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The role of somatic maturation in the tactical effectiveness, efficiency and variability of young soccer players

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ABSTRACT

The purpose of this study was to compare the tactical behaviours of soccer players who differed in their temporal distances from their respective peak height velocity (PHV). Seventy-eight soccer players (age = 14.1 ± 1.4 years, height = 163.2 ± 11.6 cm, weight = 52.5 ± 11.9 kg) participated in the study. Temporal distances from PHV were found using chronological age and anthropometric variables: height (cm), body mass (kg), sitting height (cm) and leg length (cm). Thus, sample was stratified into three groups: Pre-PHV, PHV and Post-PHV. Individual tactical behaviour was assessed using the System of Tactical Assessment (FUT-SAT). One-way ANOVA and Tukey's test were used to examine group differences in tactical behaviour and performance (level of significance of 5%). Hierarchical cluster analysis was used to verify the tactical variability. There was no difference in the tactical performance between groups ($F_{2,75}$ = 1.1; p = .75; ηp^2 = .05); players who belonged to Post-PHV were more effective in their execution of penetrations than players who belonged to Pre-PHV ($F_{2,56}$ = 5.0; p = .01; ηp^2 = .94); however, Pre-PHV group had more tactical variability. The somatic maturation affected the behaviour and tactical variability but did not affect the tactical performance.

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Decision-making; motor behaviour; organismic constraint; talent identification

1. Introduction

There are three categories of constraints acts the human movement: environment, task and organismic. Organismic constraints are intrinsic to the organism, that is, to the individual (Newell, 1986). Biological maturation can be considered an organismic constraint, and it is the process in which the tissues, organs and systems of the human body change itself to reach adulthood (Malina, 2014; Malina et al., 2015). The maturational level can be identified through somatic maturation that refers to the difference between one's chronological age and the age of peak height velocity (PHV) (Bacil et al., 2015; Mirwald et al., 2002).

Biological maturation makes the human body producing more testosterone, which changes anthropometric characteristics influencing neuromuscular abilities, it can be an advantage in athletic performance (Moreira et al., 2017). As soccer competitions are organised based on the chronological age, it is not rare to find

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young players whose chronological ages are very different from their biological ages. Therefore, there may be individual differences in functional characteristics due to biological maturation (Malina, 2014; Malina et al., 2015; Mirwald et al., 2002).

As the physical attributes of soccer players play an important role in the selection process (Dodd & Newans, 2018), biological maturation is a factor that could be construed as discriminatory and subjective. Indeed, biologically mature soccer players may be favoured during the selection process because they have better physical performance; indeed, they tend to be stronger (Bidaurrazaga-Letona et al., 2019a; Borges et al., 2017), faster (Brownstein et al., 2018; Kuranth et al., 2017), more agile (Kuranth et al., 2017), and more resistant, and more engaged in aerobic (Bidaurrazaga-Letona et al., 2019a; Borges et al., 2017) and anaerobic (Valente-dos-Santos et al., 2012a).

In this sense, a higher number of biologically mature players among new teams of boys than among those who were already a part of the Under (U)-15 team (Bidaurrazaga-Letona et al., 2019a). Besides that, in U-17 soccer team, players who were selected at an earlier time in the season were taller, had more lean mass and had attained PHV at an earlier age than players who had been discharged from the club (Aquino et al., 2017). This finding supports the premise that soccer coaches implicitly associate sports talent with the player's body size (Furley & Memmert, 2016; Peña-González et al., 2018). Consequently, the process of training, identifying and selecting players may be biased in favour of biologically mature players and may fail to accommodate players who require more time to achieve the corresponding stage of development.

For example, players who matured at an early age were better performance on tests of technical skills (e.g., ball control, dribbling, passing, kicking and tackling) than among those who matured at a later age (Aquino et al., 2017; Malina et al., 2005; Moreira et al., 2017). However, when biological maturation was controlled for, the development of ball skills evolved with the advancement of chronological age (Valente-dos-Santos et al., 2012b). It should be noted that, in these studies, assessment procedures did not simulate game situations and may result in misinterpretations of a player's on-field performance.

Researches that have focused on small-sided games have found no association between biological maturation and ball skills (Silva et al., 2011) or tactical performance (Borges et al., 2018). On the other hand, Borges et al. (2017) found that players who had already attained PHV made more ball progressions and created more passes lines than players who were yet to attain PHV. Thus, it seems clear that the effect of biological maturation on the prevailing tactical aspects of soccer is still not well established.

Therefore, it is unknown whether the tactical behaviours that are required to solve the problems of the soccer differ between players who mature at a later age and those who mature at an earlier age. Thus, the aim of this study was to compare the tactical behaviours of soccer players who differed in their temporal distances from their respective PHVs (i.e. in years). Our hypothesis that somatic maturation will not affect individual tactical effectiveness but will affect efficiency and tactical variability.

2. Method

2.1. Participants

Participants were seventy-eight male soccer players who were between the ages of 11 and 17 years (age = 14.1 ± 1.4 years, height = 163.2 ± 11.6 cm, weight = 52.5 ± 11.9 kg). They were athletes who belonged to clubs that had competed in the U-13, U-15 and U-17 State Championships, regularly participated in the training and official games, were assessed in their respective training environments. Their parents and/or legal guardians read and signed the consent form.

The participants should be soccer players associated to the soccer clubs of the local federation (inclusion criteria), and they would be excluded from the research if they had an injury during the tactical assessment in the small-sided games (exclusion criteria). However, there were no soccer players excluded from the sample. The research project was approved by the ethics committee in research with human beings. All procedures complied with the guidelines of the resolution of the Declaration of Helsinki.

2.2. Experimental design

2.2.1. Identification of the somatic maturation

Maturational level of the players was assessed in terms of their temporal distances in years from PHV. In addition to chronological age, this method considers the following anthropometric variables: height (cm), body mass (kg), sitting height (cm) and leg length (cm). A vertical stadiometer (length: 210 cm, precision: .1 cm), a digital scale (range of calibration and gradation: 0–150 kg, precision: .1 kg) and a tape measure (150 cm, precision of .1 cm) (Welmy brand, São Paulo, Brazil) were used to measure the anthropometric variables.

In order to generate a coefficient that represents the temporal distance of players from their respective PHVs was used the following equation (Mirwald et al., 2002): −9.236 + 0.0002708 (leg length x sitting height) – 0.001663 (chronological age x leg length) + 0.007216 (chronological age x sitting height) + 0.02292 (body mass/height). Thus, participants were stratified into three groups: Pre-PHV (i.e. who did not reach PHV; coefficients < −.5), PHV (i.e. who were reaching PHV; coefficients between −.5 and .5) and Post-PHV (i.e. who had already reached PVC; coefficients > .5) (see Table 1).

2.2.2. Tactical assessment

Individual tactical behaviour was assessed using the System of Tactical Assessment in Soccer (FUT-SAT) (Costa et al., 2011) (see Figure 1) through identification of 10 fundamental tactical principles (Costa et al., 2009) (Table 2). The video recordings of soccer players' tactical behaviours were analysed by an analyst who was unaware of the participants' maturational levels.

Were obtained the following tactical indicators: number of tactical actions that are performed, percentage of successful tactical actions and the tactical performance index. The number of tactical actions and the percentage of successful tactical actions are variables that indicate the level of tactical efficiency. On the other hand, the tactical performance index is related to tactical effectiveness. The tactical performance index, which can range from 0 to 100 points, can be calculated by computing the aforementioned data using the

Table 1. Characterisation of the sample per group from the maturational level identified by temporal distances from PHV (i.e. in years). Mean ± standard deviation (95% confidence interval) of chronological age, height, body mass, sitting height, leg length and distance of PHV.

	Pre-PHV (n = 45)	PHV (n = 23)	Post-PHV (n = 10)	p	$\eta 2$
Chronological age (years)	13.2 ± 1.1 (12.9 to 13.6)	15.0 ± .8* (14.6 to 15.3)	15.7 ± .8* (15.1 to 16.3)	<.01	.94
Height (cm)	156.1 ± 9.5 (153.2 to 158.9)	170.6 ± 6.5* (167.8 to 173.4)	175.8 ± 3.2* (173.5 to 178.0)	<.01	.80
Body mass (kg)	45.7 ± 9.9 (42.8 to 48.7)	59.4 ± 6.4* (56.7 to 62.2)	66.6 ± 7.3* (61.3 to 71.8)	<.01	.71
Sitting height (cm)	78.9 ± 4.9 (77.4 to 80.3)	86.9 ± 3.3* (85.5 to 88.3)	90.8 ± 1.9*† (89.5 to 92.1)	<.01	.79
Leg lenght (cm)	84.6 ± 8.2 (82.1 to 87.1)	86.0 ± 6.0 (83.4 to 88.6)	91.1 ± 6.6* (86.4 to 95.8)	.05	.31
PHV (years)	−1.7 ± .9 (−2.0 to −1.4)	.0 ± .3* (−.1 to.2)	1.0 ± .3* (.7 to 1.2)	<.01	.96

*p < .05 in relation to Pre-PHV; †p < .05 in relation to PHV.

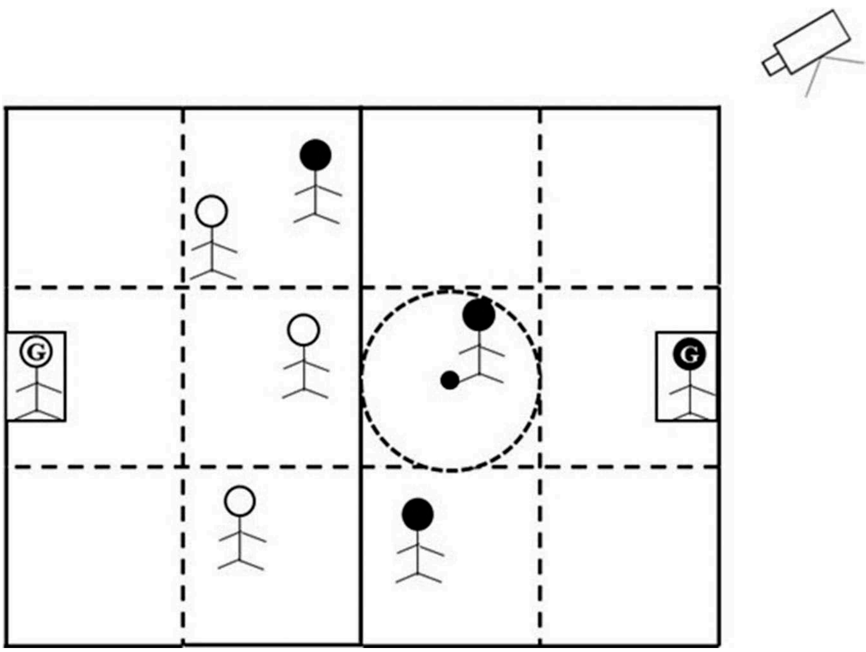

Figure 1. FUT-SAT consists of small-sided games (GK + 3 vs. 3 + GK) that last for 4 min and are played in a 36 m × 27 m field. The following spatial references are used to identify tactical principles: four sectors, three corridors, twelve zones and the game centre, which has the ball as its epicentre. The camera was placed on a professional tripod and in a diagonal position that was higher than the field of play; this facilitated the subsequent analysis of the video recordings (Costa et al., 2011).

following equation: Σ tactical action (principle performed × principle performed successful or unsuccessful × localisation of tactical action × result of the tactical action)/number of tactical actions (Costa et al., 2011).

Location of the action on the field was identified as defensive or offensive midfield, and the result of the tactical action in a scale that can range from 1 to 5 points (finalisation of the

Table 2. Fundamental tactical principles and the spatial references their (Costa et al., 2009).

Tactical principles	Definition	Spatial references
The offensive phase of a game of soccer		
Penetration	Action that ruptures the opponent's defensive lines (i.e. dribbling)	Player in possession of the ball advances towards the goal
Offensive coverage	Action that aims to create a pass vector around the ball carrier and/or decrease the opponent's pressure about it	Player not in possession of the ball and inside the game centre Player not in possession of the ball, outside the game centre, and positioned in parallel to the less offensive half of the game centre
Width and length	Action that aims to create a pass vector for the ball carrier along the width and length of field (i.e. player not in possession of the ball) Action that aims to gain decision-making time when the player is in possession of the ball	Player not in ball possession, outside the game centre, and between the ball and the last defensive line before of the goal Player in possession of the ball in the direction of own goal or the laterals of the field
Depth mobility	Action performed in the opponent's last defensive line that aims to create a pass vector in width and length, to increase the forward coverage area of one's own team	Action taken outside the game centre, between the opponent's last defensive transversal line and the goal
Offensive Unity	Action that aims to create backward pass line for ball carrier	Action taken outside the game centre and behind the ball line
The defensive phase of a game of soccer		
Delay	Offering primary opposition to the opponent in possession of the ball	First player after the ball carrier, and inside the game centre
Defensive coverage	Offering secondary opposition to the ball carrier	Second player after the ball carrier and inside the game centre
Defensive balance	Action that aims to obstruct the pass line of the ball carrier, occupying critical areas of the field (outside the game centre) Action that aims to follow the ball carrier behind the ball line (inside the game centre)	Player outside the game centre in areas close to the ball localisation. Player inside the game centre in the less offensive half.
Concentration	Action that aims to protect one's own goal	Player outside the game centre in on zone near ball localisation.
Defensive unity	Action that allows the team to decrease the distance between the defensive transversal lines, and compacting them by decreasing the interpersonal distance	Player in front of the ball line and out of the game centre Player is behind the ball, out of the game centre, and distance between two sectors of ball localisation

goal and recuperation of ball possession are the highest scores that can be obtained for a given action in the offensive and defensive phases of play, respectively) (Costa et al., 2011).

Soccer Analyzer® software was used to tactical analysis, and the data were recorded in an ad hoc Windows® Excel spreadsheet (Costa et al., 2011). To film the games, a Sony W830 camera (20.1 megapixels, High Definition; Japan) and a professional tripod (Sl-2111, 1.20 m) that was positioned above the field were used. The analysis of the video-recorded was conducted using a notebook of the Samsung.

2.3. Data analysis

All calculations were conducted using SPSS 20.0 (IBM, USA); the significance level was specified as .05; however, results with *p*-values that were above .05 but below .07 were also considered to be marginally significant. To verify the veracity of the trend, effect size indicators were used (ηp^2 e Cohen's *d)* and are presented below (Dancey & Reidy, 2013).

2.3.1. The intra-rater reliability of the tactical assessment

Intra-rater agreement analyse (duplicate) was done with approximately 10% of the total tactical actions. Tactical actions reanalysed were defined randomly. Kappa index (κ) was computed and results of the analyse demonstrated a high degree of intra-rater agreement between the two previously randomised observations ($\kappa = .88$, $p < .01$) (Robinson & O'Donoghue, 2007).

2.3.2. Group comparisons

Data normality was tested using Kolmogorov–Smirnov test ($p > .05$). One-way analysis of variance (ANOVA) was used to examine group differences in the total number of tactical actions, the percentages of successful tactical actions and the tactical performance index. Post-hoc analyses were conducted using Tukey's test (i.e. $p < .05$) (Dancey & Reidy, 2013).

Partial squared eta (η_p^2) was used as an indicator of effect size for significant ANOVA results; it can range from .0 to 1.0. A large η_p^2 value is indicative of a large effect size. Cohen's d was used to measure the effect sizes of significant group differences. Cohen's d is a ratio of the means and standard deviations; values were classified as small ($d = .2$), medium ($d = .5$) and large ($d = .8$) (Dancey & Reidy, 2013). Additionally, odds ratios were computed for the; we used a 2 × 2 contingency table across the three groups that differed in their maturational levels (Altman, 1991).

2.3.3. Cluster analysis

Hierarchical cluster analysis was used to verify the relationships between the 10 tactical principles and the tactical variability of the groups. We estimated the nearest and farthest neighbours between the groups; this entails the estimation of the squared Euclidean distance and the distance between the new groups of the variables.

The number of tactical actions, percentage of successful tactical actions and the tactical performance index of each tactical principle were used to estimate the relationships between them. A low coefficient for the relationships between the principles (i.e. the squared Euclidean distance) is indicative of greater similarity. From the first relationship between two variables, a new variable is created and compared with another (Fávero & Belfiore, 2015).

3. Results

3.1. Group comparisons

There was no statistically significant difference in the tactical performance index of the game between the three groups ($F_{2,75} = 1.0$). Players who belonged to Post-PHV ($p = .06$; 95% CI = −52.8, 1.0; $d = 1.0$) were more effective in their execution of penetrations than players who belonged to Pre-PHV. Although the significance level of the result that emerged for the group comparison was .06, the effect size was large ($\eta_p^2 = .92$, $d = 1.0$) (see Table 3).

Players who belonged to Post-PHV (tactical actions: $p < .01$; 95% CI = −15.7, −2.3; $d = 1.3$; offensive tactical actions: $p = .03$; 95% CI = −14.6, −0.6; $d = .9$) and PHV (tactical actions: $p = .03$; 95% CI = −10.3, .6; $d = .7$; offensive tactical actions: $p = .05$; 95% CI = −10.3, 0.0; $d = .6$) exhibited more tactical actions ($F_{2,75} = 7.0$) and offensive tactical

Table 3. Means and standard deviations for the frequencies of tactical actions (first line), percentages of successful tactical actions (second line), and tactical performance index (third line), as a function of the phases of the game, tactical principles, and biological maturity levels.

	Pre-PHV	PHV	Post-PHV	*p*	$\eta 2$
Actions	55.4 ± 8.0	60.9 ± 8.7*	64.4 ± 6.2*	.02.35.75	.48.10.05
	87.0 ± 9.1	90.0 ± 5.8	86.3 ± 5.3		
	41.3 ± 6.2	42.5 ± 5.9	41.7 ± 5.7		
Offensive actions	26.2 ± 8.7	31.3 ± 8.1*	33.8 ± 8.0*	.01.18.77	.36.36.05
	89.7 ± 9.2	93.7 ± 6.1	92.2 ± 9.7		
	49.6 ± 11.3	51.4 ± 7.5	50.0 ± 7.9		
Penetration	1.7 ± 1.6	1.9 ± 1.4	2.1 ± 1.9	.78.01.05	.06.94.92
	41.8 ± 41.7	67.9 ± 35.5*	82.4 ± 17.3*		
	37.1 ± 29.1	48.8 ± 23.9	63.0 ± 22.3*		
Offensive coverage	9.8 ± 4.9	12.0 ± 5.6	12.3 ± 4.9	.15.57.68	.30.35.03
	97.5 ± 5.0	95.1 ± 15.2	97.8 ± 3.7		
	51.7 ± 15.3	50.8 ± 14.1	47.3 ± 7.3		
Depth mobility	2.4 ± 2.8	3.3 ± 3.2	2.7 ± 1.8	.50.23.49	.03.04.26
	98.4 ± 6.2	96.3 ± 12.1	91.7 ± 15.4		
	61.9 ± 21.2	66.4 ± 15.7	70.0 ± 18.6		
Width and length	8.0 ± 4.4	10.1 ± 3.4	12.4 ± 4.5*	<.05.83.91	.61.11.03
	95.8 ± 8.2	96.9 ± 5.4	95.3 ± 10.5		
	49.1 ± 14.1	49.5 ± 7.9	47.5 ± 10.9		
Offensive unity	4.2 ± 3.0	4.0 ± 2.5	4.3 ± 1.9	1.0.68.37	.03.18.30
	78.3 ± 29.4	84.9 ± 27.2	78.9 ± 33.9		
	43.9 ± 18.3	50.4 ± 18.3	50.0 ± 22.3		
Defensive actions	29.2 ± 9.4	29.5 ± 7.9	30.6 ± 9.4	.90.43.48	.04.12.17
	84.2 ± 12.0	85.6 ± 8.9	80.3 ± 6.2		
	35.0 ± 4.8	34.1 ± 5.5	32.9 ± 5.6		
Delay	6.5 ± 3.7	7.4 ± 3.6	7.3 ± 3.5	.57.33.12	.02.11.43
	73.6 ± 22.9	65.5 ± 25.8	66.7 ± 12.8		
	34.3 ± 12.4	30.5 ± 10.5	26.7 ± 9.7		
Defensive coverage	1.2 ± 1.6	1.5 ± 1.1	1.3 ± 1.7	.69.02.66	.44.45.02
	91.3 ± 27.3	100.0 ±.0	65.0 ± 41.8*†		
	40.9 ± 22.0	46.8 ± 25.5	38.9 ± 17.1		
Concentration	4.4 ± 3.0	3.8 ± 2.4	3.8 ± 2.5	.63.53.30	.05.10
	99.2 ± 5.1	98.0 ± 6.7	100.0 ±.0		<.01
	30.4 ± 9.1	27.3 ± 8.3	31.7 ± 8.1		
Defensive balance	9.6 ± 4.4	9.9 ± 4.2	10.0 ± 3.9	.96.47.94	.01.33.08
	82.4 ± 19.9	84.6 ± 15.4	76.2 ± 12.0		
	34.7 ± 9.2	33.9 ± 7.8	34.5 ± 7.9		
Defensive unity	7.5 ± 3.7	7.0 ± 2.9	8.2 ± 2.9	.61.02.70	.44.29
	85.3 ± 17.4	95.8 ± 7.8*	92.0 ± 9.2		<.01
	35.8 ± 11.3	38.0 ± 10.7	37.8 ± 10.4		

*p < .05 in relation to the Pre-PHV; †p < .05 in relation to the PHV.

actions ($F_{2,75}$ = 4,9) than players who belonged to Pre-PHV. Players who belonged to Post-PHV (p = .01; 95% CI = −7.8, −.9; d = 1.0) exhibited a greater number of tactical width and length actions than players who belonged to Pre-PHV ($F_{2,75}$ = 5.3) (see Table 3).

Players who belonged to Post-PHV (p = .03; 95% CI = −78.4, 2.7; d = 1.4) and PHV (p = .05; 95% CI = −52.3, 0.1; d = .7) had more successful executions of penetrations than players who belonged to Pre-PHV ($F_{2,56}$ = 5.0). Players who belonged to Pre-PHV (p = .07; 95% CI = −1.6, 54.3; d = .8) and PHV (p = .01; 95% CI = −63.9, −6.1; d = 1.7) were more successful in the execution of defensive coverage than players who belonged to Post-PHV ($F_{2,46}$ = 4.3). Players who belonged to PHV (p = .02; 95% CI = −19.3, −1.7; d = .8) were more efficient in the execution of defensive unity than players who belonged to Pre-PHV ($F_{2,75}$ = 4.3) (see Table 3).

Players who belonged to Pre-PHV had higher odds of successfully executing defensive coverage than players who belonged to Post-PHV, who in turn had higher odds ratio of successfully executing penetrations than players who belonged to the other groups. Players who belonged to PHV had higher odds ratio of successfully executing penetration than players who belonged to Pre-PHV and successfully executing defensive coverage than players of the other groups (see Table 4). There was no difference in the other variables ($p > .05$).

3.2. Cluster analysis

In the clustering of tactical principles, in the general tactical behaviours of the sample, offensive coverage, and width and length (coefficient = 3.5), and offensive unity and defensive coverage (coefficient = 65.3) emerged as the principles that had the shortest Euclidean distance between them (see Table 5). Penetration (22.2%), offensive coverage (55.6%), offensive unity (33.3%) and defensive balance (22.2%) had the highest number of clusters (see Table 6).

In the Pre-PHV group, offensive coverage, and width and length (coefficient = 12.5) emerged as the principles that had the shortest Euclidean distance between them. Defensive balance and defensive unity (coefficient = 14.1) had the second shortest Euclidean distance between the principles in this group (see Table 5). Offensive coverage (44.4%), offensive unity (33.3%), delay (22.2%), defensive coverage (22.2%) and defensive balance (22.2%) were most densely connected to the other principles (see Table 6). Therefore, Pre-PHV group had greater tactical variability than the other groups; five principles evidenced a participation rate of more than 20% in the connections between the tactical variables.

In the PHV group, offensive coverage, and width and length (coefficient = 8.6) were the principles that had the shortest Euclidean distance between them. Width and length also had the second lowest coefficient of connection with defensive coverage (coefficient = 91.5) (see Table 5). Penetration (22.2%), offensive coverage (66.6%), defensive balance (22.2%) and concentration (22.2%) had the highest number of connections with the other principles (see Table 6).

Table 4. Odds ratio, confidence interval, and the level of significance for the percentage of successful executions of penetration and defensive coverage actions, as a function of the biological maturity of the players.

Penetration		
	PHV	**Post-PHV**
Pre-PHV	2.9	6.3
	1.6, 5.2	3.3, 12.0
	$p < .01$*	$p < .01$*
PHV		2.1
		1.1, 4.2
		$p = .02$*
Defensive coverage		
Pre-PHV	2.9	5.4
	1.2, 36.4	2.5, 12.1
	$p = .04$*	$p < .01$*
PHV		10.9
		6.6, 180.7
		$p < .01$*

*$p < .05$.

Table 5. Dissimilarity matrix of the tactical behaviours of sample (A), and the Pre-PHV (B), PHV (C), and Post-PHV (D) groups that were obtained using the squared Euclidean distance of the study variables in the following order: **1** = penetration; **2** = offensive coverage; **3** = width and length; **4** = depth and mobility; **5** = offensive unity; **6** = delay; **7** = defensive coverage; **8** = defensive balance; **9** = concentration; **10** = defensive unity.

		1	2	3	4	5	6	7	8	9
A	**2**	1166.2								
	3	1093.7	**3.5**	.0						
	4	1265.3	338.1	357.8	.0					
	5	286.4	314.3	270.5	545.0	.0				
	6	413.0	1190.1	1091.6	2009.5	464.6	.0			
	7	513.1	291.3	233.8	675.5	**65.3**	452.8	.0		
	8	585.9	489.3	426.7	1261.3	219.2	178.8	151.6	.0	
	9	1628.5	464.1	405.3	1332.1	673.5	940.4	348.7	378.8	.0
	10	915.3	209.4	164.0	878.5	236.5	546.9	96.1	110.7	133.3
B	**2**	3376.0	.0							
	3	3096.6	**12.5**	.0						
	4	3809.0	158.5	200.0	.0					
	5	1381.0	460.7	348.6	727.6	.0				
	6	1040.0	885.3	716.1	1390.8	120.6	.0			
	7	2469.0	228.7	134.9	489.6	189.9	388.4	.0		
	8	1719.0	515.2	389.3	1043.0	132.5	88.5	189.9	.0	
	9	3348.5	485.5	376.3	993.8	623.0	677.5	182.7	327.9	.0
	10	1928.4	406.2	288.2	875.6	127.5	141.3	102.9	**14.1**	231.8
C	**2**	851.2	.0							
	3	907.4	**8.6**	.0						
	4	1143.2	321.6	333.2	.0					
	5	300.0	168.0	179.6	386.0	.0				
	6	347.9	1313.5	1352.6	2258.5	787.0	.0			
	7	1033.2	151.7	**91.5**	402.4	247.0	1492.8	.0		
	8	546.4	399.8	391.2	1235.1	306.0	385.5	471.2	.0	
	9	1341.8	629.0	533.0	1531.7	703.7	1079.2	388.2	258.1	.0
	10	908.1	191.1	143.4	822.2	281.4	976.5	124.9	149.4	128.6
D	**2**	587.7	.0							
	3	514.8	**6.2**	.0						
	4	135.0	641.9	613.1	.0					
	5	187.2	426.2	339.4	564.8	.0				
	6	1593.9	1418.8	1277.0	2519.1	701.2	.0			
	7	883.0	1267.6	1115.0	1676.7	325.3	189.2	.0		
	8	914.1	635.2	538.2	1550.2	279.2	159.3	221.7	.0	
	9	1294.3	321.7	345.0	1535.2	776.8	1145.8	1283.5	610.8	.0
	10	765.8	141.5	122.3	1065.3	333.4	764.3	777.9	262.6	**120.6**

In the Post-PHV group, offensive coverage, and width and length (coefficient = 6.2) had the shortest Euclidean distance between them. Concentration and defensive unity were the second pair of principles with the least amount of dissimilarities between them (coefficient = 120.6) (see Table 5). Penetration (44.4%), offensive coverage (33.3%), delay (33.3%) and concentration (22.2%) had the highest number of connections with the other principles (see Table 6). Post-PHV group has a greater number of connections with the penetration principle, differently of the other groups (see Figure 2).

4. Discussion

This research aimed to compare the tactical behaviours of soccer players who differed in their temporal distances from their respective PHVs (i.e. in years). Were compared tactical effectiveness, efficiency, and variability between groups who have attained

Table 6. Agglomeration (A: tactical behaviour of the sample; B: Pre-PHV; C: PHV; D: Post-PHV) obtained through squared Euclidean distance of the variables: **1** = penetration; **2** = offensive coverage; **3** = width and length; **4** = depth and mobility; **5** = offensive unity; **6** = delay; **7** = defensive coverage; **8** = defensive balance; **9** = concentration; **10** = defensive unity.

		Cluster combined			Stage cluster first appears		
	Stage	*Cluster 1*	*Cluster 2*	Coefficients	*Cluster 1*	*Cluster 2*	Next stage
A	1	*2*	*3*	3.5	0	0	5
	2	*5*	*7*	65.3	0	0	4
	3	*8*	*10*	110.7	0	0	4
	4	*5*	*8*	175.8	2	3	5
	5	*2*	*5*	299.9	1	4	6
	6	*2*	*9*	400.6	5	0	8
	7	*1*	*6*	413.0	0	0	9
	8	*2*	*4*	769.7	6	0	9
	9	*1*	*2*	895.5	7	8	0
B	1	*2*	*3*	12.5	0	0	5
	2	*8*	*10*	14.1	0	0	3
	3	*6*	*8*	114.9	0	2	4
	4	*5*	*6*	126.9	0	3	7
	5	*2*	*4*	179.1	1	0	8
	6	*7*	*9*	182.7	0	0	7
	7	*5*	*7*	341.4	4	6	8
	8	*2*	*5*	597.5	5	7	9
	9	*1*	*2*	2462.9	0	8	0
C	1	*2*	*3*	8.6	0	0	2
	2	*2*	*7*	121.6	1	0	4
	3	*9*	*10*	128.6	0	0	5
	4	*2*	*5*	198.2	2	0	7
	5	*8*	*9*	203.7	0	3	8
	6	*1*	*6*	347.9	0	0	9
	7	*2*	*4*	360.8	4	0	8
	8	*2*	*8*	543.5	7	5	9
	9	*1*	*2*	1042.3	6	8	0
D	1	*2*	*3*	6.2	0	0	6
	2	*9*	*10*	120.6	0	0	6
	3	*1*	*4*	135.0	0	0	7
	4	*6*	*8*	159.3	0	0	5
	5	*6*	*7*	205.5	4	0	9
	6	*2*	*9*	232.6	1	2	8
	7	*1*	*5*	376.0	3	0	8
	8	*1*	*2*	741.1	7	6	9
	9	*1*	*6*	1025.7	8	5	0

different levels of somatic maturation. Thus, we are going to explain the research results in three blocks: effectiveness, efficiency and tactical variability.

In relation to the tactical effectiveness, somatic maturation did not affect tactical performance (game, offensive and defensive). These results are consistent with the findings of other studies (Borges et al., 2017, 2018). That is, the level of somatic maturation did not affect the overall tactical performance of the players, and this must have happened because the groups showed levels of tactical efficiency in differentes tactical variables, and like the tactical performance index is compost to this variables, there was no difference. For example, soccer players biologically late performed better in the execution of skills without the ball, because they were able to visually perceive the positional information of other players to perform tactical movements successful, compensating for their physical disadvantage compared to biologically matured players. While the biologically matured soccer players performed better in the execution of skills

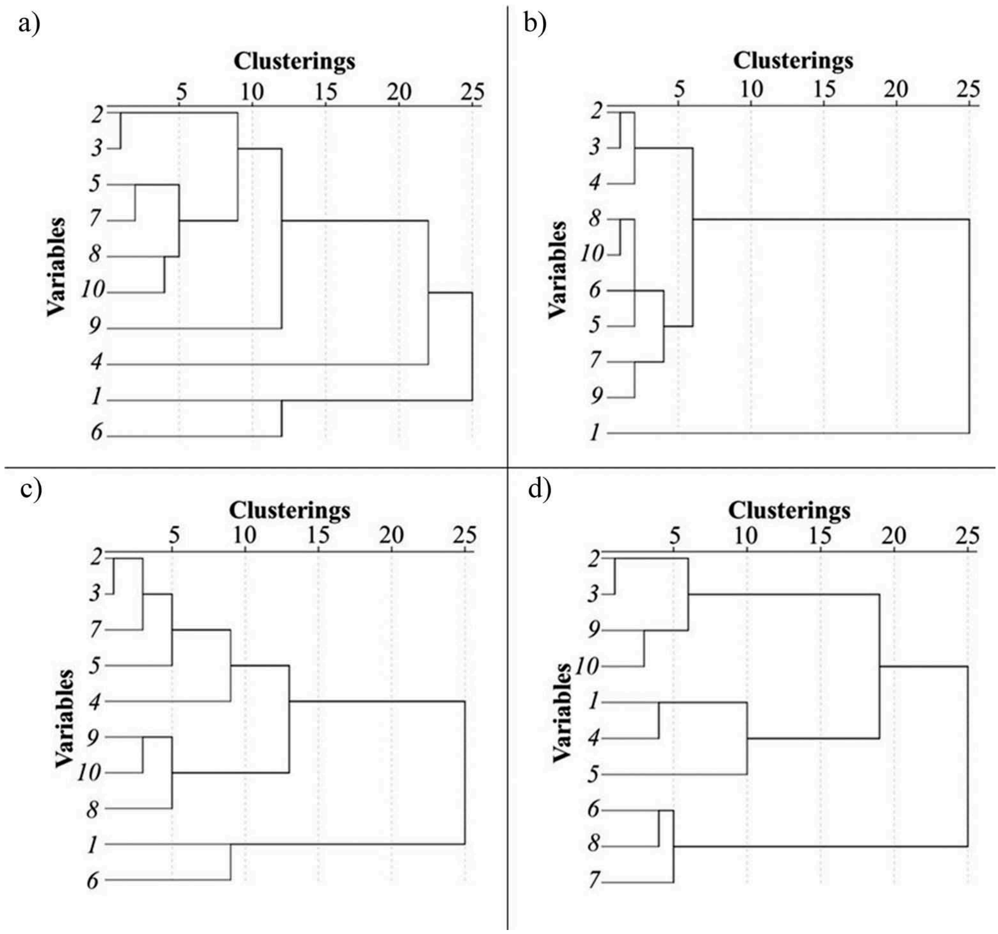

Figure 2. Dendrogram of the general tactical behaviour of the sample (a), Pre-PHV (b), PHV (c) and Post-PHV (d) groups displaying the tactical patterns that emerged from the total frequency of tactical actions, the percentage of successful tactical actions and tactical performance index of the study variables in the following order: **1** = penetration; **2** = offensive coverage; **3** = width and length; **4** = depth and mobility; **5** = offensive unity; **6** = delay; **7** = defensive coverage; **8** = defensive balance; **9** = concentration; **10** = defensive unity.

with the ball, because they were more stronger (Bidaurrazaga-Letona et al., 2019a; Borges et al., 2017), faster (Brownstein et al., 2018; Kuranth et al., 2017), more agile (Kuranth et al., 2017) and more resistant (Bidaurrazaga-Letona et al., 2019a; Borges et al., 2017; Valente-dos-Santos et al., 2012a).

As the player's body size may be influenced by biological maturation, coaches must not rely solely on body size to identify and select soccer players (Furley & Memmert, 2016). Even though there may be implicit discriminatory processes that are biased against players who mature at a later age, those who persist and practice tend to attain sports expertise. For example, 60% of the players who had attained biological maturation at a later age became professional soccer players; in contrast, the percentage was only 12% among players who had attained biological maturation at an earlier age (Ostojic et al., 2014). This occurs they may be more adaptive and resilient to compensate for their physical disadvantages (Malina et al., 2015).

In order to develop player identification and selection processes that are less discriminatory and more holistic, the organisation of sports competitions and competing teams must be based on the biological ages. Soccer players reported that they predominantly used tactical and technical skills when they played with (physically) larger players than when they practiced with similarly sized players (Cumming et al., 2018).

Penetration was the tactical principle most affected by somatic maturation. Specifically, biologically mature players were more successful, had higher odds ratio to execute action and had greater problem-solving skills than Pre-PHV players. These results are similar other research that biological maturation affected skills performed soccer players in possession ball (i.e. dribbling) (Malina et al., 2005).

This result may be explained the better physical performance that was observed among players who had matured (Bidaurrazaga-Letona et al., 2019a, 2019b; Borges et al., 2017). In practice, the assessment of the tactical skills of soccer players is typically a subjective process, because the methods used are not reliable and focus solely on the player's ball skills. Therefore, players identification and selection processes that are exclusively guided by the subjectivity of coaches may be seriously flawed (Valente-dos-Santos et al., 2012b).

This may be the case because the larger body sizes of Post-PHV players could be more impressive than those of the Pre-PHV. However, the ball skills of Post-PHV players may not be as effective and efficient as those of the Pre-PHV players. In fact, Pre-PHV players may use strength, speed and endurance (physical performance) in their execution of ball skills to impress the coaches. Yet, this physical advantage disappears with the advancement of age (Valente-dos-Santos et al., 2012b) or even at the end of the season (Bidaurrazaga-Letona et al., 2019b).

In relation to the tactical efficiency, we found that PHV players exhibited more tactical actions and offensive tactical actions than players who had not yet reached PHV. In addition, Post-PHV players exhibited a greater number of width and length actions than Pre-PHV.

These results partially corroborate the findings of Borges et al. (2018), whereby similar trends were observed for offensive coverage and offensive unity. In addition, Borges et al. (2017) found a moderate correlation between offensive efficacy and aerobic power. Accordingly, the repetition of an action enhances stabilisation of the action through a negative feedback mechanism (i.e. detection and correction of the error) (Tani et al., 2014). This can serve as a tactical advantage to biologically mature players in athlete identification and selection as well as in motor learning of a tactical task.

A greater number of width and length actions were exhibited by PHV players than by Pre-PHV players. This trend is evident in professional soccer because offensive tactical actions allow the player to create forward and sideway passes for the ball carrier. Further, when teams played twice a week rather than once a week, width and length performance was impaired (Folgado et al., 2015).

We also found that the efficiency of the execution of defensive coverage was better among less biologically mature players than among Post-PHV players. This tactical action requires one to protect the player who is pressing the opponent's ball carrier, decreasing the pressure on the teammate (Costa et al., 2009). The player who performs this action gains a privileged position with regard to the learning of perceptual skills.

For example, the visual search of expert and creative soccer players was different from those of less skilled and less creative. Specifically, they tended to focus less on the ball and more on the empty space in the field (Roca et al., 2018). These kinds of perceptive skills favour actions that occur after ball recuperation, which in turn can generate an effective offensive transition. It allows one to identify the teammate who is best positioned to receive the pass, immediately upon the recuperation of the ball (Barreira et al., 2014). Efficient defensive coverage actions entail different decision-making and perceptive skills that Pre-PHV soccer players can learn and use in unfavourable contexts.

We also found that PHV players had more successful executions of defensive unity actions than Pre-PHV players. Borges et al. (2018) found that aerobic and lower limb power, which is associated with body mass, accounted for 33% of the defensive tactical performance of young soccer players. In addition, the greater amount of testosterone that results from biological maturation allows players to refine their spatial skills (Moreira et al., 2017). Defensive unity is characterised by the defensive return of the attackers or the defensive cohesion of the defenders when the team presses the opponent (Costa et al., 2009). Thus, the physical performance that is associated with spatial skills contributes to the efficiency of these actions; this explains the better performance of PHV players when compared to Pre-PHV.

Ultimately, in relation to the tactical variability, we found that there was greater tactical variability among Pre-PHV players than among PHV and Post-PHV. Tactical variability is an indicator of success in high-level soccer; indeed, Eurocopa 2012 finalist teams had higher levels of tactical variability level than the semi-finalist (Moura et al., 2015). Tactical variability is fundamental to solve problems in unpredictable environments (Corrêa et al., 2015).

Variability acts as a redundancy mechanism that facilitates functional stabilisation when the system is perturbed (i.e. allowing adaptation). Functional stabilisation (spatial and temporal standardisation of the action) and perturbation (interference in functional stabilisation) are two essential attributes of the motor learning (Corrêa et al., 2015).

Pre-PHV players demonstrated a greater number of connections between the principles. This may be the case because the perturbation that results from a physical disadvantage is attributable to biological maturation. Thus, tactical behaviour may enable players who are biologically disadvantaged at the beginning of the training process to develop more tactical skills (Malina et al., 2015), especially skills that do not require a ball; these skills may win them the opportunity to play in professional soccer more frequently (Ostojic et al., 2014).

This process occurs when the player is resilient enough to find a practice environment that allows him to develop his skills. However, the level of physical activity decreases in adolescence and is influenced largely by biological (late) rather than chronological age (Bacil et al., 2015). Thus, mechanisms are needed to avoid the early abandonment of the biologically less favoured players and to provide adequate incentives to encourage biologically mature players to step outside their comfort zones. Such changes require the creation of public policies for sports and the reformulation of the organisation of competitive categories and competitions.

Among Post-PHV players, the principle of the penetration was the guiding attribute of their tactical behaviours, and it had many connections with the other principles. This reinforces the previously articulated contention about the role that the physical aspects of biological maturation play in the execution of tactical ball skills.

Finally, we found that the principles of offensive coverage and offensive unity were tactical actions that had a greater number of connections with the other principles when the maturational level of the sample was ignored. These tactical principles play a fundamental role in contemporary soccer because they allow the team to play with offensive compaction and offer pass vectors to the ball carrier in all directions of the playing field (Costa et al., 2009). Thus, the execution of these principles allows the team to decrease the interpersonal distance between the transversal lines of attack and increase the odds of the teams shooting in the opponent's goal (Moura et al., 2012).

Often, soccer observers and coaches do not use reliable and objective assessments as a part of the identification and selection processes. Instead, they may simply analyse players' performance based on only one factor (e.g., offensive ball skills with ball). This may lead to erroneous decisions about the maintenance and/or dispensing of players. Further, inadequate training stimuli may be offered to subjects who have different physical characteristics (e.g., body size) that may be attributable to the effects of biological maturation.

The assessment process of soccer players should not focus solely on ball skills because their physical performance is also influenced by non-trainable factors (biological maturation); doing so may adversely affect the development of sports talent in soccer. In addition, this is the first study to demonstrate how soccer players who differ in their maturational levels behave tactically under the premise of tactical variability.

The results of the present study suggest that coaches should offer adequate stimuli to meet the unique needs of players who, despite training together, differ in their biological ages. Thus, biologically mature players need adequate training stimuli to help them improve the tactical skills that do not require a ball; further, players who are yet to reach biological maturity require opportunities to learn to make contact with the ball. It is also important for clubs and sports federations to organise competitions and divide competitive categories based on the biological ages of players so that all players (i.e. irrespective of biological age) can access high-level sports competitions.

5. Conclusion

We concluded that somatic maturation did not affect tactical effectiveness. However, biologically mature players were more effective and efficient in performing offensive ball skills than Pre-PHV players. They also exhibited a greater number of tactical actions, offensive tactical actions and offensive width and length actions, and they were more successful in the execution of defensive cohesion actions. However, Pre-PHV and PHV players were more successful in performing defensive coverage actions than biologically mature players. Pre-PHV players demonstrated greater tactical variability than players who belonged to the other groups.

Disclosure statement

No potential conflict of interest was reported by the authors.

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