MATURITY-ASSOCIATED VARIATIONS IN ANTHROPOMETRY, PHYSICAL FITNESS, AND SPORT-SPECIFIC SKILLS AMONG YOUNG MALE AND FEMALE FUTSAL PLAYERS

ABSTRACT

Purpose. The aim of this study was to determine the maturity-related variations in anthropometry, physical fitness, and sport-specific skills among young male and female futsal players.

Methods. Overall, 77 athletes (44 boys and 33 girls) aged 10.5–13.7 (12.3 ± 0.9) years were measured for stature, body mass, 2 skinfolds, as well as 3 fitness and 2 sport-specific test items.

Results. Compared with boys, girls were significantly more advanced in maturation and had greater body mass index and body fat percentage. Except for the countermovement jump result, boys outperformed girls in all fitness and sport-skill assessments. Regardless of gender, early maturing players were significantly taller and heavier and had higher body fat percentage and grip strength than their late maturing counterparts. In boys, none of the other physical fitness and sport-specific skill measures significantly differed between contrasting maturity groups. In turn, early maturing girls had significantly better scores in all physical fitness measurements than late maturing girls. Partial correlations, with chronological age controlled as a covariate, indicated moderate to high correlations between the maturation indicator and stature and body mass in both boys and girls. Except for grip strength and dribbling tests for boys and girls, respectively, other physical fitness and sport-specific skill measures did not show a significant correlation with maturity status.

Conclusions. These results highlight that rather than with functional and sport-specific characteristics, physical maturity status may be associated with greater body size in young futsal players.

Key words: biological maturation, functional capacities, futsal, physical growth

Introduction

Biological maturation is defined as the progress towards the biologically mature state [1]. It is a biological process that involves all bodily tissues, organs, and systems [2] and is influenced by various genetic and environmental factors [3]. Timing and tempo are 2 components of maturation [4]. They refer to the time at which specific maturity-associated changes occur and the rate at which biological maturation progresses, respectively [5]. Thus, children of the same chronological age may vary in their maturational status [6, 7].

Earlier studies have documented the maturity-related variations in morphological and functional characteristics of young athletes [8–11]. Additionally, several investigations reported significant associations between maturity status and actual performance such as ranking [12, 13]. Depending on the specific characteristics and requirements of a sport, being late or advanced in maturation may be the key...
factor in the selection and the development of young talented athletes. For instance, in females, while being a late maturer may provide over-representation in gymnastics and figure skating, it may lead to under-representation in tennis and swimming [14].

During the last decades, there has been a growing research interest regarding factors affecting the performance in futsal [15]. In a recent observational study, for example, a relative age effect was reported in a large cohort of Spanish futsal players [16]. Furthermore, other recent studies investigated the sports skills, match activities, and performance variables of both young and professional futsal players [17–19]. However, according to Alvares et al. [20], there is scarce information about the role of puberty in the motor performance of futsal players. Correspondingly, to the best of the authors’ knowledge, there is no previous report on the influences of maturity status on the physical and functional characteristics in young futsal players of both genders. Therefore, the purpose of this cross-sectional study was to examine the maturity-related variations in anthropometry, physical fitness, and sport-specific skills among young futsal players.

**Material and methods**

**Participants**

Overall, 77 (44 boys and 33 girls) young, aged 10.5–13.7 (12.3 ± 0.9) years, futsal players participating in school-based competitions were recruited in the study. They were included in accordance with the following criteria: (i) at least 2 years of experience in futsal training and (ii) at least 3 training sessions per week.

**Measurements**

**Anthropometric measurements**

A portable stadiometer (Seca 213, Hamburg, Germany) was used to measure sitting and standing height to the nearest 0.1 cm. A digital weighing scale was utilized to evaluate the body mass to the nearest 0.1 kg. A calliper (Holtain Ltd, Crymych, UK) served to assess triceps and medial calf skinfolds to the nearest 0.2 mm. Percentage of body fat (BF%) was determined with the equations of Slaughter et al. [21]. The maturity status of the players was estimated by the percentage of predicted adult stature (PAS%) attained at the time of observation [22]. The maturity status of each player was categorized on the basis of their z-score for PAS%. Subsequently, the participants’ maturation was classified as early (z-score > 0.5), on-time (z-score ± 0.5), and late (z-score < 0.5).

**Grip strength**

A digital hand dynamometer (TKK-5401 Grip-D, Takei, Japan) was utilized to measure the grip strength of the players. They were asked to squeeze the dynamometer, adjusted to their hand size, as hard as possible for 3 seconds. The best of the 3 trials was recorded.

**Countermovement jump**

A contact mat (SmartJump, Fusion Sport, Australia) was used to evaluate the vertical jump height. The participants started the test in a standing position. They were asked to keep their hands on the hips. After an immediate downward movement, they performed a take-off to jump the maximal height. The highest value of 2 trials was recorded. The players were instructed for the technical criteria to properly execute the jump. A non-recorded trial was conducted to ensure that the correct movement was performed. The observer provided corrective feedback if necessary.

**505 change of direction test**

The participants were asked to run from a 15-m marker toward a line and through 5-m markers, turn on the line, and run back through the 5-m markers [23, 24]. The time spent in the 10 m was measured by electronic timing gates (Smartspeed, Fusion Sport, Australia). The faster value of 2 trials was noted.

**Ball control**

The ball control test was administered within a 9 × 9 m square. The players were asked to keep the ball in the air without using their hands or arms. The numbers of successful hits were recorded. The counting ended when a player moved out of the square or touched the ball with the hands or arms, or the ball hit the floor [25]. The highest value of 2 trials was recorded.

**Dribbling**

The dribbling skills of the participants were assessed by the slalom dribble test [26]. The test requires a player to navigate a ball around 9 cones (2 m apart) and return to the starting line as fast as possible. The dribbling performances were measured by an elec-
Electronic timing gate (Smartspeed, Fusion Sport, Australia). The better of 2 attempts was recorded.

Statistical analysis

The normality of the data was verified with the Shapiro-Wilk test and the variables of age, PAS%, BF%, handgrip, vertical jump, and agility presented normality problems. Attempts to normalize the data were unsuccessful. In addition, the distribution of participants in maturity groups resulted in a low number of members in each group. Consequently, the choice of tests for inferential analyses considered the presented condition. Gender differences were analysed by means of Mann-Whitney U tests. The Kruskal-Wallis test was used to examine maturity status differences in the study variables of boys and girls separately. Between-group differences were analysed with a pairwise comparison, with the Bonferroni correction for multiple tests, as post-hoc tests. Subsequently, partial correlations, with age control and with 95% bias corrected, and accelerated confidence limits based on 1000 bootstrap samples [27], were performed between the PAS% and the dependent variables. All procedures were carried out by using the SPSS (v. 22.0) software, with a significance level of \( \alpha = 0.05 \).

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the Non-interventional Research Ethics Board of Kirikkale University (No. 2020.06.20).

Results

The descriptive statistics of boys and girls and gender differences are presented in Table 1. Compared with boys, girls were found to be significantly more advanced in maturation and to have greater values of body mass index (BMI) and BF%. In turn, except for the countermovement jump test, boys outperformed girls in terms of all fitness and sport-skill assessments.

The descriptive statistics of boys in different maturity groups and the results of the Kruskal-Wallis test and partial correlations (controlling for chronological age) are given in Table 2. The Kruskal-Wallis test revealed that early maturing boys were significantly older, more advanced in maturation, and taller than their on-time and late maturing counterparts. They had also higher values in body mass and BF%, and greater scores in grip strength than late maturing boys. None of the other physical fitness or sport-specific skill measures differed significantly between contrasting maturity groups. Partial correlation results indicated moderate to high correlations between PAS% and stature, as well as between body mass and grip strength, and a week correlation between PAS% and BF%, variables in which early maturing athletes scored significantly higher than their peers, which suggests a relevant effect of somatic maturation on these variables. Other physical fitness and sport-specific skill measures did not show a significant correlation with PAS%.

Table 1. Descriptive statistics of boys and girls and gender differences

| Variables                  | Boys (n = 44) | Girls (n = 33) | U     | p     |
|----------------------------|--------------|---------------|-------|-------|
| Chronological age (years)  | 12.5 (0.8)   | 12.2 (0.9)    | 584.0 | 0.143 |
| PAS%                       | 84.5 (4.2)   | 86.9 (4.4)    | 485.5 | 0.013 |
| Anthropometry              |              |               |       |       |
| Stature (cm)               | 157.8 (10.6) | 156.5 (9.2)   | 704.5 | 0.825 |
| Body mass (kg)             | 45.4 (9.9)   | 49.0 (10.1)   | 545.5 | 0.063 |
| Body mass index (kg/m²)    | 18.1 (2.4)   | 19.9 (2.9)    | 462.0 | 0.007 |
| Body fat percentage (%)    | 17.5 (1.9)   | 22.7 (5.1)    | 254.5 | 0.001 |
| Fitness                    |              |               |       |       |
| Grip strength (kg)         | 24.0 (6.0)   | 20.4 (4.6)    | 490.5 | 0.015 |
| Vertical jump (cm)         | 25.5 (3.4)   | 25.7 (7.1)    | 685.5 | 0.677 |
| 505 COD (s)                | 3.7 (0.3)    | 3.9 (0.3)     | 372.0 | 0.001 |
| Sports skills              |              |               |       |       |
| Dribbling (s)              | 21.1 (1.4)   | 24.4 (2.5)    | 174.0 | 0.001 |
| Ball control (n)           | 38.0 (9.6)   | 16.1 (6.3)    | 25.0  | 0.001 |

PAS% – percentage of predicted adult stature, COD – change of direction.

Informed consent

Informed consent has been obtained from all individuals included in this study and their parents.
### Table 2. Descriptive statistics of boys by maturity status and the results of Kruskal-Wallis test, post-hoc comparisons, and partial correlations, with 95% bias corrected and accelerated confidence limits based on 1000 bootstrap samples, between maturation and dependent variables, controlling for chronological age

| Dependent variables | Maturity groups | Kruskal-Wallis | Post-hoc comparisons | Correlations: $X_{i}-Y_{i}, X_{i}-Z_{i}, X_{i}-W_{i}$ |
|---------------------|----------------|---------------|----------------------|--------------------------------------------------|
|                     | Early ($n = 15$) | On-time ($n = 16$) | Late ($n = 13$) | Value | $p$ |                     |                      |
| Chronological age (years) | 13.4 (0.3) | 12.5 (0.4) | 11.5 (0.6) | 32.391 | < 0.001 | Early > on-time > late | – |
| PAS%                | 89.1 (1.7) | 84.3 (1.1) | 79.3 (2.1) | 38.367 | < 0.001 | Early > on-time > late | – |
| $Y_{i}$: Anthropometry |                     |               |                    |          |        |                      |                      |
| Stature (cm)       | 168.3 (8.1) | 156.4 (5.3) | 147.6 (6.4) | 26.299 | < 0.001 | Early > on-time > late | 0.833 (0.679; 0.920) |
| Body mass (kg)     | 53.9 (10.9) | 43.6 (5.2) | 37.8 (4.5) | 21.698 | < 0.001 | Early & on-time > late | 0.538 (0.313; 0.695) |
| Body mass index (kg/m²) | 18.9 (2.5) | 17.9 (2.6) | 17.3 (1.7) | 3.428 | 0.180 | – | –0.042 (-0.374; 0.287) |
| Body fat percentage (%) | 18.6 (1.2) | 17.6 (2.1) | 16.2 (2.0) | 8.149 | 0.017 | Early > late | 0.391 (0.059; 0.620) |
| $Z_{i}$: Fitness   |                     |               |                    |          |        |                      |                      |
| Grip strength (kg) | 26.7 (4.5) | 24.0 (6.2) | 20.9 (6.2) | 10.675 | 0.005 | Early > late | 0.533 (0.252; 0.737) |
| Vertical jump (cm) | 25.9 (3.6) | 26.2 (3.3) | 24.0 (3.1) | 2.701 | 0.259 | – | –0.117 (-0.163; 0.415) |
| 505 COD (s)        | 3.5 (0.2) | 3.7 (0.3) | 3.8 (0.4) | 2.874 | 0.144 | – | –0.037 (-0.360; 0.248) |
| $W_{i}$: Sports skills |                     |               |                    |          |        |                      |                      |
| Dribbling (s)      | 20.6 (1.2) | 20.9 (1.2) | 21.9 (1.5) | 5.114 | 0.078 | – | –0.109 (-0.387; 0.148) |
| Ball control (n)   | 38.4 (11.1) | 40.4 (10.2) | 34.6 (5.8) | 1.886 | 0.390 | – | 0.055 (-0.246; 0.342) |

95% CL – BCa (bias-corrected and accelerated) bootstrap 95% confident limits
PAS% – percentage of predicted adult stature, COD – change of direction

### Table 3. Descriptive statistics of girls by maturity status and the results of Kruskal-Wallis test, post-hoc comparisons, and partial correlations, with 95% bias corrected and accelerated confidence limits based on 1000 bootstrap samples, between maturation and dependent variables, controlling for chronological age

| Dependent variables | Maturity groups | Kruskal-Wallis | Post-hoc comparisons | Correlations: $X_{i}-Y_{i}, X_{i}-Z_{i}, X_{i}-W_{i}$ |
|---------------------|----------------|---------------|----------------------|--------------------------------------------------|
|                     | Early ($n = 14$) | On-time ($n = 10$) | Late ($n = 9$) | Value | $p$ |                     |                      |
| Chronological age (years) | 12.9 (0.3) | 12.1 (0.6) | 11.1 (0.4) | 23.165 | < 0.001 | Early > on-time & late | – |
| PAS%                | 90.7 (1.1) | 87.0 (1.5) | 80.8 (2.2) | 28.236 | < 0.001 | Early > on-time & late | – |
| $Y_{i}$: Anthropometry |                     |               |                    |          |        |                      |                      |
| Stature (cm)       | 163.7 (4.4) | 157.3 (4.1) | 144.2 (4.9) | 24.847 | < 0.001 | Early > on-time & late | 0.849 (0.691; 0.936) |
| Body mass (kg)     | 57.7 (5.9) | 46.4 (5.9) | 38.5 (7.1) | 21.117 | < 0.001 | Early > on-time & late | 0.487 (0.197; 0.727) |
| Body mass index (kg/m²) | 21.6 (2.6) | 18.7 (2.3) | 18.5 (2.9) | 8.318 | 0.016 | Early > on-time | 0.140 (-0.198; 0.448) |
| Body fat percentage (%) | 25.6 (5.0) | 21.4 (3.3) | 19.5 (4.8) | 9.318 | 0.009 | Early > late | 0.151 (-0.283; 0.546) |
| $Z_{i}$: Fitness   |                     |               |                    |          |        |                      |                      |
| Grip strength (kg) | 23.4 (2.9) | 20.7 (4.5) | 15.5 (2.4) | 16.297 | < 0.001 | Early & on-time > late | –0.090 (-0.489; 0.310) |
| Vertical jump (cm) | 30.1 (6.7) | 25.0 (6.2) | 19.7 (3.1) | 11.485 | 0.003 | Early > late | –0.024 (-0.307; 0.313) |
| 505 COD (s)        | 3.8 (0.2) | 3.9 (0.3) | 4.2 (0.2) | 13.621 | 0.001 | Early < late | –0.061 (-0.387; 0.239) |
| $W_{i}$: Sports skills |                     |               |                    |          |        |                      |                      |
| Dribbling (s)      | 22.9 (1.9) | 24.5 (2.4) | 26.6 (1.5) | 13.342 | 0.001 | Early < late | –0.327 (-0.554; -0.092) |
| Ball control (n)   | 18.3 (6.3) | 16.1 (6.3) | 12.8 (5.2) | 4.860 | 0.088 | – | 0.039 (-0.324; 0.371) |

95% CL – BCa (bias-corrected and accelerated) bootstrap 95% confident limits
PAS% – percentage of predicted adult stature, COD – change of direction
The descriptive statistics of girls in different maturation groups and the results of the Kruskal-Wallis test and partial correlations (controlling for chronological age) are given in Table 3. The Kruskal-Wallis test showed that early maturing girls had significantly greater values of all anthropometric measures, except for BMI, and exhibited better performances on all fitness tests than late maturing girls. Moreover, they achieved significantly better results in the dribbling skill test than late maturing girls. Furthermore, they were significantly taller, heavier, and had a higher BMI value than on-time maturing girls. There were no significant differences between early and on-time maturing girls in terms of functional or sports skill tests. No significant differences were observed between on-time and late maturing girls in the dribbling test. Early maturing girls were significantly taller, heavier, and had a higher BMI value than on-time maturing girls. There were no significant differences between early and on-time maturing girls in terms of functional or sports skill tests. No significant differences were observed between on-time and late maturing girls in sports skill measures. On-time maturing girls exhibited better performances in grip strength than late maturing girls. However, PAS% correlated significantly only with stature (high positive correlation), body mass (moderate positive correlation), and dribbling (weak negative correlation).

**Discussion**

The aim of the study was to determine the maturity-related variations in morphological characteristics and functional capacities in young male and female futsal players. The results revealed that, regardless of gender, early maturing players were significantly taller and heavier. Supportively, when chronological age was controlled as a covariate, partial correlation results indicated moderate to high correlations between the maturation indicator and stature and body mass in both boys and girls. Similar results were also observed in a non-athletic [28] and athletic [29, 30] population. In addition, findings of previous research conducted in young soccer players showed significantly higher values for anthropometrics among early maturers [31, 32]. The increase in body size during puberty is primarily due to changes in hormonal activity [33].

The results demonstrated that, except for grip strength (moderate correlation) in boys, there were no significant associations between maturity status and physical fitness scores in either male or female players. According to Figueiredo et al. [34], variations in functional capacities of young soccer players may not be explained only by biological maturation but also by such predictors as chronological age, experience, and the test items administered. The result regarding the grip strength is in line with the findings of earlier examinations [35, 36]. Greater values obtained by early maturing boys might be attributed to the level of serum testosterone and the body size [33, 37].

The correlation results indicated, except for the dribbling test (weak correlation) in girls, no significant relationships between maturity status and sport-specific skills in either gender. This result is in line with the findings of the previous studies in young soccer players [31, 32, 38]. As noted by several authors [39–40], in addition to maturity status, other factors such as chronological age, body composition, experience, and regular training also have effects on sport-specific skills.

The results revealed that, compared with boys, girls were significantly more advanced in maturation and had greater BMI and BF% values. Conversely, except for the countermovement jump result, boys outperformed girls in terms of all fitness and sport-skill assessments. In a recent investigation, supportive observations were reported for semiprofessional futsal players [41]. However, the paucity of data on the gender effect in young futsal players prohibits the explanation of this finding. Nevertheless, similar results were noted for young soccer players [42, 43].

**Conclusions**

This study is original in the sense that it provides data on various morphological and performance characteristics for both male and female young futsal players. The results highlight that rather than with functional and sport-specific features, physical maturity status may be associated with greater body size among futsal players aged 10–14. It must be taken into account that the present study is limited with a relatively small sample size. Therefore, it is recommended for future research to extend the observation in a large sample of young futsal players.

**Disclosure statement**

No author has any financial interest or received any financial benefit from this research.

**Conflict of interest**

The authors state no conflict of interest.

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