ANTHROPOLOGICAL CHARACTERISTICS AND BIOLOGICAL AGE IN SOCCER PLAYERS

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Abstract

In order to determine the differences between individual morphological characteristics and motor abilities of 45 U14 soccer players (although all of different biological age), an experiment was conducted with a battery of 10 morphological and 11 motor skills tests. The subjects were divided into two age groups: a younger, pre-U14 age group and the U14 player group. Biological maturity was visually assessed using the maturity stages classification according to the Tanner test. Based on the assessment of biological maturity, the subjects were divided into three groups (pre-puberty, early puberty and mid-puberty). The differences between motor and morphological characteristics of U14 soccer players of different biological age were analyzed using a one-way ANOVA and Fischer LSD post hoc test. Significant differences were found between the subjects of same chronological age, but different biological age, especially in morphology. These results suggest that biological age significantly affects morphological characteristics, which was to be expected considering the age and the sensitive life stage. Maturation has less effect on motor skills because it doesn't depend on biological age as much as it is a result of training and repetition.

Keywords: soccer, morphological characteristics, motor abilities, maturation

Introduction

During a soccer match, soccer players perform a large number of different activities and movements, both with and without the ball, all the while switching between high and low-level intensity activities of undetermined duration and time of occurrence. Because of that, soccer can be described as a complex acyclical interval activity. So, for example, during a soccer match, top soccer players perform, on average, between 1200 and 1400 different changes of activity every 4-6 seconds (Reilly et al., 2000). From the moment they start playing soccer to the time they reach puberty, children undergo balanced growth and development. That period is ideal for acquiring soccer skills, as well as for the development of coordination, speed and balance. In puberty, the child experiences accelerated physical growth and development. The year the child experiences the largest increase in height serves as an indicator of their biological maturity and matches the year the child achieves maximum development of most of its fitness abilities. There is significant variation in the onset of puberty among children of the same chronological age. Therefore, the children who mature earlier (biologically older children) are physically superior to the rest of their peers and have a significantly better chance of being selected for the team. According to a group of authors (Helsen et al, 2005, Vincent and Glamser, 2006), individuals born at the beginning of the year have a better chance at being selected for the team, than those born later that year, because they are physically stronger and more experienced. The authors concluded that relative age has important implications for the selection of younger players. Further on, players of the same chronological age are characterized by individual differences in the stage of maturity, which is connected with the variation in functional capacity of young players and may influence their selection (Malina, Bouchard and Bar-Or, 2004). The result of a wrong selection is the likely loss of a significant number of soccer talents. In order to reduce the influence of biological age on the recognition and selection of talents, it is necessary to direct the efforts of coaches working with lower-age categories towards the building of a player and not towards achieving sports results, systematically evaluate the biological age of children and younger players and make use of fitness tests which are best suited for discerning the successful from the less successful players at a given age. The basic goal of this paper was to determine the differences in morphological features and motor capabilities of U14 players of different biological age.

Method

Participant sample

The participant sample comprises 45 young soccer players, members of the "Jozo Matošić" soccer school from Dubrovnik. They train soccer 4 times a week, and once a week they play a competition match. The participant sample is divided into two subsamples: 20 younger U14 players with an average age of 12.3 years and 25 pre-U14 players with an average age of 10.6 years. Biological maturity was estimated visually by classifying sexual maturity phases according to Tanner. Biological maturity was estimated by a pediatrician. The participants were divided into three groups according to their biological age (pre-puberty – corresponding to Tanner I, early puberty – corresponding to Tanner II, and mid-puberty – corresponding to Tanner III).

Variable sample

The variable sample is composed of 10 tests for the evaluation of anthropometric features, 7 tests for the evaluation of gross motor skills, 3 tests for the evaluation of specific motor skills and one test for the evaluation of functional capabilities. Anthropometric features were evaluated using the following tests: body height (HGT-cm), body weight (WGT-kg), chest circumference (CC-cm), upper-arm circumference (UAC-cm), forearm circumference (FAC-cm), calf circumference (CAC-cm), back skinfold thickness (BSFT-mm), abdominal skinfold thickness (ASFT-mm), upper arm skinfold thickness (UASFT-mm) and calf skinfold thickness (CASFT-mm). Gross motor skills were evaluated using the following tests: 10-meter dash (10 m-s), 20-meter dash (20 m-s), 60-meter dash (60 m-s), standing long jump (SLJ-cm), Sargent jump test (SJT-cm), the 9-3-6-3-9 (s) test and the zig zag test (s). Specific motor skills were evaluated using the following tests: 20-meter dash with a ball (20 m B-s), the 9-3-6-3-9 test with a ball (9-3-6-3-9 B-s) and the zig zag test with a ball (zig zag B-s). Functional capabilities were evaluated using a 1500-meter run test (1500 m-s).

Data processing methodology

After the preliminary processing procedure (arithmetic mean, standard deviation, minimum and maximum measurement values and the Kolmogorov-Smirnov data distribution normality test), issues concerning the goals of determining differences between soccer player groups and subsamples were analyzed with the one-way ANOVA technique and the Fischer LSD *post hoc* test. All analyses were done separately for the two participant age groups, and especially for each of the participant subsamples within the same age group. Statistica for Windows ver. 10.0 was used for data processing.

Results

Table 1 shows differences in morphological variables among soccer players of the same chronological (pre-U14), but of different biological age (pre-puberty, early puberty). It is evident that younger soccer players differ significantly in up to 7 of a total of 10 morphologic variables. They differ the most in body weight, and the least in forearm circumference. Other variables show no statistically significant differences among the observed soccer players.

Table 1. *Analysis of differences in morphological variables among pre-U14 soccer players of different biological age (Mean – arithmetical mean, SD – standard deviation, Range – result range)*

	Pre-puberty (N = 14)		Early puberty (N = 11)	
Variable	**Mean±SD**	**Range**	**Mean±SD**	**Range**
WGT	31.86±4.05	27.00-42.00	40.45±5.89***	33.00-49.00
HGT	140.71±2.95	136.00-145.00	149.82±5.15***	140.00-160.00
BSFT	10.86±3.35	9.00-22.00	12.09±1.81	10.00-14.00
UASFT	12.79±3.19	10.00-22.00	16.00±3.58*	11.00-20.00
CASFT	15.29±2.67	13.00-22.00	17.09±2.30	14.00-20.00
ASFT	11.43±4.36	8.00-26.00	13.73±2.72	10.00-20.00
CC	64.71±3.20	61.00-73.00	68.82±3.76**	63.00-75.00
UAC	19.36±1.69	17.00-23.00	21.18±2.27*	17.00-25.00
FAC	18.50±1.34	17.00-21.00	20.18±2.09*	17.00-24.00
CAC	28.43±1.60	27.00-32.00	30.64±2.69*	26.00-34.00

*p<0.05; **p<0.01; ***p<0.001 – the significance of the differences among soccer players of different biological age

Table 2 shows the analysis of the differences among pre-U14 soccer players (divided into two biological age groups – pre-puberty and early puberty). It is evident that there are no statistically significant differences in motor skills between the observed soccer players of different biological age.

Table 2. *Analysis of differences in motor skill variables among pre-U14 players of different biological age (Mean – arithmetic mean, SD – standard deviation, Range – result range)*

	Pre-puberty (N = 14)		Early puberty (N = 11)	
Variables	**Mean±SD**	**Range**	**Mean±SD**	**Range**
10 m	2.46±0.23	2.20-2.80	2.46±0.14	2.30-2.70
1500 m	468.00±41.22	410.00-536.00	480.00±39.39	433.00-540.00
20 m	4.11±0.21	3.70-4.22	4.22±0.20	3.80-4.50
20 m F	5.01±0.55	4.20-4.93	4.93±0.33	4.50-5.60
60 m	11.24±0.66	10.20-11.63	11.63±0.72	10.30-12.40
9-3-6-3-9	10.77±0.51	9.80-11.40	11.04±0.36	10.50-11.50
9-3-6-3-9 F	13.96±1.11	11.70-15.60	14.06±0.81	12.50-15.20
SLJ	161.93±14.23	144.00-183.00	162.27±10.05	141.00-177.00
SJT	28.29±6.56	21.00-45.00	28.27±3.13	24.00-32.00
ZIG ZAG F	11.82±1.09	9.90-13.90	11.77±1.09	10.40-14.30
ZIG ZAG	8.26±0.43	7.40-9.00	8.33±0.30	7.80-8.80

*p<0.05; **p<0.01; ***p<0.001 – the significance of the differences among soccer players of different biological age

Table 3 shows results of the analysis of differences in morphological variables among soccer players of the same chronological but different biological age. It is evident that the biggest differences are found among younger U14 soccer players in pre-puberty and mid-puberty (in up to 6 out of 10 motor skill variables, with the most in weight, followed by height). The significance of differences among pre-U14 soccer players in pre-puberty and early puberty is evident in weight and chest circumference, while younger U14 soccer players in early puberty and mid-puberty differ significantly only in height.

Table 3. *Analysis of differences in morphological variables among younger U14 players of different biological age (Mean – arithmetic mean, SD – standard deviation, Range – result range)*

	Pre-puberty (N = 7)		Early puberty (N = 6)		Mid-puberty (N = 7)	
Variables	**Mean±SD**	**Range**	**Mean±SD**	**Range**	**Mean±SD**	**Range**
WGT	39.33±7.89†	27.00-50.00	49.50±17.68*	37.00-62.00	52.86±8.19	43.00-66.00
HGT	150.67±8.02†	135.00-158.00	148.50±0.71	148.00-149.00	158.86±6.23¹	151.00-168.00
BSFT	13.50±3.56	10.00-20.00	16.00±7.07	11.00-21.00	15.14±2.48	12.00-18.00
UASFT	16.17±3.66	10.00-20.00	18.00±8.49	12.00-24.00	19.14±1.68	17.00-22.00
CASFT	16.50±2.51	13.00-19.00	19.50±3.54	17.00-22.00	18.00±1.91	15.00-21.00
ASFT	14.50±3.73	10.00-21.00	16.50±6.36	12.00-21.00	15.71±2.29	13.00-19.00
CC	71.33±3.61†	67.00-76.00	80.50±12.02*	72.00-89.00	79.57±6.05	71.00-89.00
UAC	22.00±1.79†	19.00-24.00	24.00±5.66	20.00-28.00	25.57±2.30	22.00-29.00
FAC	21.50±1.38†	20.00-23.00	22.00±4.24	19.00-25.00	24.43±2.37	21.00-28.00
CAC	30.50±0.84†	30.00-32.00	34.00±7.07	29.00-39.00	34.57±2.07	33.00-38.00

*p<0.05 – the significance of the differences among soccer players in pre-puberty and early puberty; ¹p<0.05 – the significance of the differences among soccer players in early puberty and mid-puberty; †p<0.05 – the significance of the differences among soccer players in pre-puberty and mid-puberty

Table 4 shows results of the analysis of differences in motor skill variables among soccer players of the same chronological but different biological age. It is evident that younger U14 players in early and mid-puberty do not significantly statistically differ in any of the 11 motor skill variables. The significance of differences between pre-U14 soccer players in pre-puberty and early puberty are evident in the standing long jump variable, while younger U14 soccer players in pre-puberty and mid-puberty significantly differ also only in the standing long jump.

Table 4. Analysis of the differences in motor skill variables among younger U14 players of different biological age (Mean – arithmetic mean, SD – standard deviation, Range – result range)

	Pre-puberty (N = 7)		Early puberty (N = 6)		Mid-puberty (N = 7)	
Variables	**Mean±SD**	**Range**	**Mean±SD**	**Range**	**Mean±SD**	**Range**
10 m	2.35±0.21	2.20-2.50	2.25±0.18	2.10-2.60	2.27±0.18	2.00-2.50
1500 m	478.50±17.68	466.00-491.00	458.33±41.75	407.00-525.00	455.43±44.	380.00-515.00
20 m	4.05±0.21	3.90-4.20	3.98±0.26	3.60-4.20	3.89±0.18	3.60-4.10
20 m F	4.70±0.28	4.50-4.90	4.33±0.34	4.00-4.80	4.51±0.27	4.10-4.90
60 m	10.15±0.64	9.70-10.60	10.68±0.38	10.30-11.30	12.03±2.75	10.60-18.20
9-3-6-3-9	11.30±0.42	11.00-11.60	10.42±0.78	9.50-11.70	10.56±0.75	9.50-11.40
9-3-6-3-9 F	13.25±0.07	13.20-13.30	13.72±1.81	12.20-17.00	13.77±2.16	11.80-18.40
SLJ	155.50±12.02†	147.00-164.00	179.50±9.59*	171.00-195.00	180.00±19.07	165.00-208.00
SJT	28.50±0.71	28.00-29.00	33.33±4.08	29.00-40.00	30.00±7.02	22.00-42.00
ZIG ZAG F	11.65±1.06	10.90-12.40	11.05±1.53	9.80-13.50	11.23±1.27	10.30-14.00
ZIG ZAG	7.95±0.07	7.90-8.00	7.78±0.35	7.20-8.10	7.81±0.45	7.20-8.50

*$p<0.05$ – the significance of the differences among soccer players in pre-puberty and early puberty; ¹$p<0.05$ – the significance of the differences among soccer players in early puberty and mid-puberty; †$p<0.05$ – the significance of the differences among soccer players in pre-puberty and mid-puberty

Discussion

In general, the average height and weight values of pre-U14 and younger U14 soccer players are within reference limits for their age. However, at a closer glance, the average height and weight values of pre-U14 soccer players in pre-puberty (Tanner I) are significantly higher compared to American reference values (Centers for Disease Control and Prevention, 2000), and are above the 75th percentile line compared to the results of studies done hitherto. The average height and weight of younger U14 soccer players in mid-puberty (Tanner III) are also greater than the American reference values and are over the 75th percentile line (Centers for Disease Control and Prevention, 2000). According to the observation of soccer players in this research, it can be concluded that pre-U14 soccer players in pre-puberty and younger U14 soccer players in mid-puberty "stand out" from the above-mentioned reference values. The reasons for that lie in the fact that there are a considerable number of children who are maturing earlier among the observed soccer players. The analysis of differences in morphological variables among the pre-U14 soccer players of the same chronological but different biological age (pre-puberty, early puberty) showed that soccer players in early puberty have numerically higher values in all parameters compared to soccer players in pre-puberty, which is in line with the results of previous research (Figueredo et al., 2009). These differences are statistically significant in 7 out of a total of 10 morphological variables. Similarly, younger U14 soccer players in mid-puberty (Tanner III) have numerically higher values of measured morphological variables compared to soccer players of the same age group in pre-puberty and early puberty, and similar results were obtained in the study by Figueiredo et al. 2010, and by Malina et al. 2012. Children, and also soccer players, grow continuously until adulthood. However, the growth rate is not always the same. It varies, depending on the level of maturity. After the first 4-6 years of life, the average annual growth stabilizes around 5-7 cm. This period lasts until the onset of puberty. Along with a relatively stable growth, the period between six and roughly twelve years is also characterized by proportional body dimensions and an accelerated development of the nervous system. This period is therefore ideal for learning and perfecting various soccer skills. Onset of puberty is marked by a significantly accelerated growth of body dimensions. The increase of body dimensions is a result, among other things, of bone growth, which can explain the resulting differences. The analysis of differences in motor skill variables shows that there are significant differences among soccer players of the same chronological but different biological age only in subsamples of younger U14 players in the variable used to estimate explosiveness (standing long jump). It is evident that soccer players in early and mid-puberty are significantly better in manifesting explosiveness in comparison to soccer players in pre-puberty, and a 2012 study conducted by Vandendriessche et al. found similar results. During puberty, there are significant changes in body composition, especially in muscle mass and the amount of body fat. The onset of puberty is marked by a significant increase in the secretion of the sex hormone testosterone which stimulates muscle mass development. Rougly at the age of 12 (which corresponds to the age of younger

U14 soccer players) there is exponential growth of muscle mass and decrease in body fat percentage (Marković and Bradić, 2008). The above stated fact corroborates the results. It is well known that speed as a motor skill is composed of more than one relatively independent component. In soccer, however, speed is mostly observed as fast running – sprint speed. Observed thusly, speed has an identical development curve as the speed of movement direction change, or rather agility. The greatest increase in sprint speed and agility is achieved between year 5 and 9. It is assumed that these changes are largely connected with the increase in the frequency of movements. After that, both abilities develop at a somewhat slower pace until about 13-14 years of age. The achieved results were expected, and were similar to the results of former studies (Malina et al., 2000). The changes in body size, composition and functional capacity occur and increase through puberty and maturation (Malina, Bouchard and Bar-Or, 2004). The growth and maturation of young soccer players can influence the selection process. The evaluation of the biological age, or rather the maturity of young soccer players is important to us so that we can determine for each player whether he matures ahead of time, in time or with a delay. That way we can avoid "discarding" talents that mature later. Based on the evaluation of biological maturity, the coach can determine the maturation pace of each player. This information makes it significantly easier to interpret the differences in body build and the level of fitness abilities among peers in a team. What this means, is that the coach can now evaluate whether the physical superiority or inferiority of some players in relation to their peers is an indicator of their potential (talent) or a result of earlier or delayed maturation.

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