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Section III – Sports Training

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Relationship Between Tactical Performance, Somatic Maturity and Functional Capabilities in Young Soccer Players

by

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The aim of the study was to investigate the relationship between tactical performance, somatic maturity, and functional capabilities in young soccer players. Study participants were 48 soccer players (14.80 ± 1.5 years) belonging to an extension project at the State University of Maringa - Brazil. Anthropometric measurements of body mass, body height, and sitting height were carried out. The number of years to peak height velocity (PHV) was used as an index of maturation. Evaluations of functional fitness included the following tests: sit-and-reach, Yo-Yo Intermittent Recovery Test Level 1, handgrip test, modified abdominal test, and vertical jumps (Counter Movement Jump and Jump Squat). Tactical performance was assessed through the System of Tactical Assessment in Soccer (FUT-SAT). Multiple Linear Regression models were used to estimate the relative contributions of functional and maturational capacities to tactical performance. The results indicated weak associations between the tactical performance indices and somatic maturity, functional capacity, and anthropometric attributes (r < 0.40). The Yo-Yo Test contributed to 36% of the defensive tactic performance variation in the under 13 category. These results suggest that the level of maturity, growth status, and functional fitness have limited impact on tactical performance of young soccer players.

Key words: *maturation, fitness, sports selection, tactics, team sports.*

Introduction

During adolescence, the interaction between genes, hormones, nutrients, and environmental factors triggers a series of physical and functional alterations in the body. Although all individuals undergo this process, the timing of maturation varies according to each person (Malina et al., 2000). Males who mature in advance of their peers often demonstrate physical and functional advantages compared to their age peers, providing a momentary competitive advantage in activities and sports that demand strength, speed, and power (Alves et al., 2015; Figueiredo et al., 2009).

In invasion sports that require physical contact, such as soccer and rugby, talented yet late maturing athletes are more likely to be excluded or overlooked due to their inherent disadvantages (Coelho-e-Silva et al., 2010; Malina et al., 2000). To achieve excellence in such sports, however, athletes need to demonstrate competence not only in functional-energetic variables, but also tactical, technical, and psychological dimensions (Katis and Kellis, 2009; Unnithan et al., 2012). Although this scenario is known and emphasized by the specialized literature, precocity in morphological growth still provides important advantages to the early maturing male in competitive contexts (Malina et al., 2005).

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The tactical aspects of performance represent a key issue in the process of planning and periodization (Casarin et al., 2011). Few studies have, however, examined the relationship between various phenomena and the tactical behavior of young players, such as the influence of relative age (Costa et al., 2010), impact of different training methodologies (Silva and Greco, 2009), playing surface (Miranda et al., 2013), number of players (Castelão et al., 2014; Silva et al., 2014), and advantage and disadvantage on the scoreboard (Lago-Peñas and Dellal, 2010; Silva et al., 2013), among others.

Although tactical expression is of fundamental importance in team sports games (Garganta, 2001), the literature is unclear whether the level of somatic maturity contributes to better tactical performance. It is known that early maturation is associated with greater height, body mass, strength, and aerobic endurance (Torres-Unda et al., 2013; Valente-dos-Santos et al., 2014) and that specific motor skills together with motor coordination do not suffer influence from maturation (Deprez et al., 2014a; Figueiredo et al., 2011; Malina et al., 2005; Vandendriessche et al., 2012). That said, it remains unclear whether or not players advanced in maturation demonstrate superior tactical awareness or ability.

With this in mind, the purpose of this investigation was to examine the potential impact of maturity, fitness, and anthropometric characteristics on tactical ability in youth soccer players. This information has the potential to help professionals involved in training of young people to understand the influence of maturational timing on tactical behaviors performed by the players, avoiding misleading projections about future talents and unilateral decisions guided only by functional variables.

Methods

Participants

Eighty six players aged from 12 to 17, belonging to the extension project of the State University of Maringa (Brazil), called the Soccer Training Centre (Proc. 8849/2010), were invited to participate in this study. The following inclusion criteria were adopted: (1) participants must have engaged in systematic training in the sport for at least one year; (2) no present muscle or skeletal injuries; (3) participation in regional and/or state competitions; (4) training sessions with frequency of more than three times per week; and (5) provision of the Free and Clarified Consent Term (FCCT) signed by parents or a legal guardian. The final sample consisted of 48 subjects, divided into three groups as follows: 12 players from the U13 category (12.70 ± 0.56 years old), 15 players from the U15 category (14.52 ± 0.49 years old), and 21 players from the U17 category (16.21 ± 0.59 years old). The project was approved by the local Research and Ethics Committee (Opinion 653.698).

Anthropometric measures

Anthropometric measurements of body mass, body height, and sitting height were performed using a calibrated digital scale, with a maximum load of 180 kg and precision of 0.1 kg, and a wooden® stadiometer with accuracy of 0.1 cm. Leg length was calculated by subtracting sitting height from body height (Guedes and Guedes, 2006).

Somatic Maturity

As a relative indicator of somatic maturity, the age of peak height velocity (PHV) was used. This age represents the period at which maximum growth in height is achieved during adolescence. To evaluate young people, Mirwald et al. (2002) proposed an equation that allowed estimation of the distance in years which the individual was from PHV. This method serves as a non-invasive technique of prediction that considers the interactions between leg length, age, body mass, and height measurements.

Functional capabilities

The Yo-Yo Intermittent Recovery Test level 1 was used to estimate aerobic performance of the young players. The aim of the test was to perform 20 m sprints at a pre-established cadence provided by an audio beep, with a 10 s rest for every 40 m run and speed increments every interval (Krustrup et al., 2003). The test objective was to continue as far as possible, until the player could not maintain the speed required by the test stage. The final score was expressed as the maximum distance in meters that the evaluated player ran (Deprez et al., 2014b; Franchini et al., 2014).

To evaluate muscular strength of the upper limbs, the handgrip test was performed using a Takei Kiki Kogyo® Tk 1201 dynamometer. For this assessment, the athlete stood with elbows

and arms straight alongside the body without moving the arms. Three repetitions for each hand were executed, with a 1 min rest interval between repetitions, with the aim of achieving the best possible grip. The greatest value of hand prehension was measured on the dominant side (Eurofit, 1988).

Muscle power of the lower limbs was estimated based on two vertical jumps: Squat Jump (SJ) and Counter-Movement Jump (CMJ) (Bosco et al., 1983). The evaluations were performed on a jumping platform, EMG System Brasil®. Each jump was executed three times, with the best result taken for further analysis. The distance in height reached in the jump was estimated based on the equation proposed by Bosco et al. (1995). To evaluate muscular strength/endurance of the abdominal region, a modified abdominal test was used. The participants were instructed to perform the highest number of abdominal crunches in one minute (Guedes and Guedes, 2006).

The sit-and-reach test was used to estimate the flexibility of the lumbar spine and the posterior part of the thigh. For the test, the participant sat in front of the apparatus with the plantar region of the feet against the end border, with knees extended. Subsequently, the participant flexed the spine with the palms down along the measurement scale of the test apparatus. This procedure was repeated three times, with the greatest distance registered for further analysis (Wells and Dillon, 1952).

Tactical Performance Indexes

Tactical performance of players was assessed using the System of Tactical Assessment in Soccer (FUT-SAT), developed and validated by Costa et al. (2011b) to be used specifically for soccer during the phases of sports training. The purpose of the test is to evaluate the management of game space, taking into consideration tactical behaviour in relation to the ball, teammates and opponents (Costa et al., 2011a, 2011b). Ten core tactical principles were assessed: five offensive core principles (penetration, offensive coverage, width and length, depth mobility, and offensive unity) and five defensive core principles (delay, defensive coverage, balance, concentration, and defensive unit). After that, the offensive (OTPI), defensive (DTPI), and game tactical performance indexes (GTPI) were estimated through 3689 tactical actions, considering the principle executed, spatial location, and result of the action. The indexes were obtained through the following equation:

IPT = ∑tactical actions (Realization of the principle x Quality of the action x Action location x Action result)/number of tactical actions

The players were recorded with a digital camcorder Samsung® HMX-F80 in the GR3-3GR test (Costa et al., 2009). Soccer Analyser® software was used to analyze the videos. This software was built specifically to assist in FUT-SAT analysis; it inserts spatial references in the video enabling accurate assessment of the position and movement of players on the field.

Quality control of data

Fourteen subjects were randomly selected for re-testing seven days after the first collection to assess intra-rater reproducibility of anthropometric variable measurements. According to the criteria proposed by Perini et al. (2005), the following technical errors of measurement were found for anthropometric variables: body mass: 0.80%, body height: 0.27%, and sitting height: 0.89%. Regarding the Tactical Performance Index, 10% of the actions were re-evaluated by two researchers, trained and qualified to use the FUT-SAT. The reliability of assessments of tactical behavior was evaluated using the Cohen's Kappa test, obtaining agreement above 81% in all cases.

Statistical analysis

The SPSS 20.0 statistical package was used to perform the statistical tests. To analyze the normality of the data the Shapiro-Wilk test was used. In cases of non-parametric distribution, data were adjusted by a logarithmic equation. Once normality was achieved, the Levene's test was used to assess the homogeneity of variance, followed by One-Way ANOVA with Bonferroni post-hoc analyses to make comparisons between U13, U15, and U17 groups. The Pearson correlation coefficient was used to determine the relationships between anthropometric, maturational, and tactical variables. To assess the relative contributions of indicators of physical growth and functional capacities to tactical performance, we used Multiple Linear Regression models. The Stepwise method was used for the selection of predictor variables, adopting the cutoff points established in the literature (Maroco,

2014) as the criterion for removal ($p > 0.10$). The level of significance was set at $p \leq 0.05$.

Results

Table 1 shows the mean values and standard deviation of anthropometric, functional, and tactical performance variables between U13, U15, and U17 groups. As expected, players in the U17 age group presented higher values for body mass, body height, and sitting height compared to the other groups ($p < 0.001$).

Flexibility of the lumbar spine and back of the thigh was lower in the U13 compared to U17 group ($p < 0.05$). Muscle strength of upper ($p < 0.001$) and lower limbs ($p = 0.002$), as well as aerobic endurance evaluated by the Yo-Yo Intermittent Recovery Test Level 1 significantly increased across the age groups ($p < 0.001$). Contrary to expectations, offensive tactical and game performance assessments did not differ across the age groups.

Table 1

Comparison of anthropometric variables and functional and tactical performance by competitive age groups

Variables	U-13 (n = 12)	U-15 (n = 15)	U-17 (n = 21)	F	*p*
	X ± SD	X ± SD	X ± SD		
Age (years)	12.70 ± 0.56	14.52 ± 0.49[a]	16.21 ± 0.59[ab]	156.05	< 0.001
PHV (years)	-1.02 ± 0.96	-0.02 ± 0.71[a]	1.88 ± 0.66[ab]	61.86	0.020
Training experience (months)	46.91 ± 32.24	54.98 ± 24.31[a]	89.23 ± 28.69[ab]	10.78	< 0.001
Body mass (kg)	44.90 ± 8.02	50.46 ± 7.05	62.73 ± 8.78[ab]	21.17	< 0.001
Body height (cm)	155.77 ± 7.68	163.40 ± 5.86[a]	170.15 ± 7.26[ab]	16.47	< 0.001
Sitting height (cm)	79.76 ± 5.38	84.17 ± 2.99[a]	89.96 ± 4.03[ab]	24.48	< 0.001
SR (cm)	25.29 ± 6.80	29.57 ± 6.97	33.63 ± 5.15[a]	7.08	0.002
ULS (Kgf)	12.62 ± 4.89	18.30 ± 3.77[a]	29.28 ± 5.80[ab]	46.89	< 0.001
CMJ (cm)*	22.62 ± 5.86	27.80 ± 4.74[a]	27.90 ± 2.84[a]	6.51	0.002
SJ (cm)	21.84 ± 5.78	27.82 ± 4.75[a]	28.38 ± 4.92[a]	6.94	0.002
Yo-Yo Test (m)*	333.33 ± 99.93	469.33 ± 140.58[a]	820.95 ± 281.88[ab]	24.24	< 0.001
Abdominal (rep)	45.08 ± 7.46	46.66 ± 7.37	51.47 ± 5.48[a]	4.28	0.020
OTPI	44.20 ± 7.09	42.13 ± 5.05	47.33 ± 9.84	1.93	0.156
DTPI	32.36 ± 4.41	34.19 ± 4.76	28.82 ± 5.11[b]	5.70	0.006
GTPI	35.99 ± 3.69	35.84 ± 2.99	34.34 ± 3.45	1.27	0.289

**Transformed data Log[10]. SR = Sit-and-reach; ULS = Upper limb strength; CMJ = Counter Movement Jump; SJ = Squat Jump; Yo-Yo Test = Yo-Yo Intermittent Recovery Test level 1. DTPI = Defensive Tactical Performance Index; OTPI = Offensive Tactical Performance Index; GTPI = Game Tactical Performance Index. [a]Significant difference for U13; [b]Significant difference for U15.*

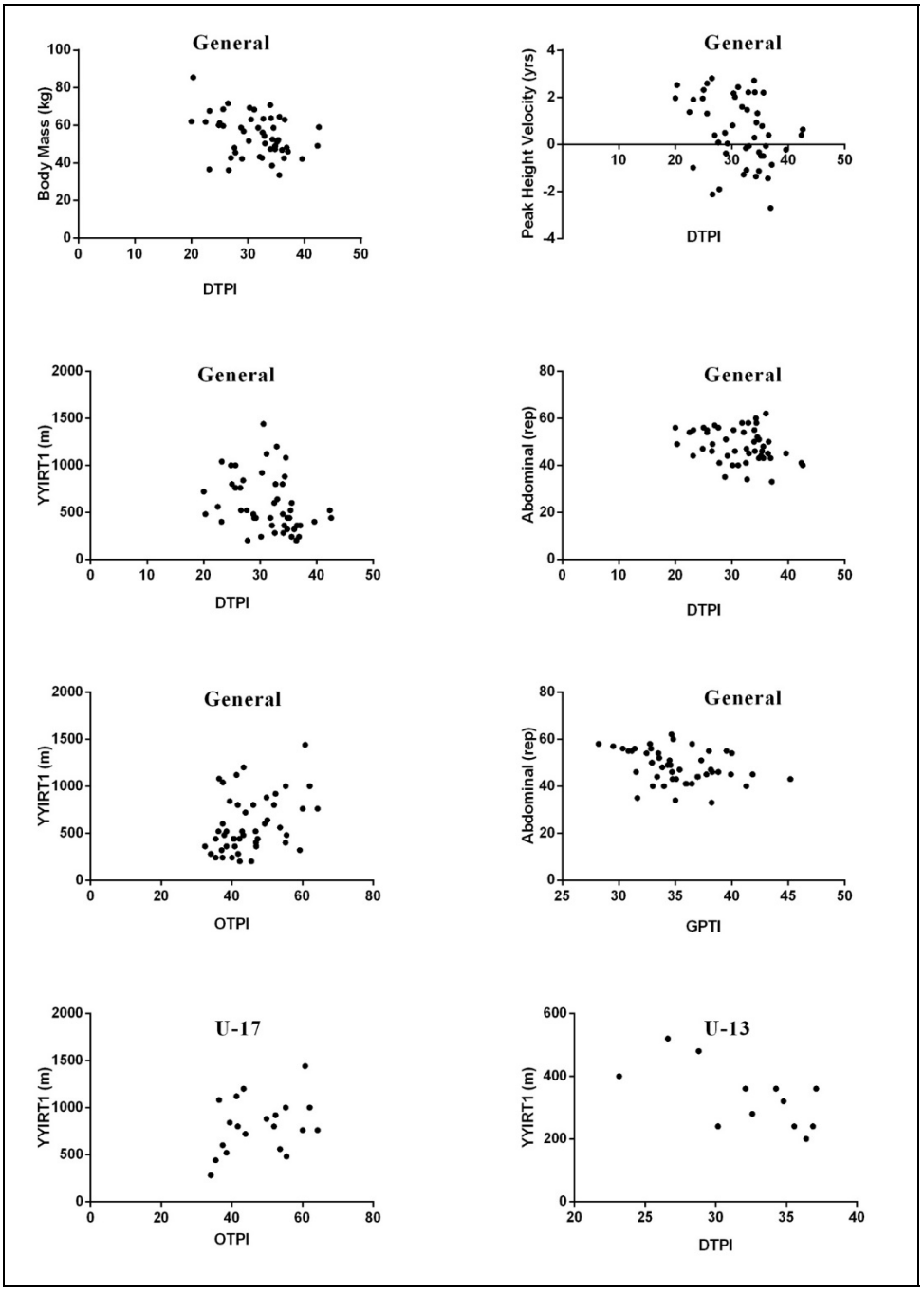

Figure 1

Correlation between the tactical performance indices and anthropometric and functional variables of young soccer players.

Table 2

Predictor variables of offensive and defensive tactical performance indices of young soccer players.

Dependent Variable	Category	Independent Variable	β	*p*	R^2 adjusted	*p*
DTPI	General	Yo-Yo Test*	-0.51	0.001	0.20	0.002
		CMJ*	0.40	0.008		
DTPI	General	Yo-Yo Test*	-0.46	0.002	0.27	0.001
		CMJ*	0.46	0.002		
		Abdominal	-0.29	0.030		
DTPI	General	Yo-Yo Test*	-0.31	0.040	0.33	0.001
		CMJ*	0.50	0.001		
		Abdominal	-0.33	0.011		
		Body Mass	-0.31	0.027		
OTPI	General	Yo-Yo Test*	0.50	0.001	0.21	0.002
		SJ	-0.34	0.017		
GPTI	General	Abdominal	-0.39	0.051	0.18	0.004
		LL	-0.31	0.020		
DTPI	U-13	Yo-Yo Test	-0.64	0.023	0.36	0.023
DTPI	U-15	Training time	0.49	0.050	0.19	0.050

**Transformed data Log^{10}; Note: DTPI = Defensive Tactical Performance Index; OTPI = Offensive Tactical Performance Index; GTPI = Game Tactical Performance Index; LL = leg length; CMJ = Counter Movement Jump; SJ = Squat Jump; $p \leq 0.05$.*

Correlations between the offensive, defensive and game tactical performance indices with the anthropometric, maturational, and functional capability variables are presented in Figure 1. Weak associations were observed between general OTPI and the Yo-Yo Test (r = 0.37) and between the general DTPI and body mass (r = -0.32), distance to the PHV (r = -0.28), the Yo-Yo Test (r = -0.33), as well as abdominal strength (r = -0.28). Although a number of correlations was statistically significant ($p < 0.05$), the magnitude of these associations varied from weak to moderate (Maroco, 2009), indicating relatively low correlations between tactical qualities, somatic maturity level, and functional capabilities.

Results of the regression analysis suggested that a number of factors contributed to variance in tactical performance. For example, the Yo-Yo test explained 36% ($p = 0.023$) of the variance in DTPI in the U13 category, whereas the Yo-Yo test, Counter Movement Jump, abdominal strength, and body mass, together explained 33% ($p = 0.001$) of the variance in defensive tactical performance of the young players (Table 2).

Defensive tactical performance in the U15 category was positively predicted by the individual's time spent training the sport.

Discussion

The aim of this study was to investigate the relationships between tactical performance, somatic maturity, and anthropometric and functional characteristics in young soccer players. The variables of interest generally demonstrated weak to moderate associations with various

indices of tactical performance.

As expected, anthropometric characteristics increased across the age groups, as did the performance in functional capabilities. Deprez et al. (2014a) evaluated the anthropometric and functional profile of 744 elite young soccer players between 8 and 18 years old in Belgium. An increase in anthropometric and functional measurements was observed as age increased. It has been verified that between the U9 and U15 categories, selection processes focus primarily on anthropometric characteristics of the goalkeepers and specific motor skills for midfield players. After the peak growth rate (U17 and U19), anaerobic performance becomes an important indicator to distinguish attackers from other positions.

In the present study the tactical dimension indices demonstrated low correlation with the level of maturity in young soccer players, suggesting a limited impact of maturation on these performance indicators. Few studies in the literature have set out to investigate the implications of energy-functional and anthropometric variables on tactical performance, making it difficult to compare these findings with previous ones. That said, research examining the impact of maturation on soccer skills has generally found weaker associations than observed between maturation and functional fitness (Malina et al., 2005). Aiming to understand if physical and anthropometric advantages derived from the relative age effect (RAE) influence the tactical defensive performance of young athletes, Cardoso et al. (2012) analyzed 684 tactical actions of 24 Brazilian players of the U12 category. The results also showed that there were no significant differences between tactical performance and the quartiles of birth, indicating that RAE advantages were not observed in tactical aspects.

In a similar study, Costa et al. (2010) analyzed the influence of the RAE on the tactical performance of 534 young Portuguese players. The authors verified that tactical performance did not suffer influence from birth quartiles, suggesting a limited impact of age and/or maturation. Collectively, these results and the results of the current study suggest that tactical aspects are not influenced by the effects of relative age, or physical and/or anthropometric variables.

Aerobic endurance, assessed by the Yo-Yo Intermittent Recovery Test Level 1 was shown to be a predictor of defensive tactical performance in the U13 category, and explained 36% of the variance in the DTPI. The soccer defensive principles require constant movements of the player in the game space to regain ball possession. It is possible that the aerobic metabolism contributes significantly to supplying the energy demands of these movements, where players with superior cardiorespiratory fitness are able to advance to the opponent's field to attack and/or return to cover and defend their zone more effectively (Santos and Soares, 2001).

In the U15 category, training experience explained 19% of the variance in defensive tactical performance. Figueiredo et al. (2011), analyzing predictors of functional capabilities and specific motor skills in 143 young Portuguese soccer players, concluded that training experience influenced passing accuracy ($R2 = 0.17$) and dribbling ability ($R2 = 0.21$). Together, these findings and the results of the present study demonstrate the importance of training experience in technical and tactical development in youth soccer.

Collectively, the Yo-Yo test, the Counter Movement Jump, abdominal strength, and body mass predicted 33% of the variance in defensive tactical performance of 12-17 year-old soccer players. It is possible that the strongest players were encouraged by coaches to adopt more defensive roles and tactics, as greater body size and physical strength contribute to an advantage in the defensive system, since invasion sports are characterized by intense physical contact (Costa et al., 2010). Consistent with this finding, Deprez et al. (2014a) reported that U15 and U17 defenders were taller and heavier than midfielders and attackers, suggesting prevalence of taller, stronger players, more advanced in the maturational process.

The greater contribution of physical attributes compared to technical and tactical qualities should be cause for concern, since maturational precocity triggers momentary competitive advantage owing to physical performance. However, these advantages may not be accompanied by enhanced tactical and technical performance; maturity was generally unrelated to tactical performance in the current

study. Gouveia et al. (2015) showed that maturational development influenced anthropometrical and functional capabilities, yet biological maturation did not seem to distinguish between in young soccer players considering specific technical tasks.

As a practical application of these results, it is suggested that clubs and federations avoid selecting players guided by unilateral criteria favoring only physical and morphological advantages (Vandendriessche et al., 2012). Tactical, technical, and psychological qualities together with functional capabilities manifest themselves in symbiosis during the game and should be seen in that way during selection, detection, and sporting formation processes (Jones and Drust, 2007).

A possible limitation of the study was the adoption of a cross-sectional design to the detriment of the longitudinal section, which limits understanding of the variables during the maturational process. A further limitation of the study was the use of the Mirwald method as an index of maturation. Recent research suggests that this method is less reliable in younger and older athletes, and in particular those who are advanced or delayed in maturation (Malina and Slawomir, 2014). In support of this contention, the mean age of PHV in the current study was considerably higher than would be expected in the normal population (i.e., 13.8 years). Future research should seek to employ more accurate measures of maturation. However, this study may contribute to future research involving the underlying processes in the development of young soccer players, aiming to optimize this complex process.

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