests were used for statistical analysis since the entire dataset did not follow a normal distribution. The variables used in the study were presented in numbers, percentages (%), and median and interquartile range (IQR). Comparison of continuous data between groups was analyzed with the Mann-Whitney U test. Statistical significance was accepted at a level of $p<0.05$. The effect size was calculated using the formula $r = z / \sqrt{N}$. Effect sizes were interpreted based on Cohen's criteria as small ($r \approx .10$), moderate ($r \approx .30$), and large ($r \geq .50$) (42).

RESULTS

A total of 84 soccer players participated in the study, including 50 players in the U12 group (59.53%) and 34 players in the U14 group (40.48%). The mean chronological ages of the U12 and U14 groups were 10.46 ± 0.78 and 12.09 ± 0.28 years, respectively, showing a statistically significant difference between the groups ($p < 0.05$). In contrast, the mean training ages were 4.28 ± 2.14 years for U12 players and 5.00 ± 2.55 years for U14 players, with no significant difference observed ($p = 0.15$).

Anthropometric characteristics of adolescent soccer players by soccer age group were presented in Table 1. According to table 1, body weight, height and fat free mass (FFM) were significantly higher in U14 groups compared to the U12 group ($p<0.05$).

However, BMI and Fat percentage values were not significantly different between the groups ($p > 0.05$) (Table 1).

Physical performance parameters of adolescent soccer players by soccer age group were presented in Table 2. The total number of falls in the Flamingo Balance Test (dominant and non-dominant sides) was significantly lower in U14 players compared to U12 players ($p = 0.019$ and $p = 0.013$, respectively). The SRT and VJ test scores were also significantly higher in U14 players ($p = 0.010$ and $p = 0.035$, respectively). Moreover, passing test scores of U14 players were significantly higher than U12 players ($p = 0.03$) (Table 2).

DISCUSSION

The aim of this study was to compare physical fitness and technical performance parameters between U12 and U14 male soccer players with similar training ages. It was hypothesized that U14 players, despite similar training ages, would demonstrate higher functional capacity and technical performance due to physiological and motor development advantages associated with age. The major findings confirmed this assumption: U14 players were found to have

Table 1. Anthropometric Characteristics of Adolescent Soccer Players by Soccer Age Group

	Soccer Age Group	Median	IQR	MR	Z	P* (r)
Body Weight (kg)	U12 (n=50)	35.10	13.50	36.48	-2.743	**0.006 (0.30)**
	U14 (n=34)	41.75	12.53	51.35		
Height (cm)	U12 (n=50)	142.00	13.00	34.97	-3.435	**0.001 (0.37)**
	U14 (n=34)	150.00	9.25	53.57		
BMI (kg/m²)	U12 (n=50)	17.20	3.70	39.50	-1.367	0.172
	U14 (n=34)	19.05	4.70	46.91		
Body Fat (%)	U12 (n=50)	15.40	6.70	43.60	-0.501	0.616
	U14 (n=34)	17.05	9.53	40.88		
FFM (kg)	U12 (n=50)	30.70	8.30	34.83	-3.495	**0.000 (0.38)**
	U14 (n=34)	35.00	7.05	53.78		

**Mann-Whitney U test. IQR: Interquartile range. MR: Mean Rank, r: effect size, BMI: Body Mass Index, FFM: Fat Free Mass*

Table 2. Physical Performance Parameters of Adolescent Soccer Players by Soccer Age Group

	Soccer Age Group	Median	IQR	MR	Z	P* (r)
Total Number of Falls in Flamingo Balance Test (Dominant)	U12 (n=50)	8.00	8.00	47.63	-2.344	**0.019 (0.26)**
	U14 (n=34)	4.00	9.25	34.96		
Total Number of Falls in Flamingo Balance Test (Non-dominant)	U12 (n=50)	9.00	8.50	47.95	-2.490	**0.013 (0.27)**
	U14 (n=34)	6.00	7.25	34.49		
SRT (cm)	U12 (n=50)	-2.00	10.00	36.86	-2.572	**0.010 (0.28)**
	U14 (n=34)	3.33	7.30	50.79		
VJT (cm)	U12 (n=50)	26.00	6.00	37.88	-2.110	**0.035 (0.23)**
	U14 (n=34)	27.00	5.30	49.29		
Mor-Christian Passing Test (#)	U12 (n=50)	5.00	3.00	30.47	-2.164	**0.030 (0.24)**
	U14 (n=34)	7.00	2.00	40.88		

** Mann-Whitney U test, IQR: Interquartile range. MR: Mean Rank, r: effect size, SRT: Sit-and-Reach Test, VJT: Vertical Jump Test* significantly better static balance, flexibility, explosive power, and technical performance than U12 players.This is consistent with previous research showing that the physical and technical qualities of youth athletes appear to improve with age and development (1,4,6,7,11). Understanding these developmental differences is crucial for age-specific training and long-term player development strategies in soccer.

Actions such as quick sprints and high jumps requiring explosive power are important in winning duels within a match (43). VJ is a good functional test for fitness and talent selection (1,44). In the present study, VJ performance of U14 was significantly higher than U12 players' results, which is consistent with previous findings that VJ scores improve with increasing CA in adolescent soccer players (1,21,45). This age-related increase until the age of 18 is often attributed to greater muscle development, particularly in the lower limbs (16). Although muscle mass was not measured directly in the present study, significantly higher FFM, which is frequently used as an indirect indicator of muscle mass (46), was observed in the U14 group. However, training age (13,15) and maturity (6,22) are also highly correlated with explosive power. CA-induced muscle mass increase may affect positively explosive power in the current study. Therefore, we may suggest that explosive power is a biomotor ability affected by multiple factors. Also, practically, the evident improvement in VJ performance might have translated into improved match-related aspects such as quick accelerations and dueling ability in the air, which may favor the on-field performance of the older age group.

Lower limb is used intensively in soccer where hamstring flexibility is vital. Consequently, SRT is widely used in soccer practices (47,48). In boys, lower back flexibility decreases linearly starting from the age of 5 until the age of 12 where it becomes the lowest. Afterwards, it starts to increase until the age of 18 (4). In the current study, flexibility of U14 players was better than U12, which is consistent with this age-related trend. Feldman et al. hypothesized that the decrease of flexibility before puberty was due to environmental factors such as the beginning of primary school, decrease of physical activities, and increase of sitting time (48). While these explanations are rather contextual, their applicability may have limitations for adolescent athletes who are generally trained on a regular basis like those in our sample. According to the training ages reported in the current study, they were homogenous between groups, thus suggesting that training history did not influence flexibility differences. While earlier research has claimed that flexibility may regress as the training age becomes higher (12), the current findings suggest that CA may have a stronger influence on flexibility development, at least within the age range we examined. Furthermore, it is shown that biological maturation has relatively less effect on levels of flexibility during the period of adolescence (26,27). Taken together, the results can be interpreted in a way that improved flexibility in the older group is more so due to physical-dimensional alterations associated with age than training or differences in maturation.

Static, semi-dynamic, and dynamic balances are required to perform well soccer technical performance (29). However, to our knowledge, no study investigated the effect of CA on static postural stability in adolescent soccer players. Only one research investigating the relationship between CA and dynamic balance found no correlation between them in soccer players aged between 11 and 19 (49). According to Wu et al., CA and training age may improve movement control (14). Moreover, postural balance needs a well designed sensori motor system which includes proprioceptive, visual, and vestibular systems. While proprioceptive system reached maturity at 3 to 4 years, visual and vestibular systems reached adult level at 15 to 16 years (50). The development of such systems, with age, would have likely favored postural improvement, although no direct measure of this phenomenon in the present study leaves it an assumption. In our study, training age was comparable between groups, yet static balance was better among the older players. Thus, our findings tentatively suggest that CA might influence static balance, possibly due to the continued maturation of sensory systems involved in postural control. The present study provides preliminary insights wherein very few studies exist and calls for further investigation with direct neurophysiological assessments.

Mor-Christian standardized test battery is a simple, valid and reliable test to evaluate soccer technical performance (40,41). In the present study, passing test scores in U14 soccer players were significantly higher than U12 soccer players. Studies showed that CA and training experience contributed slightly to soccer technical performance in adolescent soccer players (6,32). On the other hand, adiposity and heavier body weight had negative effects on technical performance, while biological maturity appears to have minimal effect (6). According to Meylan et al., chronologically older athletes tend to have more time to develop technical skills and typically possess greater fat-free mass (11). In our study, the training age and body fat percentage of both groups were similar; therefore, we attempted to control for the confounding effects of these factors, although the influence of unmeasured variables cannot be entirely excluded. Based on these findings, we suggest that the CA-related increase in FFM, along with potential developmental motor advantages associated with age, may have contributed positively to soccer technical performance. This highlights the multifactorial nature of technical skill development in youth soccer.

LIMITATIONS

Several limitations should be acknowledged. Biological maturation, which plays a key role as a determining condition for the athletes' physical development during adolescence, has not been assessed but might have influenced group comparisons. Future studies should take on board status of maturation to enhance interpretability. Although the group sizes were fairly close to one another, that slight imbalance may have affected statistical power. Moreover, technical performance was evaluated using only a passing test, which greatly limits one's view regarding the overall technical skill set. This one-dimensionality may compromise the intensity and generalizability of this research's claims regarding technical proficiency.

CONCLUSION

The current study demonstrated that U14 soccer players outperformed their U12 counterparts in several physical and technical domains, despite having similar training experience. These differences seem to be related more to age-related developmental changes instead of just training exposure. While chronological age remains a practical criterion for grouping young athletes, it may not fully capture the nuances of physical and technical development. Therefore, coaches and development programs should consider broadening their indicator systems for talent identification and training design to include biological maturity, anthropometric profiles, and motor performance. Such an individualized approach may assist with fairer competition structures and more effective long-term athlete development.

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