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Factor Analysis for detection of sports talent in football players

Análise Fatorial para detecção do talento esportivo em jogadores de futebol

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ABSTRACT
Verify the applicability of Factor Analysis - FA by crossing the variables obtained with the tests proposed by a protocol for detecting talent, anthropometry, flexibility and strength. The sample included 38 under-19 athletes from Cuiabá Esporte Clube. The evaluation consisted of the application of the iSports test protocol to detect sports talent, anthropometric tests (weight, height, BMI, WHR), flexibility test (sit and reach), manual strength test (Hand Grip) and vertical impulsion test. Through PA, 14 variables were reorganized into 4 new factors taking into account their commonalities and variances. Each new factor presents correlations between 2 or more variables that were discussed later. This type of multivariate statistical analysis proved to be efficient for grouping of data and for the possibility of being applied as a tool that helps and seeks to contemplate the multidimensionality of the identification of sporting talents.

Keywords: Multivariate analysis. Soccer. Sports performance.

RESUMO
O objetivo deste trabalho é verificar a aplicabilidade da Análise Fatorial - AF através do cruzamento das variáveis obtidas com os testes propostos por um protocolo de detecção de talento esportivo no futebol, antropometria, flexibilidade e força. Participaram da amostra 38 atletas da categoria sub-19 do Cuiabá Esporte Clube. A avaliação consistiu na aplicação do protocolo de testes *iSports* para detecção do talento esportivo, testes antropométricos (massa corporal, estatura, Índice de Massa Corporal - IMC, Relação Cintura e Quadril - RCQ), teste de flexibilidade (Sentar e Alcançar), teste de força manual (*Hand Grip*) e teste de impulsão vertical. Através da AF, 14 variáveis foram reorganizadas em 4 novos fatores levando em consideração suas comunalidades e variâncias. Este tipo de análise estatística multivariada se mostrou eficiente para o reagrupamento de dados e para a possibilidade de ser aplicada como uma ferramenta que contemplar a multidimensionalidade do talento esportivo.

Palavras-chave: Análise multivariada. Desempenho esportivo. Futebol.

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INTRODUCTION

Over the years, interest in research on the development and identification of sporting talent of football players has increased [1,2]. The identification, recruitment and development of young players is an extensive and promising area of professional football. Various agents such as coaches, scouts, sports scientists and

administrators are involved, usually funded from large facilities [3].

Several protocols for identifying sporting talent were built over the years, one of these was proposed by Louzada, Maiorano and Ara (2016) [4]. Through a multivariate approach, the authors developed indicators to evaluate football players using statistical techniques. These indicators were organized in the form of a protocol in a software with an innovative virtual interface called iSports, capable of comparing football players through physical and technical performance tests.

Even with all the advances in research on the subject, there are still coaches who restrict the process of identifying sporting talent to a subjective analysis of the athlete [5,6]. Traditionally, identification takes place through the visualization of athletes in an experimental game environment, where they seek to draw the coaches' attention [7]. With the progress of research, it is recognized that the identification of a sporting talent is a multidimensional process and involves physiological, biomechanical, technical, anthropometric, psychological, sociological, motor learning and sociodemographic variables [1,3,7-11].

Seeking a greater conception of talent identification, Johnston et al. (2018) [10], through a systematic review, verified in their study that there was an over-representation of research related to physical profiles and a greater expression of the variables height, body mass, maturity level, sprint tests, strength and agility tests. In fact, the development of a protocol meeting the full dimension of talent identification would require hard work on the part of researchers.

Factor Analysis - FA is a set of statistical procedures within the scope of multivariate analysis that reveal the implicit associations within a data set. This technique is able to understand the complex relationship patterns of a variable with all the others, and through this reduce the data to a smaller set of variables that present a greater amount of information [12].

The researchers' hypothesis was that through the application of FA, a new set of variables would better represent the collected data, which would serve as a basis for further studies that seek to contemplate the multidimensionality of the phenomenon of sporting talent identification.

Thus, by crossing the variables of the tests proposed by the iSports talent detection protocol, anthropometric, flexibility and strength analysis, this study aimed to verify the applicability of FA in the best representation of information collected from football players from the under-19 category of the Cuiabá Esporte Clube.

METHODOLOGY

STUDY DESIGN AND SAMPLE SIZE

The exploratory research raised information about the identification of talents in football. The sample consisted of a group of 38 individuals (body mass 69.84

± 8.99 kg; height 1.75 ± 0.08 cm; Body Mass Index - BMI 22.7 ± 1.95 kg/m²) all men, football athletes, under-19 category, from Cuiabá Esporte Clube. Contact was made with the technical committee of the team who, after explanation, voluntarily agreed to participate in the research.

The study included all club athletes from the aforementioned category, gathered in an afternoon in the middle of the game season. The athletes did not report any injuries or problems that would make their performance in the tests unfeasible. All of them signed the Informed Consent Form - ICF. The research was approved by the Research Ethics Committee of the Hospital Universitário Júlio Muller - HUJM (CAAE: 92144218.5.0000.5541) in accordance with Resolution 466/12 of the National Health Council.

TOOLS AND VARIABLES

- Anthropometric measurements: To collect body mass (BM) in kilograms (kg) and height (H) in meters (m), a Welmy W110H platform-type scale was used, with a maximum capacity of 200 kg and accuracy of 100 g. Anthropometric measurements were evaluated according to the conventional techniques described by Pitanga (2008) [13]. To measure waist and hip circumferences, the subjects remained in an orthostatic position. A Cescorf inextensible flexible metallic tape measuring 2 meters in length and 0.01 cm precision was used to measure the circumferences of the body segments.

- Flexibility test (Wells Bench Test / Sit and Reach): The Canadian standardization of physical fitness assessment tests from the Canadian Standardized Test of Fitness (CSTF) manual was followed [14]. The athlete remained seated with his feet supported on the bench. The evaluated individuals were instructed to keep their arms extended in front of the body with one hand over the other and flex the trunk over the hip, pushing the ruler over the box, without flexing the knees and without removing the feet from contact, reaching a maximum distance. The best result of 2 attempts was taken.

- Hand grip test: A manual dynamometer Grip Saehanmedical®, model SH5001 Hydraulic Hand Dynamometer, with a 0 to 90 kg scale, was applied. The athlete performed the test with his dominant hand, which should be along the body with the arm extended, the best result of 2 attempts was taken. This protocol followed the guidelines proposed by Marins and Giannichi (2003) [15].

- Vertical Impulse Test: The test was performed on a contact mat connected to a computer with specific software (Multi Sprint Full). The evaluated individuals followed the following instructions: they remained standing with their hands on their hips and jumped vertically as high as possible with the knees extended. The value of 3 measurements was recorded and the average of the three attempts was

calculated. This test originated four variables, average jump height, average flight, average contact between jumps and average power. The procedures were in agreement with those adopted by Bosco countermovement jump protocol [16], however, maintaining 3 jumps for 15 seconds.

- Sports Talent Identification Protocol (iSports Protocol): This protocol comprises six tests, three of them arranged in technical skills (Mor-Christian Passing Test, Five Cone Dribbling Test, Kicking After Pass Test), and three physical tests (1000 meter track test, 20 meter Cyclic Speed Test, Anaerobic Power Test). This protocol was proposed by Louzada, Maiorano and Ara (2016) [17] aiming to guide the search for sporting talent in football. Through the analysis of the results, the following scores are proposed: physical score, an indicator responsible for measuring performance only in physical tests; technical score, an indicator that only assesses the performance of individuals in technical skills tests; general score, an indicator generated to assess the six tests as a whole and provide an overview of the individual's overall performance; consistency: indicator that shows the athlete's general performance considering the joint values of the others.

All variables analyzed in this study are summarized in Table 1 below.

Table 1. Summary of the variables of the tests used

Variables (unit of measurement)	Representation
General Score	X1
Physical Score	X2
Technical Score	X3
Consistency	X4
Height (cm)	X5
Body Mass (kg)	X6
Body Mass Index (kg/m²)	X7
Wells Bench Mean (cm)	X8
Hand Grip: Manual Dynamometry (kgf)	X9
Jump Mat: Average Flight Time (s)	X10
Jump Mat: Average Jump Height (cm)	X11
Jump Mat: Average Jump Power (hertz)	X12
WHR: Waist-Hip Ratio (waist circumference/hip circumference)	X13
Jump Mat: Average Contact (s)	X14

Sorce: Created by the authors.

DATA COLLECTION

The tests were applied in the afternoon and the athletes were in the middle of the games season. The evaluation stations were properly prepared to receive the athletes following this order of tests: i) Collect the body mass and height for later calculation of the Body Mass Index - BMI; ii) Measure waist and hip circumference to

assess the Waist-Hip Ratio - WHR; iii) Flexibility Test through the Wells Bench; iv) Hand grip test using a dynamometer; v) Strength-power test for lower limbs through the Jump Mat. Then, the six tests proposed by the iSports protocol were performed.

The laboratory collection team was trained through theoretical and practical presentations on how to proceed in the course of the tests. As these are routine laboratory assessments, the same battery of anthropometric and physical tests has already been replicated in other research. However, the technical error of intra and inter collaborators measurement was not verified, as well as the index to compose the research collection team.

STATISTICAL ANALYSIS

Factor analysis provides an approximation of the dispersion matrix by grouping variables into groups called factors, and thus suggests that these factors can explain dispersion more simply. Its usefulness is proven if the new groups arising from the random variables present a high correlation so that these regrouped variables do not correlate with the other external ones [18]. Factor analysis can be used to determine the constructs evaluated by a performance test, for example [12].

In this study, Bartlett's test of sphericity was used in order to verify whether factoring could be applied to the data matrices, for later carrying out FA in the data. Values closer to 1 are considered high commonalities, while values ≤ 0.6 are considered low. Thus, variables with values close to 1 demonstrate greater importance in the analyzed model. There are cases where an appropriate interpretation of the extracted factors using the factor loadings is not obtained, there are cases where there is more than one factor and the variables are not clear enough. In this study, the Varimax method was used to rotate the coordinate axes orthogonally, minimizing the number of variables with greater loads on each factor. To perform the statistical analysis, the R statistical program version 3.5 was adopted.

RESULTS

The means, standard deviations, medians, minimum and maximum values of all variables analyzed in our study are presented in Table 2. The investigation was censused for the club's under-19 category, so there was no refusal by the athletes to participate in the sample.

Table 2. Descriptive analysis of the variables addressed in the study

Variables	MEAN	SD	MEDIAN	min	max
X1	78.45	8.15	79.64	55.97	92.94
X2	93.81	6.55	96.11	70.74	99.69
X3	68.35	13.74	69.22	40.64	93.74
X4	7.32	7.43	5.05	0.35	29.94
X5	1.75	0.08	1.74	1.63	1.92
X6	69.84	8.99	67.65	51.8	88.3
X7	22.7	1.95	22.71	18.27	26.63
X8	30.62	6.41	30.5	20	46.75
X9	37.95	6.19	37.5	25	48
X10	29.94	4.45	29.6	15.33	38.82
X11	26.24	6.53	26.58	8.47	41.4
X12	384.75	78.49	378.33	220	587
X13	0.81	0.03	0.8	0.76	0.88
X14	1.4	0.53	1.28	0.7	2.81

Note**:** Table 2 shows the means, standard deviations, medians, minimum and maximum values of all variables analyzed in this study.

To determine the applicability of the factor analysis, the Bartlett's Sphericity test was performed to indicate whether there was a sufficient relationship between the variables. The test presented a p-value < 0.001, therefore, rejecting the null hypothesis that the data matrix is similar to the identity one. Thus, factorial analysis can be applied to the database.

Table 3 shows the factors and commonalities, variance of each variable in the FA model obtained. The variables with the greatest commonalities in ascending order were BMI (0.8745), general score (0.9055), average power (0.9199) and body mass (0.9270). The only variable that obtained a value below 0.6 was the average jump height.

Table 3. Factor loadings rotated by the Varimax method and commonality of each item

Variables	Factor 1	Factor 2	Factor 3	Factor 4	Commonality
General Score		**-0.917**	-0.181	0.178	0.9055
Physical Score	-0.184	-0.506	**-0.602**		0.6592
Technical Score		**-0.788**	0.253		0.6930
Consistency		**-0.780**	-0.371		0.7523
Height	**-0.738**		-0.101	-0.305	0.6548
Body Mass	-0.51	0.101		**-0.809**	0.9270
BMI		0.248		**-0.901**	0.8745
Wells Bench	**-0.706**		0.258		0.5696
Hand Grip	**-0.847**	-0.207	-0.21		0.8056
Average Flight	**-0.717**		0.12	-0.147	0.5538
Average Height	-0.398	**-0.487**	0.477	-0.2	0.6629
Average Power	-0.568	-0.28	0.328	**-0.641**	0.9199
WHR			**0.666**		0.4459
Average Contact	**-0.712**	0.165		-0.175	0.5746

Sorce: Created by the authors.

The variables were grouped into 4 factors according to the variance shown by each one. The factors, the variables with greater expression and the names created for each factor are shown in Chart 1 below.

Chart 1. Expression of variables for each factor and their names

FACTOR	VARIABLES	Names
FACTOR 1	Height	Height, flexibility and strength
	Wells bench	
	Hand grip	
	Average Jump Flight	
	Average Jump Contact	
FACTOR 2	General Score	Performance with an average height of jumps achieved
	Technical Score	
	Consistency	
	Average Jump Height	
FACTOR 3	Physical Score	Physical aptitude and WHR
	WHR	
FACTOR 4	Body Mass	Body dimension and power
	BMI	
	Average Jump Power	

Sorce: Created by the authors.

As observed in Table 3 and outlined in Chart 1, through FA we verified that the 14 originally proposed variables can be grouped into 4 main factors. Factor 1 correlates the variables height (X5), flexibility of the lower limbs (X8), isometric forearm strength (X9), longer average flight time (X10) and contact (X14), presenting two positive indexes for explosive strength of lower limbs. Factor 2 expresses the general performance of the evaluated individuals through the general score (X1), the technical competence represented by the technical score (X3) and also consistency (X4), associated with an average height of the jumps (X11) in the explosive strength test for upper limbs. Factor 3 relates the physical score (X2), representing the physical performance of those individuals evaluated by the iSports protocol, with the WHR (X13). Factor 4, on the other hand, relates the body mass (X6) and consequently the BMI (X7) of the individuals with the best average power (X12).

DISCUSSION

By applying FA in the original set composed of 14 variables, 4 factors were obtained that best represent and group them according to their correlations. The generation of these new factors confirms the hypothesis determined by the researchers and offers an example of application of a tool that can help to contemplate

multidimensionality in the identification of sporting talents.

Factor 1 generally suggests the relationship between height, flexibility and strength. In Football, the player's advantage on the field derived from height is recognized, but the ability to withstand physical contact is equally important, thus highlighting the body mass and their physical structure as factors to be considered [19]. In the category evaluated in this study (under-19) it is important to be aware of differences arising from biological maturation. Therefore, when dealing with the identification of sports talent and physical fitness, it should be kept in mind that the maturation process varies from individual to individual [20]. The dispersion measures presented in Table 2 support the understanding of the difference existing in the analyzed sample.

With regard to flexibility and strength, there is evidence that muscle stretching promotes increased protein synthesis through increased muscle volume [21]. Adequate and well-structured planning of a flexibility program allows to improve the efficiency of muscle contraction by improving motor recruitment capacity and facilitate through less activation and greater performance of the muscle fiber for contraction and generation of rapid contraction, and jumping ability in football [22].

Football as a modality requires the use of different actions in the game that are associated with the use of force and its variants [19]. Considering the action of soccer athletes of performing sprints, short displacements at high intensity with short recovery periods during the matches, in addition to specific training for speed development, a strength-power training regimen is highly recommended, with a view to positive relationship between these variables [23]. With the exception of Factor 3, it was observed that all the others were related to some index of the explosive strength test for lower limbs, highlighting the importance of this variable for the performance of soccer players.

As highlighted above, the iSports protocol consists of six tests, three of them of technical quality, generating the technical score, and three of physical quality, generating the physical score. The general score relates the individual performance of each athlete in the six tests applied, while the consistency analyzes the joint values of all analyzed individuals.

Observing Factor 2 and the correlated variables (general score, technical score, consistency and average height of the jumps) the following considerations can be made: first, the fact that consistency has shown a strong correlation with the general score must be related to the fact that both present an interdependence relationship between them, considering that the consistency results are given by the analysis of the athletes' general score; second, the values obtained with the technical score, when third, the average height of the jumps (cm) is directly related to the force used in the jumps, this relationship reinforces the association

between specific sports actions in soccer and the development of strength [18].

Factor 3 showed a correlation between the physical score and WHR variables. The WHR index is a method to determine the accumulation of visceral fat mass in the abdominal cavity [24]. The level of physical fitness is directly associated with changes in parameters such as body mass, BMI, fat percentage and WHR [25]. Therefore, the physical level is closely linked to the WHR.

Finally, Factor 4 showed a correlation between the variables body mass, BMI and the average power of the jumps. In football players, the prevalence of overweight, assessed by BMI and its strong relationship with the percentage of body fat, indicates a negative effect on physical fitness [26]. The body composition presents important information about the athlete's general performance, one of the capacities directly influenced is the power [27]. Total fat in kg is correlated with the fatigue index, which presupposes that it acts directly on the performance decline [27].

The study of anthropometric and physical performance variables can generate useful information in the detection and selection of talents [28], but they are not the only means to be considered in this vast process. Research approaches in anthropometry, physiology, psychology and sociology, as well as genetic components in sport performance and the influence of the environment, should not be overlooked, and it is increasingly highlighted that sport and exercise science play a key role in the processes of identification, monitoring and promotion of talented soccer players [29]. Despite the segregation of each factor and separate explanation of the influence of each analyzed variable, elite soccer players must adapt to the multifactorial requirements of the game. To reach a high level of performance, athletes need to develop both adequate physical conditioning and refined technical skills in the sport.

In the literature, although the multidimensional nature of identifying sporting talent is discussed, many studies have adopted a one-dimensional or restrictive stance by focusing on few dimensions [10]. The study by Williams et al. (2020) [11] brings important considerations about the identification and development of sports talent in soccer. Among their contributions, the authors highlight the predictors of sporting talent and their interactions, as well as mediating factors capable of affecting each measure identified, such as life events, maturation and sociocultural context.

Although the iSports protocol is yet another mechanism to identify future sporting talents, this method takes into account only technical and physical factors and disregards, for example, psychosocial factors that are also of great importance in determining an athlete's optimized performance and will interfere with the development of their talent [9]. In addition to these, the inclusion of neuroscience and genetic variables are equally necessary. Longitudinal studies with constant

monitoring of young athletes, taking into account the biological maturation process, are recommended [3]. Another important limitation of this study was the lack of determination of a technical error index to avoid bias in the evaluation team, thus highlighting the importance of validation and revalidation of tools and methods in future studies.

However, despite not representing the totality of talent detection, this research showed that it is efficient to use FA in the grouping of variables to better represent the information of a sample. This method thus represents an important tool not only for determining future talent detection protocols, but any topics in the field of physical education that present a wide range of variables capable of characterizing a sample.

CONCLUSION

Through this study, it was possible to prove the use of Factor Analysis as an important procedure capable of assisting in protocols for detecting sporting talents in soccer. The 14 variables analyzed were reorganized according to their variance and gave rise to 4 factors (Factor 1 - height, flexibility and strength; Factor 2 - Performance with average jump height achieved; Factor 3 - Physical fitness and WHR; Factor 4 - Body size and power) capable of representing the under-19 athletes of Cuiabá Esporte Clube.

As a statistical method, Factor Analysis correlates random variables, being, therefore, useful in determining new constructs that appreciate a specific phenomenon. The nature of the variables in this study were modality, physical conditioning, anthropometric, flexibility and strength techniques. As a suggestion for further research, the creation and validation of a protocol that quantifies, in addition to the specific technical skills of soccer, all the elements that interact for the formation of athletes is recommended. FA proved to be efficient and is an alternative to contemplate the multidimensionality of detecting sports talents, optimizing the processing of the evaluated and presented information.

PRACTICAL APPLICATIONS

This exploratory research proposed and confirmed the use of Factor Analysis as a statistical method capable of joining the field of physical education and being an alternative representation of data collected regardless of the field of research. The detection of sports talent, in general, comprises a range of variables that are related to define the performance of athletes. Faced with this multidimensionality, FA is a tool capable of assisting in the interpretation and presentation of information collected by professionals in the field. It is suggested to collect a larger number of representative variables for talent detection in future studies, as well as a longitudinal approach to better control the athletes' evolution

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