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original article

Morphological, maturational, functional and technical profile of young Brazilian soccer players

Perfil morfológico, maturacional, funcional e técnico de jovens futebolistas Brasileiro

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Abstract – The objectives of this study were to describe and compare the anthropometric profile, physical fitness and soccer-specific skills between under-15 and under-17 Brazilian soccer players, as well as to evaluate possible differences in these variables according to biological maturation in the age categories. The sample consisted of 245 male soccer players (under-15: n=161; under-17: n=84). Anthropometric measures included weight, height and skinfolds. Biological maturation was assessed based on pubic hair development. The following tests were used for functional assessment: static and countermovement jump, Yo-Yo intermittent endurance test (level 2), RAST, 5- and 30-meter running speed, and agility T-test. Soccer-specific skills were assessed using three tests: ball control, dribbling, and kick accuracy. Descriptive statistics, t-test and analysis of variance (ANOVA) were used for statistical analysis. The results showed a larger body size (stature and body mass), longer sports experience (years of formal training) and better performance in most of the functional tests for under-17 soccer players compared to under-15 players. There were no significant differences in adiposity or soccer-specific skills between levels of competition. Significant differences as a function of maturation stage were observed in anthropometric and functional variables only in the under-15 category. In conclusion, the under-17 category differs from the under-15 category in terms of anthropometric and physical fitness characteristics. However, no difference was observed in two of the three soccer-specific skills. Physical fitness components and soccer-specific skills were associated with maturity only in the under-15 category.

Key words: Anthropometry; Functional capacity; Specific motor skills; Maturation; Soccer.

Resumo – *Foram objetivos deste estudo caracterizar e comparar o perfil antropométrico, funcional e das habilidades motoras específicas (HME) de jovens futebolistas Brasileiros brasileiros sub-15 e sub-17, assim como verificar possíveis diferenças nas variáveis referenciadas em função da maturação biológica nas categorias etárias. O efetivo da amostra foi constituído por 245 futebolistas do sexo masculino (sub-15, n=161; sub-17, n=84). As medidas antropométricas incluíram a massa corporal, a estatura e as dobras cutâneas. A maturação biológica foi acedida através do desenvolvimento da pilosidade púbica. O desempenho funcional foi realizado através dos testes: salto estático e com contra-movimento, Yo-Yo intermittent endurance test (nível 2), RAST, velocidade de 5 e 30 metros e teste T de agilidade. Nas HME recorreu-se a três testes: controle da bola, condução da bola e precisão de chute. Na análise dos dados para além da estatística descritiva foi utilizado o teste t de medidas independentes e a análise da variância de medidas independentes (ANOVA). Os resultados indicaram que os futebolistas sub-17 são mais altos e pesados e apresentam um desempenho superior na generalidade das provas funcionais. Adiposidade e duas das três HME não mostraram diferenças significativas em função da categoria. Foram observadas diferenças significativas em função do estágio maturacional apenas nos sub-15 em variáveis antropométricas e funcionais. Em conclusão, os futebolistas sub-17 diferem dos sub-15 nas características antropométricas e capacidades funcionais. No entanto as HME parecem não ser sensíveis à influência da idade.*

Palavras-chave: *Antropometria; Capacidade funcional; Futebol; Habilidade motora específica; Maturação.*

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INTRODUCTION

The importance of obtaining precise information about the morphology, biological maturation and functional development of children and young soccer players is documented in the literature. In recent decades, studies have attempted to collect and systematize information in order to characterize and understand the sports training of young soccer players[1-8].

Anthropometric characteristics such as stature, body mass and skinfolds are some of the indicators analyzed and are considered to be important to predict the success of young soccer players[9]. Until 13-14 years of age, the relationship between stature and body mass of soccer players tends to be similar to that observed in the general population. However, after this age until the end of the growth period, body mass seems to surpass stature. In addition, a significant increase in the mesomorph component of the somatotype of young soccer players is observed[4-6].

Maturation status is one of the most important aspects evaluated. The period between 10 and 16 years of age is characterized by variations in the biological maturation of children and young people, which have repercussions on morphology and functional performance[10]. In fact, during puberty, different morphological and physiological transformations improve performance and sports readiness. During this period of growth and development, the performance shown is often limited by the biological maturity status[4,5,8]. Studies indicate that children and young people in an advanced maturation stage tend to show better functional performance than those who are delayed, and are consequently chosen by stakeholders during the process of selection and development of soccer players[3,11].

The evaluation of soccer-specific skills has been an equally important focus of investigation[2]. However, despite the use of different methods and protocols, studies were unable to identify an association between soccer-specific skills and maturation status[2,3,5].

Although an increase in the number of studies on somatic growth, biological maturation and physical fitness of children and young soccer players has been observed in the last decade, these studies were generally conducted in European countries and we found no investigation on Brazilian soccer players published in important international scientific journals. In addition to this gap in the literature, the information available focuses on the age group of 11-14 years[2,4,6] and little is known about soccer players in the final period of puberty and their formal training aimed at high sports performance (14-16 years).

These limitations are incomprehensible when considering that the importance of the Brazilian soccer school has been recognized internationally. According to data from the Brazilian Football Confederation[12], 1,242 and 1,157 players were transferred to 163 different countries in 2007 and 2008, respectively. The continued, regular and large-scale training of players is a phenomenon that requires applied investigation. Data that permit to

improve the training process through a better understanding of the player will provide an adequate framework for long-term training programs.

The objectives of the present cross-sectional study were to describe and compare the morphological, maturation, functional and technical profile of under-15 and under-17 Brazilian soccer players, as well as to evaluate possible differences in these variables according to biological maturation in the age categories.

METHODOLOGICAL PROCEDURES

Sample

In a cross-sectional study, 245 male soccer players from Juiz de For a, Minas Gerais, were selected, including 161 of the under-15 category (14.2 ± 0.5 years) and 84 of the under-17 category (16.1 ± 0.6 years). The study was approved by the Ethics Committee of the Federal University of Juiz de Fora (Universidade Federal de Juiz de Fora) (Permit No. 009/11). The players and their responsible persons signed the free informed consent form.

Assessment instruments

- Anthropometric measures

Stature, body mass and skinfolds (triceps, subscapular, suprailiac, and medial calf) were measured by the same examiner according to the standardizations of Lohman et al.[13]. Body mass was measured with an electronic Filizola scale (model ID-1500) to the nearest 0.1 kg, and stature was measured with a Welmy stadiometer (model W 200/5) to the nearest 0.1 cm. Skinfolds were measured with a Lange caliper to the nearest 0.1 mm.

- Functional characteristics

Lower limb power was evaluated by static (SJ) and countermovement jump (CMJ) according to the protocol of Bosco et al.[14]. Aerobic resistance was determined by the Yo-Yo intermittent endurance test level 2 (YY-IE2) developed by Bangsbo[15]. Relative anaerobic power was evaluated by the RAST test. Speeds was obtained by the 5 and 30 meter running speeds, proposed by Balsom[16], and agility was evaluated by the T test[17].

- Soccer-specific skills

Soccer-specific skills were evaluated using tests proposed by the Portuguese Football Federation[18]. To test ball control, the player was asked to maintain the ball in the air without the use of arms or hands in a space measuring 9 x 9 meters. Performance was evaluated by the number of times the player touched the ball before it fell. In the dribbling test, the player was asked to dribble the ball around 9 cones positioned in a straight line at a distance of 2 meters, from the starting line to the last cone and back. The proposal was to complete the course within the shortest time possible without knocking down the cone. If the cone was knocked down, the player should put it back. The time was recorded with photoelectric cells. Kick accuracy was tested by performing three shots over a period of one minute on a goal measuring

7.32 x 2.44 m (width x height) at a distance of 16.5 m. The goal was divided into nine targets with four elastic bands, two in the vertical direction and two in the horizontal direction. The player should shoot the ball into the highest scoring area, with the central quadrant scoring 6, all lower quadrants scoring 1, and the remaining quadrants scoring 3. Performance was evaluated by the sum of the three shots. The official ball number 5 (pressure of 0.8 bar) of the Minas Gerais Football Federation was used in all tests. Each player performed two trials and the best performance was recorded.

- Sexual maturation

Sexual maturation was evaluated by self-assessment of secondary sex characteristics using the stages of pubic hair development proposed by Tanner[19]. This procedure has been increasingly used by the scientific community to avoid embarrassment of the subject due to the invasion of privacy and has been shown to be a relatively reliable indicator of biological maturation[1,2,4]. The recommendations of Matsudo et al.[20] were followed.

- Time of experience

The soccer players were asked about the number of years of organized and systematic training and their participation in soccer competitions as described by Figueiredo et al.[21].

Procedures for data collection

Data were collected on two days of a week because of the physical effort necessary for the tests. On the first day, stature, body mass, skinfolds, soccer-specific skills, and RAST were determined. The vertical jump, agility and YY-IE2 tests were performed on the second day.

Statistical analysis

Descriptive statistics (mean and standard deviation), t-test for independent samples, and analysis of variance (ANOVA) of independent samples were used for statistical analysis. Multiple comparisons were performed by the Tukey test. A level of significance of 5% was adopted. Data were analyzed using the SPSS 19.0 program.

RESULTS

Analysis of the results according to competitive category is shown in Table 1. In general, significantly higher values were observed for under-17 players when compared to the under-15 category. Under-17 players were taller and heavier, had more years of experience, and presented significantly better functional performance ($p<0.05$).

With respect to soccer-specific skills, under-17 players performed significantly better only in the ball control test ($p<0.05$). No significant differences in skinfold sum, dribbling or kick accuracy were observed between categories ($p>0.05$).

Table 1. Comparison of temporal, anthropometric and functional variables and soccer-specific skills between under-15 and under-17 soccer players.

Variables	Under-15 (n=161)	Under-17 (n=84)	p	η^2
Temporal				
Chronological age	14.2 ± 0.5	16.1 ± 0.6	0.01	0.73
Years of experience	3.4 ± 2.0	5.2 ± 2.7	0.01	0.12
Anthropometric				
Stature (cm)	165.0 ± 8.0	170.9 ± 7.4	0.01	0.11
Body mass (kg)	54.2 ± 9.5	61.7 ± 9.6	0.01	0.11
Skinfold sum (mm)	44.6 ± 19.5	44.4 ± 18.8	0.94	0.00
Functional				
SJ (cm)	26.6 ± 4.5	28.2 ± 4.5	0.01	0.03
CMJ (cm)	30.2 ± 5.1	32.9 ± 5.0	0.01	0.06
V5 m (s)	1.2 ± 0.1	1.1 ± 0.1	0.02	0.04
V30 m (s)	4.9 ± 0.4	4.6 ± 0.4	0.01	0.10
Agility (s)	10.4 ± 0.6	10.10 ± 0.5	0.01	0.05
YY-IE2 (m)	660.9 ± 378.6	819.5 ± 336.4	0.01	0.04
Pot Max Rel (watt/kg)	7.3 ± 1.9	8.68 ± 1.5	0.01	0.11
Soccer-specific skills				
Ball control (No.)	41.9 ± 34.5	51 ± 33.9	0.04	0.02
Dribbling (s)	20.1 ± 2.7	19.6 ± 2.5	0.16	0.01
Accuracy (score)	7.4 ± 3.5	7.7 ± 3.5	0.55	0.0

Values are the mean ± standard deviation. $p<0.05$ indicates a significant difference.
η^2: percentage of variance explained by the age category; SJ: static jump; CMJ: countermovement jump: V5 m: 5-meter running speed; V30 m: 30-meter running speed; YY-IE2: Yo-Yo intermittent endurance test level 2.

Table 2 shows the distribution of the soccer players according to stage of pubic hair development. None of the players was classified as pre-pubertal. A higher frequency of stages 4 and 5 was observed among soccer players of both competitive categories.

Table 2. Distribution of soccer players according to stage of pubic hair development (P).

Age category	P3	P4	P5	Total
Under-15	22	101	38	161
Under-17	---	49	35	84

Table 3 shows the characteristics of under-15 soccer players in different stages of maturation. Significant differences were observed in stature, weight, SJ, 30-meter running speed, and agility. Soccer players classified as stage 3 were shorter and lighter and exhibited lower performance in the SJ, 30-meter running and agility tests compared to players classified as stage 5 ($p\leq0.05$). No significant differences were observed for the other variables.

Table 4 shows the temporal, anthropometric and functional variables and soccer-specific skills of under-17 soccer players according to maturation stage. No significant differences in the variables studied were observed between players in different stages of maturation ($p>0.05$).

Table 3. Comparison of temporal, anthropometric and functional variables and soccer-specific skills between under-15 soccer players in different stages of maturation.

Variables	**P3** (n=32)	**P4** (n=41)	**P5** (n=41)	p	η2
Temporal					
Years of experience	4.3 ± 2.3	3.4 ± 2.2	3.1 ± 1.6	0.15	0.03
Anthropometric					
Stature (cm)	159.1 ± 9.9[a.b]	165.2 ± 7.3	167.9 ± 6.8	0.01	0.19
Body mass (kg)	48.6 ± 8.8[a.b]	54.5 ± 9.1	58.2 ± 12.3	0.02	0.07
Skinfold sum (mm)	43.4 ± 16.3	44.1 ± 20.3	48.7 ± 23.3	0.45	0.01
Functional					
SJ (cm)	24.9 ± 4.5[a.b]	26.4 ± 4.3	27.8 ± 4.5	0.05	0.04
CMJ (cm)	28.3 ± 4.3	30.2 ± 5.0	31.1 ± 5.5	0.11	0.03
V5 m (s)	1.2 ± 0.9	1.2 ± 0.9	1.2 ± 0.1	0.49	0.01
V30 m (s)	5.0 ± 0.5[a.b]	4.8 ± 0.4	4.8 ± 0.3	0.01	0.05
Agility (s)	10.7 ± 0.6[a.b]	10.4 ± 0.6	10.3 ± 0.7	0.03	0.04
YY-IE2 (m)	720.0 ± 469.9	639.0 ± 359.0	682.4 ± 380.5	0.68	0.01
Pot Max Rel (watt/kg)	6.4 ± 1.1	7.3 ± 1.8	7.6 ± 2.7	0.11	0.03
Soccer-specific skills					
Ball control (No.)	43.7 ± 37.8	39.9 ± 33.2	42.6 ± 36.9	0.88	0.00
Dribbling (s)	20.2 ± 3.2	20.2 ± 2.6	19.6 ± 2.7	0.52	0.01
Accuracy (score)	6.9 ± 3.5	7.2 ± 3.4	8.0 ± 3.7	0.47	0.01

Values are the mean ± standard deviation. η^2: η^2: percentage of variance explained by the age category; SJ: static jump; CMJ: countermovement jump: V5 m: 5-meter speed; V30 m: 30-meter speed; YY-IE2: Yo-Yo intermittent endurance test level 2. a: significantly different compared to P4 ($p<0.05$). b: significantly different compared to P5 ($p<0.05$).

Table 4. Comparison of temporal, anthropometric and functional variables and soccer-specific skills between under-17 soccer players in different stages of maturation.

Variables	**P4** (n=41)	**P5** (n=41)	p	η2
Temporal				
Years of experience	5.2 ± 2.5	5.3 ± 3.1	0.87	0.00
Anthropometric				
Stature (cm)	170.1 ± 7.9	172.0 ± 6.2	0.29	0.02
Body mass (kg)	61.9 ± 11.1	62.6 ± 9.6	0.79	0.00
Skinfold sum (mm)	46.5 ± 22.2	44.6 ± 23.6	0.70	0.00
Functional				
SJ (cm)	28.4 ± 5.1	27.8 ± 3.5	0.57	0.00
CMJ (cm)	33.4 ± 5.3	32.1 ± 4.4	0.25	0.02
V5 m (s)	1.7 ± 0.1	1.2 ± 0.1	0.98	0.00
V30 m (s)	4.6 ± 0.4	4.5 ± 0.3	0.40	0.01
Agility (s)	10.1 ± 0.6	10.0 ± 0.5	0.46	0.01
YY-IE2 (m)	817 ± 344	823 ± 331	0.94	0.00
Pot Max Rel (watt/kg)	8.6 ± 1.6	8.7 ± 1.3	0.88	0.00
Soccer-specific skills				
Ball control (No.)	44.9 ± 32.8	60.0 ± 33.7	0.06	0.05
Dribbling (s)	19.9 ± 2.5	18.9 ± 2.4	0.10	0.04
Accuracy (score)	7.9 ± 3.5	7.3 ± 3.6	0.49	0.01

Values are the mean ± standard deviation. η^2: η^2: percentage of variance explained by the age category; SJ: static jump; CMJ: countermovement jump: V5 m: 5-meter speed; V30 m: 30-meter speed; YY-IE2: Yo-Yo intermittent endurance test level 2.

DISCUSSION

The results of the present study show that the mean stature of the under-15 soccer players studied was higher than that observed in a sample of Portuguese soccer players[5], similar to that of French international soccer players[22], and shorter than that of Belgian soccer players[7]. With respect to stature of under-17 soccer players (170.9 cm), taller statures have been reported by Silva et al.[23] in a review of Brazilian soccer players and in studies involving samples from Europe[7] and Asia[24]. The body mass of the under-15 soccer players was similar to that reported for Portugues[21], French[22], and Belgian[7] soccer players. For the under-17 category, the body mass was within the range reported by Silva et al.[23] for that category (60-71 kg). The results agree with those obtained by Malina[11] who suggested that young soccer players tend to present a higher body mass in relation to stature during formal training. Malina et al.[6], Seabra[3], and Figueiredo[4] found the same trend for the under-13, under-15 and under-17 categories.

Comparison of the two competitive categories showed that under-15 players were shorter and lighter than under-17 players. This difference can be explained by the process of growth that occurs during the first two decades of life[25]. No significant differences in skinfold sum were observed between the under-15 and under-17 categories, suggesting that age exerts no influence on this variable.

In the functional tests, some of the results obtained for the two categories differed from those reported in other studies using the same assessment protocols. Belgian[7] and French[22] soccer players presented better performance in the SJ and CMJ tests. However, similar values were reported for Portuguese soccer players[4]. The differences in the results between studies may be due to the different levels of competition of the soccer players studied, since the Belgian and French players were classified as international and national level.

Comparison of functional performance between the categories studied showed lower performance of under-15 players in the SJ and CMJ tests, 5- and 30-meter speed tests, agility test, RAST, and YY-IE2. The differences observed might be associated with auxological parameters since the two age groups studied are in different stages of growth and development.

Roescher et al.[26], monitoring the development of aerobic capacity in 130 soccer players aged 14 to 18 years over a period of 5 years, observed an increase in aerobic capacity with age. An influence of age has also been reported by Vaeyens et. al.[7], Figueiredo et. al.[4,5] and Le Gall et al.[22]. Muscle strength increases linearly with chronological age since the beginning of childhood until approximately 13/14 years, followed by a marked acceleration[25,27]. A significant increase in serum testosterone levels is observed after this period[28]. Peak height velocity is followed by peak strength gains[25]. Displacement speed gradually increases from 5 to 16 years of age. Some factors can favor the performance of this skill during growth: an increase in stride length, improvement of ground-based force production, muscle

strength gain, and neural influence[29]. According to Gallahue and Ozmun[30], agility improves over time. Marked improvement of this skill is observed in boys between 5 and 8 years of age, followed by increases at a lower rate thereafter[10]. Environmental factors (years of experience) that influence the development of the neuromuscular system[10] should also be taken into consideration. In fact, the under-17 players studied here had on average two more years of formal training than the under-15 players.

In contrast to the anthropometric and functional variables, in the soccer-specific skill tests only ball control was sensitive to age differences. In the remaining tests, despite the observation of higher values for under-17 players, the differences were not significant. Studies associating biological maturation, chronological age and soccer-specific skills have reported contradictory results. Figueiredo et al.[5] observed an influence of age on ball control in the under-13 and under-15 categories, whereas Malina et al.[2] found no significant differences in any soccer-specific skill in a similar age group.

With respect to the identification of differences in the variables analyzed as a function of maturation stage, differences in anthropometric and functional indicators were only observed for the under-15 category. In contrast, no influence of biological maturation on soccer-specific skills was observed. This finding might be explained by the fact that players of the under-17 category were only classified as P4 and P5; thus, this category was more homogenous in terms of maturation when compared to the under-15 category. In the latter, in addition to being taller and heavier, players classified as P5 showed better performance in the SJ, 30-meter running and agility tests than those classified as P3. No significant difference was observed between P4 and P5.

According to the literature, advancing maturation is not always associated with better performance. An influence has been reported for body size (stature and body mass), explosive power (SJ)[1,5,7], 30-meter speed[1,7] and agility[7], as observed in the present study for the under-15 category. However, the results obtained for aerobic resistance are contradictory. In contrast to the present study, some reports have shown an influence of maturation on this variable[1,22]. However, it should be remembered that performance is the result of the interaction of different variables. In the study of Malina et al.[1], 50% of the variance in 30-meter speed was explained by body mass and maturation, 41% of the variance in vertical jump by stature and maturation, and 21% of the variance in aerobic performance by the number of years of experience and maturation.

In the two competitive categories, no significant differences in soccer-specific skills were observed between soccer players in different stages of maturation. Similar results have been reported in previous studies[2,4]. The selection of individuals favored by early physical development at the expense of those with normal or late development[3] does not seem to be a matter of concern for the under-17 category. Soccer coaches should be aware of the possible influence of maturation on the performance of under-15

athletes since those in a more advanced stage may present greater somatic dimensions and better functional performance.

On the other hand, it is important that all individuals involved in the process of selection and formal training of young soccer players understand the transient nature of these maturational advantages, without neglecting strategies of sport promotion for those who show a slower growth rhythm characteristic of more biologically delayed young people.

CONCLUSION

Anthropometric and functional characteristics seem to be important factors that differentiate the under-15 and under-17 categories. With respect to soccer-specific skills, only ball control was sensitive to the competitive category. In the under-15 category, soccer players in a more advanced stage of maturation seem to have some advantage in terms of anthropometric and functional variables. Sexual maturation does not seem to significantly influence soccer-specific skills. Technicians involved in the process of selection and formal training of young soccer players need to be aware of these data, particularly the transient nature of the advantages associated with advanced maturation, since no influence of maturity is observed in categories closer to a high level of competition (under-17). Thus, greater care with systematic evaluation is essential in order to maintain the tie with the modality among those whose growth and development times and rhythms are less conducive to immediate success, but could lead to it on a medium-term basis.

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