# Maturity status and tactical behavior of youth soccer players across a competitive season[1]

## Estado madurativo y comportamiento táctico de jóvenes futbolistas durante una temporada competitiva

## Estatuto Maturacional e comportamento tático de jovens jogadores de futebol durante uma temporada competitiva

[Research Article]

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## Abstract

This study compares groups with lower and higher variability of peak height velocity concerning offensive, defensive, and general tactical behavior efficiency across a competitive season. It also aims to present the tactical behavior profile in competitive games. Twenty-one young soccer players participated in the study, which included two assessment moments. Additionally, five competitive matches were analyzed. Maturity Offset was verified, and the System of Tactical Assessment was used to assess tactical behavior efficiency in soccer. Based on the results, we concluded that players with higher peak height velocity variability exhibited greater defensive (t = -2.367; $p$ = .029; moderate ES) and in-game tactical behavior efficiency (t = -2.507; $p$ = .021; moderate ES). In the competitive context, U-13 and U-15 soccer players demonstrated stable tactical behavior efficiency throughout the competitive season.

**Keywords**: football, talent identification and development, tactical assessment, youth soccer.

## Resumen

Este estudio compara los grupos con menor y mayor variabilidad de velocidad de pico de altura en relación con la eficiencia del comportamiento táctico ofensivo, defensivo y general, a lo largo de una temporada competitiva. También debe presentar el perfil de comportamiento táctico en juegos competitivos. Veinte y un joven jugador de fútbol participarán en el estudio con dos momentos de evaluación. También fueron analizadas cinco partidas competitivas. La Compensación de Madurez fue verificada y el Sistema de Evaluación Táctica validó la eficiencia del comportamiento táctico en el Fútbol. Concluimos que los jugadores con mayor variabilidad de velocidad de pico de altura presentan mayor eficiencia en el comportamiento táctico defensivo y en el juego. En un contexto competitivo, los jugadores de fútbol sub-13 y sub-15 presentan eficiencia y alto comportamiento táctico durante una temporada competitiva.

**Palabras clave:** futebol, identificación y desarrollo de talentos, avaliação tática, futebol juvenil.

## Resumo

Este estudo compara os grupos com menor e maior variabilidade da velocidade de pico de altura em relação à eficiência do comportamento tático ofensivo, defensivo e geral, ao longo de uma temporada competitiva. Também visa apresentar o perfil do comportamento tático em jogos competitivos. Vinte e um jovens jogadores de futebol participaram do estudo com dois momentos de avaliação. Também foram analisadas cinco partidas competitivas. O Maturity Offset foi verificado e o System of Tactical Assessment avaliou a eficiência do comportamento tático no Futebol. Concluímos que jogadores com maior variabilidade da velocidade de pico de altura apresentaram maior eficiência do comportamento tático defensivo e em jogo. No contexto competitivo, jogadores de futebol sub-13 e sub-15 apresentaram eficiência estável e alta do comportamento tático durante uma temporada competitiva.

**Palavras chaves:** futebol, identificação e desenvolvimento de talentos, avaliação tática, futebol juvenil.

## Introduction

The tactic is the way to materialize the coaches' ideas. It involves the management of the playing space through the players' positions and movements on the field (Teoldo, Guilherme, and Garganta, 2015b). The tactical behavior of soccer players is influenced by several variables, with biological maturation being one of them (Gonçalves et ál., 2020; Gonçalves, Noce, Barbosa, Figueiredo, and Teoldo, 2021). Biological maturation is a qualitative biological phenomenon related to the maturation of the functions of different organs and systems, which allows individuals to progress to higher levels of functioning (Malina, Bouchard, and Bar-Or, 2004).

One of the most commonly used biological indicators in studies involving young soccer players is peak height velocity (PHV) (Doncaster, Iga, y Unnithan, 2018; Figueiredo, Gonçalves, Coelho-e-Silva, y Malina, 2009; Moran et ál., 2018; Romann, Javet, y Fuchslocher, 2017). This somatic indicator refers to the moment of the highest rate of growth in individuals' height (Malina et ál., 2004; Philippaerts et ál., 2006). When studying the influence of PHV on the speed of young soccer players, McCunn and collaborators (2017) observed a trivial relationship in the U-11 category, while in the U-15 category, the relationship between PHV and speed over a 15 m distance was quite significant.

Still considering the PHV, Borges and colleagues (2017) evaluated anthropometric, functional, motor, and cognitive indicators of young soccer players aged 13 to 17. Results from this study reported that players who underwent the PHV registered better performance in motor tests. Additionally, players before the PHV showed better declarative tactical knowledge. Despite the growing interest in studying the interaction of PHV in young soccer players, there is still a gap regarding the relationship between PHV and tactical behavior efficiency (Gonçalves, Sarmento, Teoldo, Tessitore, and Figueiredo, 2022). Consequently, basic concepts can be neglected or taught incorrectly because coaches cannot interpret and use such information accurately.

Fernandes-da-Silva and collaborators (2016) analyzed 11-a-side and 7-a-side matches and related the age at PHV to the individual activity profiles of young players aged between 13.5 and 15.9 years. Findings from this study revealed that the correlation coefficients remained unchanged, indicating that this variable did not influence running performance in 11-a-side and 7-a-side matches. However, despite the importance of these results, it is worth noting that general, operational, or even core tactical principles still need to be analyzed.

Although the authors did not evaluate biological maturation, a recent study by Praça et ál. (2017) analyzed the tactical behavior of U-14 and U-15 age-category soccer players over ten months. The results show the evolution of procedural-tactical knowledge in the U-14 group, while the players' tactical development process in the U-15 group remained unchanged. These results highlight the importance of continuity and specificity in the evaluation and training of core tactical

principles in soccer. In fact, despite soccer match analysis considering countless variables, there is still a lack of knowledge about the tactical principles investigated in the competitive context. Therefore, the primary purpose of this study is to compare groups of young soccer players with low and high variability in maturity status concerning their offensive, defensive, and general tactical behavior efficiency during an entire competitive season. The secondary purpose is to analyze their tactical behavior profiles in competitive matches.

## Methods

### Participants

Twenty-one young male soccer outfield players (characteristics are shown in Table 1) were recruited for this study from the U-13 and U-15 age groups of a Portuguese professional club. The inclusion criteria were regular participation in practice sessions and competitions, as well as the absence of injury in the past six months. Since the players were part of a convenience sample, no statistical calculation was performed to determine the sample size; therefore, all players who met the inclusion criteria were analyzed. In the end, three players from the U-13 age group were excluded from the analysis due to injury. According to the Portuguese Soccer Federation rules, each official match lasted 60 minutes (U-13) and 70 minutes (U-15). During a regular in-season microcycle, players practiced for four 90-minute training sessions and one match per week.

### Informed Consent

Before data collection, subjects and their legal guardians were informed about the study protocol and that they could withdraw from the study at any time. In addition, they were invited to provide informed consent and acknowledge that they could not be identified through the paper and that their information had been fully anonymized.

Furthermore, all the research procedures conformed to the Declaration of Helsinki (2013) and followed the ethical standards of the ethics committee of the lead institution (nº 29072017).

**Table 1**

*Players' characteristics*

| | U-13 (n = 9) | | U-15 (n = 12) | |
|---|---|---|---|---|
| *Variables* | Means | SD | Means | SD |
| Age (years) | 13.10 | .09 | 14.77 | .06 |
| Age at PHV (years) | 14.23 | .06 | 13.79 | .10 |
| Height (cm) | 157.55 | .85 | 175.16 | 1.70 |
| Body Mass (kg) | 44.22 | 1.41 | 59.78 | 1.14 |
| CMJ (cm) | 29.81 | .89 | 32.75 | 3.07 |
| Change of direction (s) | 5.16 | .43 | 5.13 | .03 |
| 10 m (s) | 1.71 | .01 | 1.39 | .02 |
| 30 m (s) | 4.60 | .06 | 3.90 | .05 |
| YYIE2 (m) | 710.57 | 64.00 | 1083.33 | 55.36 |

*Note:* SD = Standard deviation; PHV = Peak height velocity; CMJ = Countermovement jump; YYIE2 = Yo-Yo Intermittent Endurance test level 2.

## Experimental design

Participants were assessed at the beginning and the end of the 2016/2017 competitive season. All tests were performed during players' practice sessions between 6 PM and 7:30 PM. Data collection regarding the Small-sided Games (SSG) and the soccer players' profiles was conducted similarly on two days (i.e., at least 48 hours apart). On the first day, the anthropometrical and functional capacity tests were the Counter Movement Jump (CMJ), Zig-Zag test, 10 m acceleration, and 30 m velocity, while on day two, the Yo-Yo Intermittent Endurance Test level 2 (YYIE2) and the SSG were performed. Data collection sessions occurred in the club's training facilities, where athletes regularly practiced. All functional capacity tests and SSG were conducted outdoors on the artificial grass field. Thus, the full battery of participants' evaluations included chronological age, somatic maturity status, anthropometry, functional capacity tests, the SSG, and tactical profile in competitive matches.

### Anthropometrics

Weight (kg) (portable digital scale 770, SECA, Germany), height (cm) (stadiometer, Sanny(r), Brazil), sitting height (cm) (stadiometer, Sanny(r), Brazil), and four skinfolds were measured by a single observer: triceps, subscapular, suprailiac, and medial calf (adipometer Baseline, Fabrication Enterprises Inc., USA) following the protocol described previously (Lohman, Roche, and Martorell, 1988). Players wore shorts and a T-shirt, and shoes were removed.

### Maturational analysis

Equation by Mirwald, Baxter-Jones, Bailey, and Beunen (2002) was used to estimate the maturity status of young players. Thus, anthropometric measurements (height, sitting height, body mass) were entered into the equation to predict the Maturity Offset:

$$\textit{Maturity Offset} = -9.236 + (0.0002708 \times \textit{leg length and sitting height interaction}) + (-0.001663 \times \textit{age and leg length interaction}) + (0.007216 \times \textit{age and sitting height interaction}) + (0.02292 \times \textit{weight by height ratio})$$

The equation can measure Maturity Offset within an error of ± one year 95% of the time. Additionally, the equation has been used previously to predict maturational status in pediatric research with a standard error of approximately six months (Mirwald et ál., 2002). In the sports-related studies conducted between 2015 and 2018 and published in peer-reviewed journals, more than 90% used PHV to characterize the biological maturation of young soccer players (Gonçalves et ál., 2022).

### Match Analysis: SSG and competitive matches

The System of Tactical Assessment in Soccer (FUT-SAT) (Teoldo, Garganta, Greco, Mesquita, and Maia, 2011) was used to collect data regarding the efficiency of tactical behavior. This assessment system considers the frequency of execution of offensive and defensive tactical principles and their success rate to characterize the efficiency of tactical behavior. FUT-SAT is based on ten core tactical principles of the soccer game, which are, in the offensive phase: penetration, offensive coverage, depth mobility, width and length, and offensive unity; and in the defensive phase: delay, defensive coverage, balance, concentration, and defensive unity (Teoldo, Garganta, Greco, and Mesquita, 2009). Previous studies utilized the FUT-SAT to assess tactical behavior (Gonçalves et ál., 2020; Gonçalves et ál., 2021; Gonçalves, Rezende, and Costa, 2017; Padilha, Guilherme, Serra-Olivares, Roca, and Teoldo, 2017).

According to Teoldo et ál. (2011), the observation and analysis units are based on the possession of the ball, which is achieved when a player fulfills one of the following conditions:

performs at least three consecutive contacts with the ball, makes a positive pass to a teammate (allowing for the retention of possession), or shoots at goal (Garganta, 1997). Therefore, the three steps for the analysis of the game with FUT-SAT comprise (1) the analysis of the actions performed by the player during the game, (2) the assessment, classification, and recording of tactical actions, and (3) the calculation of the variables in the categories Tactical Performance Index, Tactical Actions, Percentage of Errors, and Place of Action Related to the Principle. Video analyses were performed by trained evaluators who underwent a training process regarding the procedures and methods of analysis with FUT-SAT.

Two 7-a-side field tests were performed on an artificial grass field measuring 71 m by 40.30 m for six minutes for each U-13 and U-15 age category. These matches were conducted at the beginning and the end (September 2016 and June 2017) of the 2016-2017 competitive season. Coaches were encouraged to provide feedback during the SSG, and players were instructed to play as if they were competing.

Considering competition matches, U-13 players played five matches under the same conditions for 60 minutes, separated by 10-minute intervals. In this case, 6 minutes of tactical analysis is sufficient to characterize the players' behavior (Teoldo, Guilherme, y Garganta, 2015a). On the other hand, U-15 players also played five matches on an artificial grass field measuring 100 m by 65 m, for 70 minutes, separated by 10-minute intervals. In these dimensions, the time required to characterize tactical behavior is 8 minutes (Teoldo et ál., 2015a).

### Reliability analysis

The test-retest design was used to verify the reliability of the analyses performed by the evaluators (Table 2). The sessions to determine reliability were conducted with a three-week interval to avoid issues related to task familiarity. The reliability coefficient was calculated using Cohen's Kappa test (Robinson and O'Donoghue, 2007). The percentage of tactical actions used in the reliability assessment was 10%, as the scientific literature proposed that this was enough to check reliability (Tabachnick and Fidell, 2012).

**Table 2**
*Values of reliability intra and inter-evaluators*

| | U-13 | | U-15 | |
|---|---|---|---|---|
| | Min (SE) | Max (SE) | Min (SE) | Max (SE) |
| Intra-evaluators | .921 (.010) | .997 (.002) | .901 (.012) | .996 (.003) |
| Inter- evaluators | .847 (.013) | .989 (.004) | .887 (.013) | .956 (.009) |

Note: Min (SE) = Minimum (Standart Error), Max (SE) = Maximum (Standart Error).

## Functional capacities profile

### *Counter Movement Jump*

The CMJ was performed on a contact jump mat (Globus®, ErgoJump portátil, Italy) connected to a computer, as described previously (Gravina et ál., 2008; Silva-Junior et ál., 2011). Three jumps were performed, with two-minute rest periods provided between trials. We chose this protocol because it allows us to discriminate the contribution of the lower limbs to the performance of the jump (Markovic, Dizdar, Jukic, y Cardinale, 2004).

### *Change of direction*

The Zig-Zag test proposed by Little et ál. (2005) was used to evaluate the players' change of direction ability. As reported by the authors, the test consists of a 20 m run divided into four 5 m sections, with each change of trajectory angled at 100°. This test was chosen because it involves accelerations, decelerations, and sudden direction changes. Players were instructed to remain standing in the initial position, where there was a pair of photocells (Brower Timing Sprint Testing System SpeedTrap II, USA). At the signal, they had to run through the 20 m at the highest possible speed. They could not break down the barriers that marked the change direction points or make them fall to the ground until the final mark, which was indicated by the other pair of photocells (Brower Timing Sprint Testing System SpeedTrap II, USA). Players wore their soccer shoes, with three attempts per test, separated by at least 3 minutes of recovery (Peñailillo, Espíldora, Jannas-Vela, Mujika, y Zbinden-Foncea, 2016). The fastest time was used for further analysis.

### *10 m and 30 m*

Before the sprinting tests, a warm-up of 10 minutes with accelerations was specifically applied to prepare the players. First, players had to start standing, placing their forward foot just behind the starting line. Then, they performed 10 m and 30 m sprints with a stationary start, timing

as soon as the rear foot crossed the line (Wong, Chamari, Dellal, y Wisløff, 2009). Speed was measured with an infrared photoelectric cell (Brower timing sprint testing system SpeedTrap II, USA) positioned 10 m and 30 m from the starting line at a height of 1 m. There were three trials per sprinting test, and a 3-minute passive recovery was allowed between each trial, along with a 5-minute passive recovery between each sprinting test. The fastest time per sprinting test was selected for analysis.

### *Yo-Yo Intermittent Endurance Test*

The Yo-Yo Intermittent Endurance Test Level 2 (YYIET2) was applied according to the guidelines established by Bangsbo (1994). The test consists of incremental shuttle running until exhaustion. The YYIET involves 20-meter shuttle runs performed at increasing velocities, with 5 seconds of active recovery consisting of 2 x 2.5 jogging. Players must reach the 20-meter line when each beep is heard. The test ends when the participant fails twice to reach the front line in time or cannot cover another shuttle at the dictated speed (Castagna, Impellizzeri, Belardinelli, et ál., 2006). Audio cues of the YYIET were recorded on a CD and broadcast using a portable CD player. The total distance covered during YYIET Level 2 was considered the testing score (Castagna, Impellizzeri, Chamari, Carlomagno, and Rampinini, 2006).

### *Statistical analysis*

Descriptive analysis (means, median, and standard deviation) was performed, and the Shapiro-Wilk test validated the goodness of fit for normality. Finally, to verify the effect of maturity status variability on tactical behavior efficiency, cases were classified into two groups according to the standard deviation of the variability of the years to and from peak height velocity (Y-PHV) across the season, separated by the median.

Subsequently, independent t-tests were performed to compare offensive, defensive, and general tactical behavior efficiency between players with higher and lower maturity status variability. The equality of variances was tested using Levene's test. Effect sizes were calculated using Cohen's d. Values were interpreted categorically as trivial (0 - .19), small (.20 - .59), moderate (.60 - 1.19), large (1.20 - 1.90), and very large (2.0 - 4.0) (Haugen, Danielsen, McGhie, Sandbakk, and Ettema, 2018; Hopkins, Marshall, Batterham, and Hanin, 2009). The significance level was set at $p < .05$. Statistical procedures were performed using SPSS®, version 25.

## Results

Players with higher variability in maturity status (Y-PHV) across the season (Group 2) were significantly more efficient in their defensive (t = -2.367; $p$ = .029; moderate ES) and general tactical behavior (t = -2.507; $p$ = .021; moderate ES) compared to players with lower Y-PHV variability (Group 1) (Table 3).

**Table 3**

*Means and standard deviations of offensive, defensive and general tactical behavior efficiency (TBE), and characteristics of Groups 1 (lower Y-PHV variability) and 2 (higher Y-PHV variability).*

| *Tactical behavior* | Group 1 (n = 10) | | Group 2 (n = 11) | | | |
|---|---|---|---|---|---|---|
| | Means | SD | Means | SD | p | *d* |
| Offensive TBE | 92.21 | 6.13 | 96.61 | 2.81 | .059 | .93 |
| Defensive TBE | 87.33 | 6.96 | 93.23 | 4.26 | .029* | 1.03** |
| General TBE | 89.96 | 5.77 | 94.94 | 3.04 | .021* | 1.09** |

*Note*: SD = Standard deviation; *Significant difference ($p$ < .05); **Moderate effect size (.6 - 1.19).

Accordingly, the effect sizes (close to the threshold between moderate and large) indicate that Group 2 had more than one standard deviation above Group 1 regarding offensive and general tactical behavior efficiency. In addition, players from Group 2 displayed higher values of offensive tactical behavior efficiency (t = -2.145; moderate ES), although the difference is only significant at the $p$ = .059 level.

## Discussion

This study compared groups of young soccer players with low and high variability in maturity status concerning their offensive, defensive, and general tactical behavior efficiency during an entire competitive season.

The findings of this study show that players with greater Y-PHV variability exhibited better tactical behavior in the defensive phase and throughout the entire match. In contrast, players closer

to the PHV made more errors in executing the core tactical principles. In this sense, our results indicate that this maturation indicator and others influence the players' tactical ability. Thus, considering the players' average age at PHV presented in previous studies (Philippaerts et ál., 2006), the most tactically efficient players were further from PHV.

In a previous study by Moran et ál. (2018), the authors found that players furthest from the PHV showed worse performances in 10 m and 30 m sprint tests, as well as in their ability to change direction. Our results confirm these findings, albeit with the caveat that the tests used to assess the ability to change direction in our study and in the aforementioned study were different. Nevertheless, these results indicate the need for coaches to be alerted to the distinction between "fast" and "strong" young players who demonstrate excellent tactical efficiency. After all, tactical ability is an essential variable that distinguishes professional players from amateur players who, in adulthood, will remain amateurs (Kannekens, Elferink-Gemser, y Visscher, 2011).

During the identification and selection of young soccer players, the efficiency of tactical behavior should be a more highly valued aspect. On the other hand, when developing intelligent and creative players for the game, evaluating their tactical ability is essential to guide the planning and choice of activities that the match imposes. Understanding game space management has a latent phase that needs to be better assimilated (Greco, Benda, y Ribas, 1998; Teoldo et ál., 2015b). The combination of an appropriate form of training for individual capacity and exposure to the competitive context must be considered by coaches to better take advantage of each player's performance (Kannekens et ál., 2011).

Besides, continuing a sports career with high motivation also depends on an excellent balance between participation in practice sessions and competitions. On the one hand, practice sessions must have content relevant to improving tactical knowledge (e.g., SSG and phase-of-play activities) (Ford, Yates, and Williams, 2010). On the other hand, competitions must have a difficulty level consistent with the young person's knowledge (Forsman, Blomqvist, Davids, Liukkonen, and Konttinen, 2016; Forsman, Gråstén et ál., 2016). A study by Cumming et ál. (2018) shows that players feel more motivated toward practice when exposed to competitions that take maturation into account for team organization. It also shows that players realize that strength and speed are less important than technique and tactics in soccer. Once again, our results support the idea that young soccer players should participate in matches with players whose biological maturity is equivalent to theirs, as they are slower but have better tactical efficiency.

Regarding tactical behavior in competitive matches, the U-13 and U-15 teams in which the players were placed during the competitive season, regardless of the opponents' quality, maintained a high level of tactical efficiency. The coaches stated that the players who participated in our study were those preferentially selected to take part in these matches. In particular, it is possible to observe that the offensive, defensive, and game tactical behavior exceeded 90% in all five analyzed matches.

**Figure 1**

*U-13 soccer players' Tactical behavior efficiency in a competitive season*

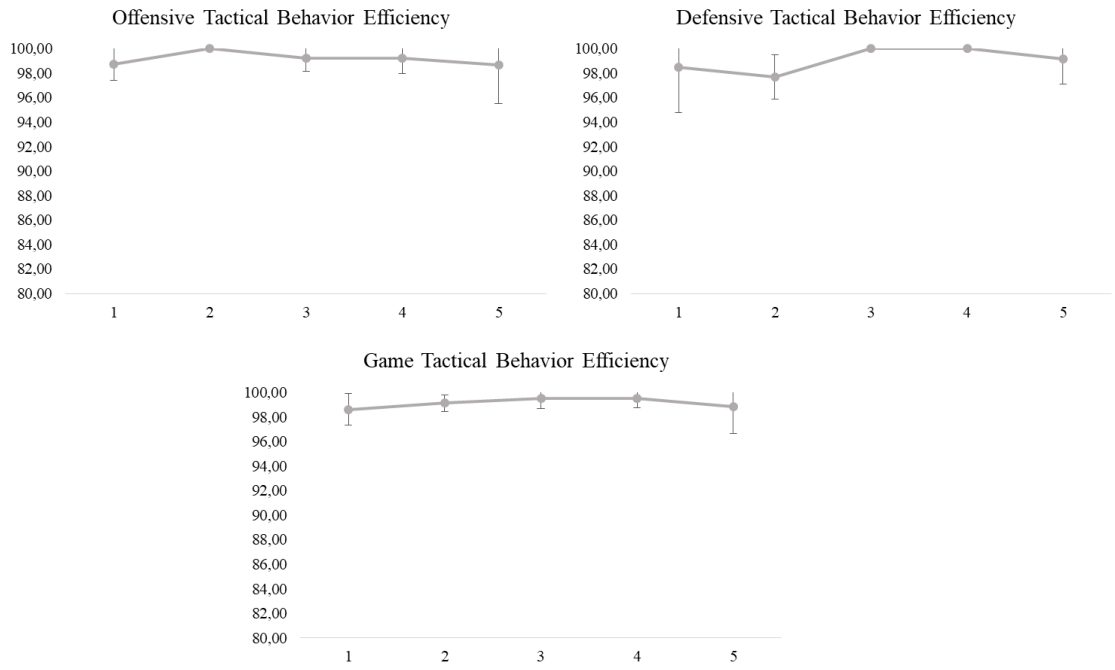
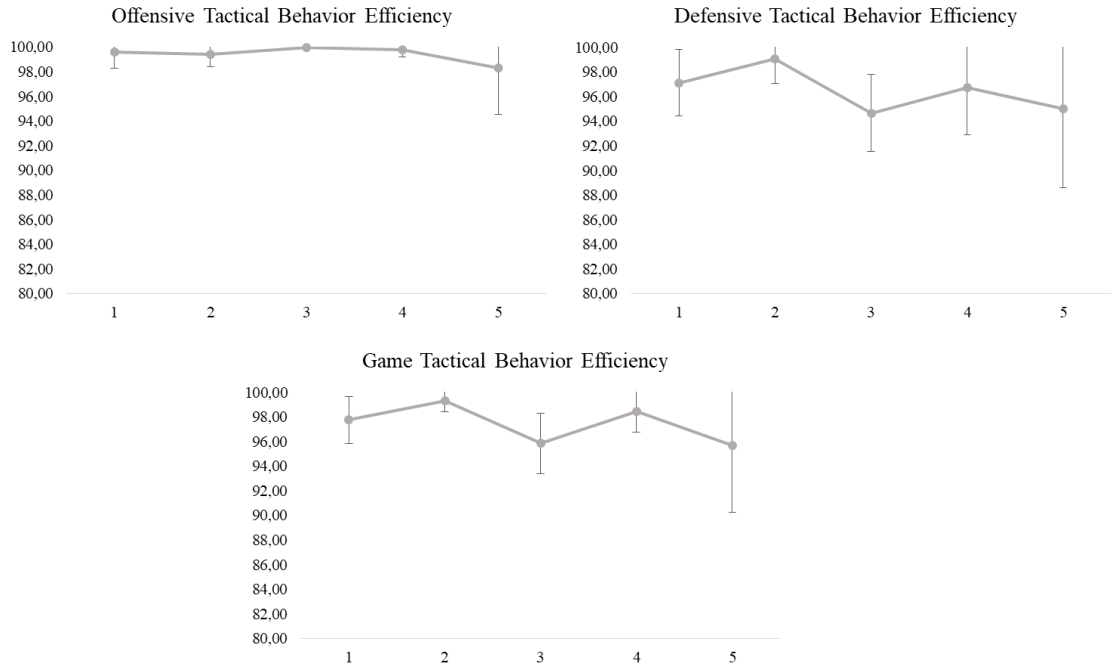



**Figure 2**

*U-15 soccer players' Tactical behavior efficiency in a competitive season*



As previously reported by Forsman, Blomqvist, et ál. (2016), our results are conditioned by the high level of players' tactical behavior. In our study, since they were players with high tactical knowledge, the variation in behavior was minimal during the soccer season. However, our findings show that it is essential to monitor individual biological maturation when working with young soccer players.

In a ten-month analysis of U14 and U15 players' tactical behavior, Praça et ál. (2017) identified that the U14 category did not evolve in terms of tactical efficiency in both the offensive and defensive phases of the game. These results indicate the importance of continuously evaluating players' tactical abilities and providing a training program focused on tactical principles. On the other hand, results from Praça et ál. (2017) also show a considerable evolution in the U15 category; however, unlike in our study, their biological maturation was not assessed. Considering chronological age, we assume that players in the U15 category are closer to the PHV. In bodily terms, this maturation indicator usually causes temporary disorganization in young people. In our study, these players exhibited less efficiency in tactical behavior, as expected.

Analyzing players aged 14.80 ± 1.52 years, Borges, de Andrade, et ál. (2017) showed that advanced players, in terms of maturation, perform worse in managing game space. Our results align with the study mentioned above, as the players closest to the peak of growth velocity also exhibited worse efficiency in tactical behavior. Regarding the study by Borges, de Andrade, et ál. (2017), our study demonstrates advances in how players execute tactical principles in the competitive context and emphasizes the importance of analyzing them over a competitive season, rather than relying solely on cohort analysis. Longitudinal studies in soccer face challenges due to players leaving clubs and potential injuries. In our study, three players did not participate in the evaluation at the end of the competitive season, which limited the number of players. Future studies could analyze the ability to read the game and the time taken for decision-making.

## Conclusion

The peak height velocity affects the efficiency of tactical behavior, conditioning the actions of players closest to this maturation indicator. However, when considering players at a highly competitive level, the efficiency of behavior in official games varies little, even if these players are close to the PHV. The talent identification process must be approached with caution, requiring coaches to use information from various sources. Our study shows that biological maturation is essential in coaches' analyses of players.

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