Do football athletes in the under-20 and professional categories have similar anthropometric and physical characteristics?

https://doi.org/10.11606/issn.1981-4690.2022e36183678

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Abstract

Of this study was to compare the anthropometric characteristics and physical capacities of soccer athletes in the under-20 and professional categories. For this, 53 soccer athletes, selected in a non-probabilistic way (32 athletes from the under-20 category [18.4±0.7 years old] and 21 from the professional one [24.7±4.1 years old]) were subjected to anthropometric evaluations (weight, height, index of corporal mass and corporal composition), and physical evaluations (flexibility, aerobic and anaerobic capacity and vertical jumps). The results showed that in the anthropometric evaluations, the under-20 category presented lower values for the body mass variables, body mass index and fat percentage ($p<0.05$), but without significant difference in height ($p>0.05$). In the physical evaluations, the under-20 category presented higher aerobic capacity compared to professionals ($p<0.05$), maximum and average anaerobic power ($p<0.05$), but not in the fatigue index ($p>0.05$). In relation to professionals, the under-20 category presented higher results in vertical jump, Counter Movement Jump and Squat Jump tests, besides showing higher flexibility ($p<0.05$). Age demonstrated positive correlation only with body mass index (0.685) and fat percentage (0.526); and negative correlation with aerobic fitness (-0.457), average anaerobic power (-0.342), Squat Jump (-0.388) and flexibility (-0.662) ($p<0.05$). It can be concluded that the under-20 category had better anthropometric and physical indexes in relation to professionals. Thus, it may be beneficial using the under-20 athletes at the beginning of the season to gain experience in the professional category and to readapt the professional ones.

Keywords: Soccer; Physical evaluation; Body mass index; Fat; Oxygen consumption.

Introduction

Soccer is one of the most popular team sports in the world, offering several preparatory categories to the professional, and it has complex characteristics. Thus, the performance variables of soccer athletes are extremely important[1,2]. Motor components such as strength, power, speed, aerobic and anaerobic endurance, as well as body composition of players have a direct relationship with their performance, associated with morphology: their tactical and psychophysiological technique[3-5].

Soccer is considered a sport of extreme complexity, not only for its characteristics, but also for the occurrence of intermittent actions. During the specific games or trainings that the sport proposes, players are required to perform movements of acceleration, deceleration, jumps, spins, physical contact, fast decision making, change of direction in short, medium and/or long spaces and with high intensity[6-8]. It demands from athletes an excellent level of physical conditions and the ability to use them efficiently, facing the situations that arise during the 90 minutes or even the 120 minutes of a match[9].

Therefore, soccer players routinely need to perform some tests which measure their variables, especially in the early stages of their training. These measures can be performed in laboratories and/or on the pitch through several tests that have aerobic and anaerobic predominance[10-11,8,5]. It is of great importance to know the anthropometric profile and physical abilities of athletes and to be aware that the category under 20, among the several that precede the professional category, is the one that is closest to this level. Thus, checking the different variables between the categories may help coaches and/or physical trainers organize and plan the training in a general and/or specific way[8,2,6,5].

In this sense, previous studies have made comparisons of anthropometric variables, body composition and physical capacities in male and female athletes, as well as correlations[8,4,2,5]. Those studies have compared several under-17 and under-19 basic categories with professionals or exclusively with the under-20 category. However, there is no scientific consensus on the relationships between the under-20 category and the professional one[12,3,6].

Our study, therefore, aims to compare the anthropometric and physical characteristics of under-20 soccer athletes with professionals. Our hypothesis is that soccer athletes belonging to the under-20 category may present similar characteristics in anthropometry and body composition, whereas those belonging to the professional category present better physical performance.

Methods

Type of Study and Sample

This is an experimental research on cross-sectional design. 53 soccer athletes selected in a non-probabilistic way and with convenience technique were investigated in the study: 32 players from the under-20 category (age: 18.4±0.7 years) and 21 from the professional category (age: 24.7±4.1 years). The selected athletes participated in national and state level competitions in the Northeast region of Brazil. All the evaluations were always carried out in the same period of the day, between 8am and 10am.

The following inclusion criteria were adopted to analyse the data: a) conclusion of the entire experimental protocol by the athlete; b) no musculoskeletal injury during the performance of the tests that would make it impossible to perform them; c) being authorized by the medical department of the club; and d) being from the professional or under-20 team that would dispute the state/national competition.

Informed consent

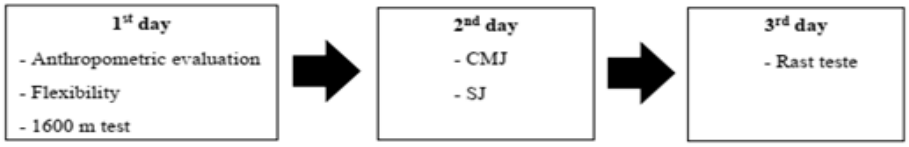
Before starting the research, all the participant athletes, as well as their guardians (for those who were under eighteen years) were notified about the study procedures and signed an Informed Consent Form (ICF).

Ethical approval

All the procedures used followed the regulations required by Resolution 466/2012 of the National Health Council on research involving human beings. This study was part of the project submitted and approved by the Research Ethics Committee, under registration number 212.091.

Study Design

The experimental protocol was divided into three stages: 1) First, the athletes were subjected to anthropometric evaluation, body composition and flexibility, followed by an aerobic capacity test (1600 meters). 2) Two days later, they underwent the vertical jump tests in Counter movement jump (CMJ) and the Squat jump (SJ). 3) Finally, on the third visit, they did the RAST (running anaerobic sprint test). The visits were all after a minimum interval of 48 hours. The experimental design is shown in FIGURE 1.



Note:
CMJ: Counter Movement Jump;
SJ: Squat Jump;
RAST: Running anaerobic Sprint;
Interval of 48h between the days of the protocol.

FIGURE 1 - Experimental design flowchart.

Tests and Procedures

Anthropometric Evaluation and Body Composition

The data were collected in the initial phase of physical preparation. The variables measured were: body mass (kg), verified through a Tech Lyne digital platform scale, with a precision of 0.1 kg to height (m), measured by a Physical metal stadiometer, with precision of 0.1 cm. Later, calculation of the body mass index (BMI) was made. The following skin folds in (mm) were also analysed: pectoral, abdominal and medial thigh always on the right side of the athlete. The measurements were performed in a scheme of duplicate rotation to estimate the percentage of body fat[13-14]. The mean value was considered for estimating body density according to the predictive equation of Jackson and Pollock[15]. Fat percentage was calculated according to Siri[16] formula = (4.91 / density - 4.5) × 100. A validation equation of the Cescorf apparatus was used, being estimated by means of the Lange apparatus allowing the minimization of errors, according to Okano et al.[17]. All processes involving data collection were performed by a single evaluator, skilled and experienced in the area of physical evaluation with relative Measurement Technical Error (% MTE) intra-assessor of 90%, calculated by the equation described by Silva et al.[18].

Motor Competence Tests

Flexibility Test

Flexibility of the athletes was measured using the Wells bench (Sanny brand) through the sit and reach test. The athletes sit on a gym mattress facing the bench, with legs fully extended and feet resting on the base of the seat. Then, in order to do the test, they had to lean their body forward and try to reach the measuring scale as far as possible by sliding their overlapping hands, performing three consecutive attempts and checking the best result[19].

Aerobic Capacity Test (1600 meters)

In this protocol, the athletes ran 1600 meters in a properly 400-metre circular track within the shortest time possible. The average speed (1,600Vm) was later analysed, and consequently the maximum oxygen consumption (VO_{2max}) was estimated (km/h) per minute. The estimate of the maximum oxygen uptake was given by the following equation: VO_{2max} (mL.kg-1.min-1) = [0.177*1600Vm (m.min-1)] + 8.101, according to Almeida et al.[20].

Vertical Jump Test

Counter movement jump (CMJ) and Squat jump (SJ) tests were used to determine the power of lower limbs by means of a contact mat (Cefise brand), coupled to the electronic system. The CMJ jump was performed with the athletes standing on a contact mat, with the legs extended and the hands on the hips. Then, the knees were first flexed at 90º (eccentric action) and then extended abruptly in a coordinated manner (concentric action) in order to reach the maximum height possible. In SJ, the jump execution followed the same patterns as CMJ, but the athletes started the movement from a squatting position with the knees bent at approximately 90º, immobile, with their torso upright, looking forward and with their hands on the hips.

All athletes made three attempts for each of the jumps, with performances being separated by a 30-second recovery interval. The best result obtained in each of the two jumps (cm) among the attempts was recorded for further analysis of the athletes in their categories[21].

Anaerobic Capacity Test (RAST)

Anaerobic power was assessed through the Running Anaerobic Sprint Test (RAST) proposed by Zacharogiannis et al.[22]. The test consists of

six 35-meter races at maximum speed, performed on a surface used by athletes in their daily training routines (soccer pitch with natural grass), preceded by a passive 10-second recovery interval before each race. A manual chronometer measured the time of each race. Each athlete was equally instructed and motivated to reach the maximum of their performance during the test. A previous warm up was done before the test, with approximately 5 minutes of specific exercise for that purpose. The anaerobic parameters determined by the respective test were: maximum power, average power and fatigue index, similar to a previous study[8].

Statistical Analysis

A descriptive analysis with mean and standard deviation was performed. Kolmogorov-Smirnov Test was used to assess data normality. The t Student Test for non-paired samples was used to compare the means between the groups, as well as Pearson's linear correlation for analysis between variables. We adopted $p<0.05$ as significance level. Effect size was used considering the scores: 0.0-1.9, no effect, 0.2-0.49 low effect, 0.5 - 0.79, moderate effect and >0.8 high effect. The statistical package SPSS version 22.0 was used.

Results

TABLE 1 presents the general characteristics of the sample for the under-20 and professional categories. The under-20 presented lower values with significant difference for the variables age, body mass, body mass index and fat percentage ($p<0.05$). This category also presented higher VO_{2max}, compared to the professional category ($p<0.05$), as well as a higher maximum and mean anaerobic power ($p<0.05$). However, there was no difference between the fatigue index ($p>0.05$) when comparing both categories. The under-20 category showed higher results for the vertical jump through the Counter Movement Jump and Squat Jump tests than the professional category ($p<0.05$) and a higher flexibility index ($p<0.05$) (TABLE 1). The effect sizes were considered high (>0.8) with the exception of height (0.47 - moderate) and fatigue index (0.12 - no effect).

TABLE 1 - Comparison of mean values and standard deviation of anthropometric variables and physical capacities of under-20 and professional soccer athletes (n=53).

	Under-20 (n=32)	Professional (n=21)	P	d
Age	18.5 ± 0.7*	24.8 ± 4.2	<0.01	2.11
Anthropometry and body composition				
Body mass (kg)	65.4 ± 7.5*	80.8 ± 10.5	<0.01	1.68
Height (cm)	175.4 ± 6.4	178.9 ± 8.4	0.09	0.47
Body mass index (Kg/m2)	21.2 ± 1.9*	25.1 ± 1.9	<0.01	2.02
Fat percentage	5.9 ± 3.7*	10.8 ± 5.5	<0.01	1.04
Physical tests				
VO_{2max} (mL/kg·min)	56.2 ± 3.5*	52.1 ± 4.0	<0.01	1.07
Maximum power - RAST (W.kg-1)	11.3 ± 2.6*	9.3 ± 1.7	<0.01	0.87
Average Power - RAST (W.kg-1)	9.0 ± 2.0*	7.5 ± 1.1	<0.01	0.89
Fatigue index	8.9 ± 3.5	8.5 ± 3.6	0.67	0.12
Counter Movement Jump (cm)	36.2 ± 4.6*	32.2 ± 4.2	<0.01	0.90
Squat Jump (cm)	36.3 ± 4.9*	31.6 ± 3.9	<0.01	1.05
Flexibility (cm)	44.3 ± 5.7*	29.9 ± 7.6	<0.01	2.13

*p<0.05 compared to the professional category;
d= d Cohen.

When analysing the factor age in correlation with the anthropometric variables, body composition and physical composition, TABLE 2 shows that the variable age presented positive correlation with BMI and fat percentage ($p<0.05$) and negative correlation with VO_{2max}, mean anaerobic power, squat jump and flexibility ($p<0.05$). However, there was no significant correlation between age and maximum anaerobic power, fatigue index and counter movement jump ($p>0.05$).

TABLE 2 - Linear correlation between age and anthropometric variables, body composition and physical composition (n=53).

	BMI	% Fat	VO_{2max}	RAST maxP	RAST meanP	RAST FI	CMJ	SJ	FLEX
Age	0.685*	0.526*	-0.457*	-0.269	-0.342*	0.129	-0.264	-0.388*	-0.662*

*p<0.05;
BMI: body mass index;
% Fat: Fat percentage;
VO_{2max}: maximum oxygen consumption;
RAST: Running Anaerobic Sprint Test;
maxP: maximum power;
meanP: mean power;
FI: fatigue index;
CMJ: counter movement jump;
SJ: squat jump;
FLEX: flexibility.

Discussion

This study aimed to compare the anthropometric and physical characteristics of under-20 and professional soccer athletes. Our hypothesis was that soccer athletes belonging to the under-20 category could present similarity in anthropometry and body composition, while those from the professional category might present better physical performance due to longer training time and thus, more experience and physical control. However, this hypothesis was not confirmed in anthropometry and body composition because they present significant differences ($p<0.05$), except for height, with better values for the under-20 category. Moreover, this hypothesis was not confirmed in the physical tests because the under-20 category presented better results ($p<0.05$) than the professional category, except for the fatigue index, in which they achieved similar values. Besides, there was correlation of age with increased BMI and fat percentage in anthropometric variables. However, there was negative correlation with VO_{2max}, average power, squat jump and flexibility ($p<0.05$). The findings of the present study do not corroborate the research results found by Figueiredo et al.[6], where significant differences in anthropometric and physical variables between the categories were found. The under-17 category presented the following variables: height= 1.70±11.1 m; body mass= 62.9±12.3 kg; % fat= 10.9±2.0 %; CMJ= 32.6±5.1 cm and CJ= 35.3±6.7 cm. The values of the category under-19 were: height= 1.76±5.6 m; body mass= 69.0±6.6 kg; % fat= 10.7±1.2 %; CMJ= 37.5±4.4 cm; CJ= 35.6±2.9 cm; and those of the professional category were: height= 1.81±8.3; body mass= 85.5±9.3; % fat= 11.1±4.4; CMJ= 43.0±6.6; and CJ= 42.4±6.5. Altogether, 48 athletes were evaluated, 16 from each group. The athletes from the professional category obtained better results than the other categories.

On the other hand, a previous study by Rosa[12], which compares the profile of under-20 and professional athletes, found results resembling ours. In relation to anthropometry, the professional category presented: body mass= 78.0±8.79 kg; height= 1.80±0.08 m; BMI= 23.9±1.53 kg/m2; age= 22.9±4.33 years old). The values of the under-20 category were: body mass- 73.3±6.98 kg; height=1.78±0.06 m; BMI= 23.0±1.32 kg/m2; age= 18.7±0.83 years old). A number of 76 soccer players were investigated; 38 from each category.

Silva et al.[23] also found results similar to ours regarding the anthropometric characteristics of the categories, as follows: Under-17 category: height= 1.76±6.8 m; body mass= 69.2±6.3 kg and CMJ= 42.0±2.7 cm. Under-20 category presented: height= 1,78±8,1 m; body mass= 75,4±8,4 kg and CMJ= 42,8±3,6 cm. The professional category achieved the following values: height= 1.79±6.1 m; body mass= 79.9±10.1 kg and CMJ= 44.2±3.7 cm. On the other hand, when comparing the power of lower limbs through CMJ, the results of these authors' study showed values different from ours. They investigated 20 athletes from the under-20 category and 19 professional players.

Regarding the percentage of body fat, our study obtained results with an average of 5.9±3.7% and 10.8±5.6% for the under-20 and professional categories, respectively. These values are in accordance with the literature, which recommends a general average of 6 to 12% for soccer players. They also corroborate the results found by Barbalho et al.[25], that showed an average of 12.4%

body fat in professional soccer athletes and are also in accordance with Oliveira et al.[8] who found 9.74 ±3.52 % in professional elite athletes from the state of Pernambuco.

In the case of maximum oxygen uptake, in general, the mean values presented by soccer players range from 50 to 70 ml/kg/min of metabolic demand. In our study, we also investigated maximum oxygen uptake among the variables of physical capacities, and the mean rates found were 56.20 ± 3.5 ml/kg/min for the under-20 category and 52.15 ± 4.00 ml/kg/min for professionals. Thus, we observed that these results are in accordance with the literature[24, 25]. Abrantes Junior et al.[26] found values that resemble our study, investigating 22 athletes from the under-20 category with ages between 16 and 20 years: % fat= 9.42±0.97; VO_{2max} = 56.5±3.0.

In turn, when we analysed the maximum oxygen uptake in the professional category, the rates were between 50-70 ml/kg/min, similar to the study by Oliveira et al.8. They investigated professional soccer players of the League of Pernambuco state, serie A, with the following results: 55.4 ± 2.0 ml/kg/min; n = 9. Perim et al.[27] evaluated the VO_{2max} of 49 professional athletes from Brazil and Angola, aged between 18 and 31, and the mean value was 63.4 ± 0.9 ml/kg/min, that is, above the values of our study. Maybe the African biological characteristics may have contributed to the increase of maximum oxygen uptake in the results found, as well as the general age of the athletes studied in the sample.

In this sense, in the results of the correlation of the categories with age, we observed that age correlated positively with the BMI and also with the percentage of corporal composition of the athletes. In addition, there was a negative correlation in the variables VO_{2max}, average anaerobic power, Squat Jump and flexibility ($p<0.05$). Again, it demonstrates that the age factor can also influence physical variables. The study by Ribeiro et al.[28], besides the flexibility variable, showed very similar results to our study on the sit and stand test, in which their soccer players obtained values of 32.0 ± 6.0 cm whereas our professionals got 29.9 ± 7.6 cm.

We believe that the differences between the results, in general, can be partially explained by the fact that these athletes, from teams considered to have lower investment or less national potential, spend most of the annual soccer calendar without specific training for soccer, practicing only in the first half of the year. It should also be considered that the real time of state competitions is approximately four months most of the time, with athletes showing a lower level of performance in relation to the ones from national competitions.

Another aspect observed is that the athletes of the under-20 category, for being young and having better metabolism, presented better performance in the variables analysed in this study, both in the pre-season phase and at the beginning of the season[29]. According to Abrantes Junior et al.[26], soccer athletes present among themselves some differences in relation to the components of physical capacity, mainly due to age, maturation phase and the requirement levels of each category or imposed by the sport.

As a practical application, we suggest that soccer instructors should take advantage of such knowledge to help professional athletes to recover more specifically in the variables where they presented less physical conditioning compared to the under-20 category athletes, at the beginning of the season. In addition, it is a fact that professional athletes should also consider technical, tactical, psychological and nutritional factors, among others.

The results of our study, when analysing the characteristics of the athletes in the under-20 category, show that they are able to be transferred to a professional team in the northeast region with first division soccer. Undoubtedly, by training together, the athletes of the under-20 category will be able to help the professional ones to better prepare themselves physically.

Conclusion

Professional and under-20 athletes from a north-eastern team did not present similar anthropometric and physical characteristics at the beginning of the season. The under-20 category presented better anthropometric (body mass, body mass index and fat percentage) and physical indexes (maximum oxygen consumption, mean power, maximum power, counter movement jump, squat jump and flexibility) in relation to the professional category in the initial training period.

Conflict of interests

Authors state no conflict of interest.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Resumo

Os atletas de futebol das categorias sub-20 e profissional possuem características antropométricas e físicas semelhantes?

O objetivo deste estudo foi para comparar a características antropométricas e a capacidades físicas de jogadores de futebol das categorias sub-20 e profissional. Para isso, 53 atletas de futebol, foram selecionados de forma não probabilística (32 atletas da categoria sub-20 [18.4±0.7 anos] e 21 profissional [24.7±4.1 anos]) foram submetidos para avaliações antropométricas (peso, altura, índice de massa corporal e composição corporal), e avaliações físicas (flexibilidade, capacidade aeróbia e anaeróbia e salto vertical). Os resultados mostraram que nas avaliações antropométricas, a categoria sub-20 apresentou baixo valores para a variável massa corporal, índice de massa corporal e percentual de gordura ($p<0.05$), mais sem diferença significativa na altura ($p>0.05$). Nas avaliações físicas, a categoria sub-20 apresentou superior capacidade aeróbia comparada aos profissionais ($p<0.05$), potência anaeróbia máxima e média ($p<0.05$), mais não no índice de fadiga ($p>0.05$). Em relação para os profissionais, à categoria sub-20 apresentou resultado superior no salto vertical, testes de counter movement jump e squat jump, além disso, mostrou superior flexibilidade ($p<0.05$). A idade demonstrou uma correlação positiva somente com o índice de massa corporal (0.685) e percentual de gordura (0.526) e correlação negativa com a aptidão aeróbia (-0.457) potência anaeróbia média (-0.342), squat jump (-0.388) e flexibilidade (-0.662) ($p<0.05$). Pode se concluir que a categoria sub-20 teve melhores índices antropométricos e físicos em relação para os profissionais. Portanto, pode ser benéfico utilizar os atletas da categoria sub-20 no início da temporada para ganhar experiência na categoria profissional e para readaptar os profissionais.

Palavras-chave: Futebol; Avaliação física; Índice de massa corporal; Gordura; Consumo de oxigênio.

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Submitted: 04/01/2021
Revised: 12/11/2021
Accepted: 06/29/2022