Correlation between physical, technical and tactical dimensions in under-20 category football players

Correlación entre las dimensiones física, técnica y táctica en futbolistas de categoría sub-20

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Abstract

Introduction: presentation of the topic (maximum two key sentences).
Objective: The objective of the present study was to analyze the correlation level between physical, technical and tactical variables of young football players.
Methodology: 40 under-20 athletes (18 and 19 years old) who were part of 2 professional clubs in João Pessoa city participated to the study. Data collection was conducted on a football field lasting 5 consecutive days, and the players underwent anthropometric assessments, physical tests (speed, agility, VO2 and jump height), technical tests (shooting, passing and dribbling) and tactical knowledge (TacticUP). A canonical correlation analysis was performed for data analysis using the SPSS v.28 program between the three set pairs of physical, technical and tactical variables (e.g., physical and technical, and so on). The prerequisites of the model (linearity, normality of distributions, and absence of multicollinearity) were initially tested.
Results and Conclusions Findings show that there are medium correlations between the technical-tactical and physical-tactical variables, as well as a high correlation between the technical-physical variables.

Keywords

Football, performance, training, team sports.

Resumen

Objetivo El objetivo de este estudio fue analizar el nivel de correlación entre variables físicas, técnicas y tácticas en jóvenes futbolistas
Metodología: Los participantes fueron 40 jugadores sub-20 (18 y 19 años) que formaban parte de 2 clubes profesionales de la ciudad de João Pessoa. La recogida de datos se realizó en un campo de fútbol durante 5 días consecutivos. Los jugadores se sometieron a evaluaciones antropométricas, pruebas físicas (velocidad, agilidad, VO2 y altura de salto), pruebas técnicas (tiro, pase y regate) y conocimientos tácticos (TacticUp). Para analizar los datos, se realizó un análisis de correlación canónica utilizando el programa SPSS v.28 entre los tres pares de variables físicas, técnicas y tácticas. Inicialmente, se comprobaron los prerrequisitos del modelo (linealidad, normalidad de las distribuciones y ausencia de multicolinealidad)
Resultados y Conclusiones: Los resultados muestran que existen correlaciones medias entre las variables técnico-tácticas y físico-tácticas, así como una alta correlación entre las variables técnico-físicas.

Palabras clave

Fútbol, entrenamiento, deportes de equipo, rendimiento.

Introduction

Football is the most practiced sport in the world with more than 265 million athletes, including men and women (Grygorowicz et al., 2013). Therefore, the competition for a prominent place in this modality is enormous.

There is now a broad consensus that a player's performance, and consequently their chances of reaching a professional level, largely depend on physical, technical, tactical and psychological factors (Vayens et al., 2008; Zanini et al., 2020). When comparing professional players with non-professionals, the former demonstrate superior physical, technical and cognitive fitness compared to the latter group which did not reach the professional level (Bennet et al., 2009).

Regarding physical capacity, it is extremely important to highlight that a player covers an average distance of 10 to 13 km during a match, divided into walking, low or high intensity running situations. Therefore, it is a sport that has aerobic and anaerobic demands (Bangsbo et al., 2006), in addition to requiring agility, flexibility, strength and muscular power (Zanini et al., 2020; Bangsbo et al., 2006; Faude et al., 2013).

Physical fitness indicators, such as agility and vertical impulsion, are in turn influenced by anthropometric variables, such as body fat percentage (Zanini et al., 2020).

Another essential prerequisite for a player's performance is technique, which can generally be defined as the ability to execute efficient movements related to time and space (Bedolla, 2003). It is a complex construct formed by several indicators, such as finishing, passing, dribbling, shooting on goal, and tackling, which can be grouped into different categories (goal scoring; attacking; defending; passing and organization). Player performance can also change according to variables such as positioning or situational variables, such as game location or team quality (Yi Q et al., 2020).

A third, increasingly important pillar in the composition of a modern player is called tactical intelligence. This can be defined as the player's ability to make the correct decision when facing a problem with several possible solutions under time pressure in a given situation (Leães & Xavier, 2011; Sternberg, 2006).

On the other hand, tactical creativity is understood as the player's ability to produce innovative, original, and unexpected solutions in their decision-making, making it more difficult for the opponent to predict what will happen (Memmert & Roca, 2019). Good tactical performance and decision-making relevant to the situation of play require complex cognitive abilities whose evolution requires specific training methods (Memmert & Roth, 2003).

In conceptual terms, it is important to note that each action during a game is based on a complex and inseparable unit of physical, technical, and tactical capabilities. Therefore, the magnitude of the correlations between these components is a recurring issue to which several studies with results offer insights of practical relevance (Zanini et al., 2020; Praça et al., 2015; Singh & Singh, 2016; Feltrin & Machado, 2009).

A study (Singh & Singh, 2016), regarding the correlation between physical and technical indicators revealed a medium correlation magnitude between them ($r=0.35^{**}$). In that sense, the authors emphasize that physique contributes to efficient technical performance. However, it is worth mentioning that the correlations between different physical and technical indicators vary considerably, even assuming negative values (-205, -241 and -200), as in the case of speed, muscular strength, endurance and cardiovascular endurance (Singh & Singh, 2016).

The relationship between performance in technical (passing, dribbling and finishing) and tactical (offensive and defensive) indicators was analyzed in a study (Praça et al., 2014), with 24 high-performance athletes in the under-15 category. The results only showed a relationship between dribbling and offensive tactical intelligence (OTI); and scoring and medium OTI r coefficients ($0.3<r<0.4$). All other coefficients were almost null, showing that there is often a discrepancy between "what to do" and "how to do it" (Praça et al., 2014).

Finally, the relationship between physical and tactical was analyzed and also revealed weak to medium associations between offensive and defensive tactical performance indices, and between physical aerobic capacity and muscular power indicators (Borges et al., 2018).

However, despite so many findings in the literature on the subject, we are not aware of studies that relate the three skills altogether (physical, technical and tactical) and their various indicators in young high-performance players.

It is necessary to understand how strong the correlation is between the components that are inherent to high-level football practice. This study therefore aims to analyze the correlation magnitude between physical, technical and tactical variables of U-20 players. We hypothesize that the sets of physical, technical and tactical variables present a moderate magnitude relationship.

Method

Study design and variables

The study design is correlational with a total of 9 variables in total. 4 variables refer to physical measurements: speed, agility, jump height and VO2; 3 refer to techniques: passing, dribbling and scoring; and 2 to tactics: offensive tactical knowledge and defensive tactical knowledge).

Participants

The sample consisted of 40 male players from youth categories (age 19.03±0.83 years; height 175.05±6.36 cm; weight 69.88±6.87 kg; BMI 22.37 ±1.50 kg/m2), members of the 2 professional football clubs in Paraíba. The group of athletes included several positions (defenders, midfielders and attackers) who were part of the teams' squad as starters or substitutes.

Although the athletes are part of the under-20 category, we characterize them as "high-performance athletes", because they dedicate themselves fully to the sport, making it their profession and seeking a financial return from it (Campos et al., 2017). Characteristics that define high-performance sport.

The research period was during the clubs' pre-season. All study procedures, risks, and benefits were previously explained to the subjects, who were asked to sign the Informed Consent Form (ICF) for participation. This project was submitted and approved under number 4,171,263 by the Research Ethics Committee of the Health Sciences Center (CCS) of the Federal University of Paraíba, in compliance with resolution 466/12 of the National Health Council.

Procedure

Data was collected from each club separately for 5 consecutive days (Figure 1). It started on the 1st day with anthropometric assessments, followed by physical, technical and tactical knowledge tests as detailed below.

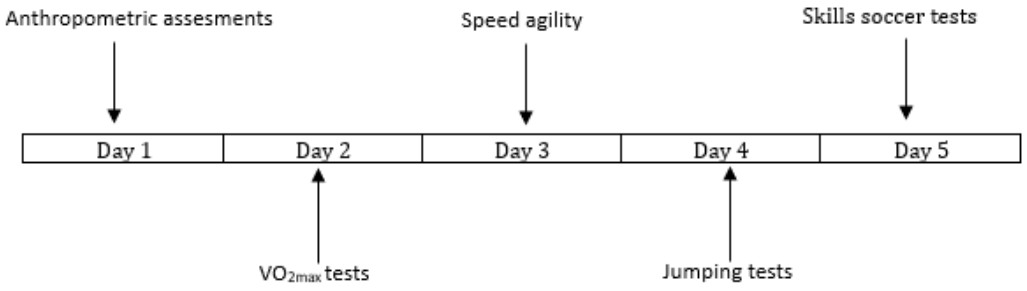
First, height measurements were taken (Sanny stadiometer – Brazil), body mass and anthropometric measurements using bioimpedance (Inbody 270). Recommendations such as not training the day before, eating a maximum of 4 hours before exercise, not using body lotions, among others, were passed on to the athletes before performing the measurements.

Physical capabilities were assessed on days 2 and 3 with VO2max tests carried out on day 2 and speed, agility and jumping tests on day 3. This choice of 24 hours of rest occurred so that no protocol would influence the other. VO2max was assessed using the 30-15 Intermittent Fitness Test (IFT)/(Buchheit, 2008). The 30m Test (Johnson & Nelson, 1975), was used to measure speed, being recorded using photocells (CEFISE) positioned at the departure and arrival points; agility was assessed using a validated protocol used specifically for football, called the Illinois Test (Getchell, 1979); and finally, the My Jump 2 (Hayner et al., 2019) application was used to measure jump height, in which each subject performed 3 attempts and the best (highest height) was chosen for analysis (Rodrigues & Marins, 2011). Then on the fourth day, the fundamentals of precision in passing, dribbling and scoring were chosen to analyze technical skills, in that order, using the General Soccer Ability Skill Test Battery protocol (Mor & Cristian, 1979). It is worth mentioning that all tests were conducted on natural grass and the athletes

were wearing football clothes and shoes, simulating football situations in the most realistic way possible. All tests were explained and demonstrated to research participants in advance.

The athletes' tactical knowledge was analyzed on the last day using TacticUp (Machado & Costa, 2020). The tests were performed individually, for which each athlete had their own laptop, in an air-conditioned environment. The test provided a score for the general index, offensive tactical principles (penetration, offensive coverage, space with the ball, space without the ball, mobility and offensive unity) and defensive principles (containment, defensive coverage, recovery balance, defensive balance, concentration and unity defensive), which range from 0 to 100. Each athlete was accompanied by a trained supervisor who provided the necessary instructions for performing the test. Before officially starting, each participant was allowed 3 attempts to simulate scenes in the program to familiarize themselves with the TacticUp test

Figure 1. Phases of time study.



Data analysis

The prerequisites of the model (linearity, normality of distributions, and absence of multicollinearity) were tested. The data was analyzed using the Statistical Package for the Social Sciences program (SPSS – 28.0).

The mean and SD were initially calculated for all variables. Next, a canonical correlation analysis was carried out between the sets of physical x technical, physical x tactical, and technical x tactical variables, aiming to identify relationships between them. Canonical correlation is the degree of association between two sets of variables. Latent variables (canonical variables) are needed to be able to determine this correlation, which are linear combinations of the original variables. The weight of these so-called canonical functions was determined to maximize the correlation between the two linear combinations (Ribeiro, 2004; Neisse & Hongyu, 2017). It is observed that the maximum number of canonical functions corresponds to the minimum number of variables in the pairs p and q.

Results

Table 1. Mean and standard deviation of anthropometric characteristics, physical, technical and tactical indicators in football athletes.

Variables	Mean±SD
Age	18±0.83
Weight (kg)	69.9±6.87
Height (cm)	177.0±6.36
BMI (kg/m²)	22.4±1.50
Fat (%)	12.0±2.99
VO_2 (ml/kg/min)	50.6±3.07
Speed (sec)	16.0±0.74
Agility (sec)	4.6±0.50
Jump Height (cm)	39.6±4.47
Off. Tat. Perf.*	71.1±6.39
Def. Tat. Perf. *	68.0±8.88
Dribbling (sec)	30.1±2.28
Passing**	7.9±1.86
Scoring***	47.0±17.27

* Scale from 0 (minimum) to 100 (maximum); ** Scale from 0 (minimum) to 12 (maximum); *** Scale from 0 (minimum) to 160 (maximum); Legend: Off. Tat. Perf. = Offensive Tactical Performance; Def. Tat. Perf. = Defensive Tactical Performance. ** Scale from 0 (minimum) to 12 (maximum);

In turn, the standardized weights (coefficients) $\vec{U}$ and $\vec{V}$ of the canonical equations Fx1 and Fy1 are presented, in addition to the correlation coefficients (CR) between the functions Fx and Fy, and finally

Cohen's set correlation (1982), which is a type of multiple correlation between the different sets analyzed. Other parameters sometimes used for interpretation are canonical charges and canonical cross charges. However, these are unnecessary for the purposes of this study.

Table 2. Weights of the indicators of the 1st canonical equation and canonical correlations.

Technical indicators	$\vec{U}$	Tactical indicators	$\vec{V}$
Passing	0.66	OTUP	-0.22
Shooting	0.-97	DTUP	-0.99
Dribbling	0.41		
	CR_1=0.32; CR_2=0.18		

Legend: OTUP = Offensive Tactic UP; DTUP = Defensive Tactic UP.

The results presented show that the canonical correlations between the sets of technical and tactical variables present values in the 1st equation of r=0.32 and in the 2nd equation of r=0.18. The result is not significant (P=0.52). The Cohen (1982) set coefficient is R_{xy}^2=0.13 (R_{xy}=0.37) which is considered as medium size. This parameter represents the shared variance (13%) between technical and tactical variables.

Table 3. Indicator weights in the 1st canonical equation and canonical correlations.

Physical indicators	$\vec{U}$	Technical indicators	$\vec{V}$
IFT	0.80	Dribbling	-0.33
Agility	-0.07	Passing	-0.89
Speed	0.14	Shooting	0.49
Jumping	0.58		
	CR_1=0.60; CR_2=0.30; CR_3=0.22		

Legend: IFT = Intermittent Fitness Test.

The correlations between the three pairs of canonical variables for the sets of physical and technical indicators present values of r=0.60; r=0.30 and r=0.22, respectively. Regarding the significance level, r=0.60 reaches an almost significant value of P=0.052. On the other hand, Cohen's set coefficient presents values of $R_{xy}^2 = 0.45$ ($R_{xy} = 0.67$), which is considered a high value. These high values cannot be interpreted in a causal sense; however, they indicate a certain limiting relationship between physical and technical indicators in the sense that athletes need physical qualities in many actions to be able to perform technical gestures, such as speed and agility for dribbling, the strength to shoot, or impulsion to head in/out the ball in offensive and defensive situations.

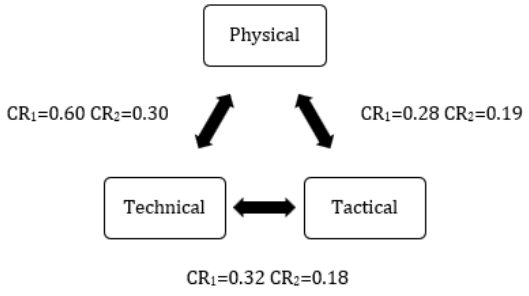
Table 4. Indicator weights in the 1st canonical equation and canonical correlations.

Physical indicators	$\vec{U}$	Tactical indicators	
IFT	-0.83	OTUP	0.01
Agility	-0.16	DTUP	0.11
Speed	0.08		
Jump	0.48		
	CR_1=0.28; CR_2=0.19		

Legend: IFT = Intermittent Fitness Test; OTUP = Offensive Tactic UP; DTUP = Defensive Tactic UP.

Finally, the canonical correlations between the physical and tactical indicators show values for the 1st equation of r=0.28 (P=0.83) and the 2nd of r=0.19. Unlike the previous correlation (physical and technical) which presented high values, this time the collective correlation presented an average value of R_{xy}^2=0.12 (R_{xy}=0.34).

Figure 2. Values of the canonical correlations between the variables.



Discussion

The objective of the present study was to analyze the relationships between the variables of the physical, technical and tactical dimensions of U-20 players through the calculation of correlations between components in pairs. The main results show medium correlations between technical-tactical and physical-tactical indicators, and high correlations between physical-technical. It is worth noting that the findings presented are results of synthesized variables, latent dimensions constructed from the original variables to which weights were assigned (Ribeiro, 2004).

Like other studies in the literature about the same topic (Praça et al., 2015; Aquino et al., 2016; Orozco et al., 2021) Two different tests were used to assess tactical knowledge (Machado & Costa, 2020) and technical skills (Mor & Cristian, 1979).

In a study investigating the correlation between offensive tactical knowledge measured using the FUT-SAT (Costa et al., 2011), assessment system, and motor skills through ball control, scoring, passing and dribbling tests in 15 young under-11 players, it was observed (as in the present study) that the correlations between these factors were not high and also without significance (Aquino et al., 2016). Similarly, another study in the literature (Praça et al., 2015) presents a weak correlation between technical and tactical factors in football.

These findings can be explained by the fact that most analysis are carried out with "closed tasks", which are tests that only evaluate athletes' motor gesture in isolation, without taking into account the situation of a match in which they are involved. This limitation affects the magnitude of the correlations analyzed, as they only consider the technical gesture carried out in question and disregards when and how it should be carried out.

The authors point out the need to analyze the technical tests that are being used to evaluate these skills, as they do not take into account parameters such as variability and unpredictability (Aquino et al., 2016). This may indicate a limitation in the assessment of athletes' technical performance, which is discreet, not very complex and predictable when compared to the adaptive demands requested in a match (Praça et al., 2015).

Therefore, as it is a complex sport which requires the athlete to perform several technical actions in sequence at different times (Ali, 2011), and given the results found with medium correlations and without significance between tactics and technique, it is of greater interest that the focus is on technical assessments that aim to efficiently execute according to real game situations (Aquino et., 2016).

Our results regarding physical-technical correlations present a high correlation value (R_xy^2==0.45) and a near significance P=0.052 between these indicators. Although an agile movement with the ball is sometimes difficult to execute (Sporiš et., 2011), our findings are consistent with the results of the study by Singh & Singh, in which the authors emphasize the relevance of certain physical capabilities for good technical performance (Singh & Singh, 2016).

However, they differ in part from another study that examined the relationships between speed, jump height and agility in situations with and without the ball in 15 young players which obtained only moderate and non-significant correlations between these indicators (Köklua et al., 2015). This divergence can be explained by Scharfen & Memmert (2021) when analyzing the correlation between physical and cognitive factors, showing that there is no strong correspondence between these indicators. The authors report that there is no universal explanation for the links between cognitive and physical abilities, as both are very specific. The same can be justified for the correlation between technique and physical indicators (Scharfen & Memmert, 2021).

The results in Table 4 show that there are average correlations between physical and tactical indicators. Studies in the literature are still scarce when it comes to correlations between these indicators, specifically as in the present study. However, some already address tactical correlations and maturational factors in football (Borges et al., 2018; Cardoso & Teoldo, 2016; Costa et al., 2010) and show that these advanced factors can often present physical advantages to young athletes; however, they are not necessarily accompanied by tactical and even technical development (Borges et al., 2016).

This statement is reinforced by a study that compared tactical performance using Fut-Sat, anthropometric indicators and physical capabilities in 48 young players who were in the pre- or post-

peak growth velocity state. The findings revealed that although athletes who were in the post-peak growth velocity were better in the physical tests of strength and vertical jump, they were only superior in 3 of the 10 tactical principles observed, which demonstrates a weak correlation between these factors (Borges et al., 2017).

Although it seems possible that physical factors, such as aerobic metabolism, have a possible influence on offensive and defensive tactical actions, as both require good cardiorespiratory capacity (Santos & Soares, 2001), it is seen in the literature that tactical action and decision-making are much more correlated to perceptual-cognitive factors. Athletes who have these more developed skills will consequently be better in this area (Cardoso & Teoldo, 2017). Therefore, the findings presented in the current and other studies are explained in relation to the correlation of these two factors.

Conclusions

This study brought together high-performance players from the under-20 category from two professional clubs who underwent various physical, technical and tactical protocols aimed at football. The variables collected had not yet been correlated and analyzed in the manner presented herein. Findings reveal that the physical, technical and tactical factors generally correlate in a medium to high magnitude with each other, however non-significantly.

In a practical way, the study can guide clubs, coaches and technical committees to possibly use new trends in tactical intelligence protocols, such as TacticUp, as well as review technical training methods aiming to create tests which provide more game-related situations and seek more cognitive capacity of the athlete.

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