Research in Kinesiology
2023, Vol. 51, No. 1 pp. 25 - 33

COMPARISON OF PHYSICAL FITNESS AND ANTHROPOMETRIC PROFILES AMONG FOOTBALL PLAYERS OF DIFFERENT CATEGORIES

Original scientific paper

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Abstract

Anthropometric variables and physical fitness levels are crucial to evaluate the performance of elite football players and different age groups, therefore the sports science community is constantly searching for which values should be discriminated between age groups. Assessment of anthropometric profile and physical fitness abilities in elite football players and different categories have not been fully studied. The purpose of this research is to compare the anthropometric characteristics and physical fitness variables between three different categories: U18, U19 and elites. ***Methods:*** *The research has a quantitative, transversal, descriptive and comparative character. A total of 57 male football players were tested, of which 17 players belonged to the U18 category (age 17.52±0.64 years), 16 players belonged to the U19 category (age 18.48±0.84 years) and 24 players belonged to the elite (age 26.57±4.8 years). For the assessment of anthropometric characteristics, we used the variables: body height, body mass, body mass index and body fat percentage, while for the assessment of physical fitness, we used the tests: sprint 10m, squat jump, countermovement jump and bench press 1RM.* ***Results:*** *Elite football players are statistically taller (p=.000; p=.006), have higher body mass (p=.000; p=.001), have a higher fat percentage (p=.002; p= .040), have better results in 10m sprint (p=.000; p=.000), and 1RM bench press (p=.000; p=.033) than U18 and U19 football players, also elites have differences and advantages in the body mass index tests (p=.023), squat jump (p=.000), and countermovement jump (p=.002) compared to the U18 category, while U19 have advantages and differences in the countermovement jump variables (p=.028) and bench press 1RM (p=.000) against the U18 category.* ***Conclusion:*** *Elite football players exhibit better anthropometric profile, upper extremity speed and strength than the other two categories.*

Keywords: *physical fitness, anthropometric characteristics, male football players, performance, ANOVA*

INTRODUCTION

Measuring physical fitness is a common and appropriate practice in preventive and rehabilitative exercise programs that aim to educate participants about their current health status in relation to health-related standards and age-appropriate norms and gender, providing data that are useful in developing exercise programs in individual and team sports to address all components of health, collecting baseline and follow-up data that allow assessment of progress by program participants of exercises, as well as motivating participants by setting reasonable and achievable health goals (Iseni, 2022). Also, body composition is an important indicator of human health and physical fitness, and in order to better determine body composition in athletes, it is necessary to understand its theoretical models (Bushman, 2017). Therefore, many studies have addressed the characteristics of physical fitness and body composition, especially in the world's most popular and commercial sport, football. Previous studies provide information and suggest that young elite football players are taller and heavier in terms of body composition compared to non-elite players of the same age (Malina et al., 2000) (Malina et al., 2004) and perform significantly better in tests of explosive strength and speed-sprinter runs (Gissis et al., 2006) (Gravina et al., 2008). The identification of formations of talented young football players has attracted research interest, in the last ten years, especially to understand the functional adaptations and levels of motor skills in youth belonging to professional clubs (Jones & Drust, 2007; Malina et al., 2007; Sannicadro, 2011). Cross-sectional research on young elite football players typically found that several anthropometric variables (height, weight, and body composition), physiological variables (speed, agility, explosive strength, and aerobic capacity), psychological characteristics (ego orientation, anticipation ability), as well as specific football game skills (dribbling, ball control), contribute to actual game success and team selection in young elite football players (Coelho et al. 2010). So far research by the authors Reilly (2000), Ostojic (2003), Hoff (2004), Macmillan (2005) has assessed the physical fitness and body composition profiles of professional football players in most parts of Europe and America, although there is still little descriptive data on these characteristics of elite players in the countries of the Balkan Peninsula, especially in North Macedonia, where the assessment of these physical fitness characteristics is not yet a priority for sports clubs and management staff. It is known that anthropometric characteristics and physical fitness skills are closely related to each other and that they obviously affect the realization of most motor tasks and the resulting efficiency. Among the morphological structure, motor skills are manifested, and this requires the need for

these two areas of anthropological characteristics to be treated together in the theory of training. This has influenced that in this paper some characteristics of the anthropological space (anthropometric and physical fitness) between football players of different categories are investigated.

METHODS

This transversal, descriptive and comparative study focused on the differences in physical fitness and anthropometric profiles between football players in the academy of KF Shkupi - North Macedonia, between the U18, U19 and elite categories. Anthropometric profile assessments included body height, body mass, body mass index, and body fat percentage, while physical fitness tests included 10m linear speed, squat jump, countermovement jump, and 1 repetition maximum bench press. All measurements were made at the stadium of KF Shkupi - Skopje in March 2023.

Participants

A total of 56 male football players participated in the study. Almost all of them had a high level of conditional preparation, while some of them have even been part of the national team. 17 players belonged to the category under 18 years (U18) with an average of years (mean±SD: 17.52±0.64), 16 players belonged to the category under 19 years (U19) with an average of years (mean±SD: 18.48±0.84) and 24 players belonged to the senior or elite category with an average of years (mean±SD: 26.57±4.8 years). The football club Shkupi accepted the use of athlete test results for publication. Participants signed a consent form before the start of data collection and were free to withdraw from the study at any time. For those under the age of 18, signed consent from a parent or guardian was obtained. Before the start of the football season, all players had a complete medical examination. The study was conducted in accordance with the Declaration of Helsinki and was approved by the institutional ethics committee of the University of Tetovo (March 14, 2023, with protocol number 19-41/1).

Procedure

Anthropometric assessment and physical fitness tests were scheduled to be performed on the first three days of each weekly team training cycle. The players were asked to avoid vigorous exercise 24 hours before testing, to prevent the effects of fatigue during the measurements. The athletes' warm-up was carried out by each category's fitness trainer, consisting of a light jog, multi-directional movements and dynamic stretching, followed by test-specific warm-ups lasting 15-20 minutes. On the first day, the anthropometric assessment was done, on the second day, the explosive strength tests of the lower extremities, squat jump and countermovement jump, and on the third day, the linear speed of 10 meters and the test of 1 maximum repetition in the bench press. All players were informed on the scoring procedures and each player was encouraged to perform as well as possible.

Test protocol

Anthropometric assessment: The anthropometric characteristics for all the examinees were performed under the same time, space and climate conditions so that the measuring instruments used in this research are standardized and properly aligned before the beginning of the measurements. Anthropometric characteristics were measured by recommendations of the International Biological Program (IPB) (Lohman et al., 1988). Body height (cm) was measured using a mobile stadiometer (Seca 213; seca gmbh, Hamburg, Germany), while body mass (kg) was measured using a balance beam scale (Seca v/700; seca gmbh, Hamburg, Germany). Body mass index (IMT) is calculated with the result of body weight and height (BMI=weight in kilograms/height in meters). The fat percentage was measured with a special scale, where the whole body composition is measured, using the Tanita bodyfat scale model BC 418MA.

10m linear sprint test: was used to assess acceleration ability and top speed in male football players (Ruger et al. 2019; Kobal et al. 2021; Loturco et al. 2020). During the test, each player performed 3 sprints at maximum intensity, with 3 minutes of rest between each sprint. This test was performed on natural grass and with football shoes, during the morning hours and with ambient conditions of 12 °C. Two-timing gates were set up with the help of the sophisticated Microgate Witty Balzano, Italy equipment, one at the starting point and the other at the designated 10m. Players started the 10m linear sprint test, 1m before the start line and were instructed to start when ready and to work as fast as possible.

Squat jump and the countermovement jump with free hands: These tests are used to assess the maximum strength of the lower extremities. The specific warm-up consisted of several jumps with both feet on a box 50 cm high. The squat jump test begins when the player stands on the tensiometric platform, and places his hands on his hips, then jumps with his legs bent at the knees to approximately 90° and immediately jumps as high as possible without bending the knees at all, and squats down back to the starting position. The same procedure is also with the countermovement jump free hand test, only here the hands are free during the execution of the test and help the high jump. All players completed 3 maximum attempts on the contact platform and had 3 minutes of recovery time between each repetition. The tests were evaluated with the help of the sophisticated Optojump Microgate apparatus, in Balzano, Italy.

Bench1RM: This test is used to evaluate the maximum strength of the chest muscle group. Subjects should perform an adequate warm-up. A good example would be 5-10 reps with a medium weight, then 1-minute rest, then a slightly heavier warm-up with 2-5 reps, with a 2-minute rest. Then the subjects rest for 4 minutes, then perform a maximum repetition effort. If the lifting is successful, we rest for 2-4 minutes and increase the load by 5-10% and try another lifting. If the subject fails to perform the load, then rest again for 2-4 minutes and reduce the weight by 2.5-5%, until the maximum is performed with one maximum repetition.

Statistical analysis

Through the data from this study, the basic statistical parameters such as arithmetic mean and standard deviation were first calculated for all academy football players, while to evaluate the differences between the players in the three football academy categories in the anthropometric variables and physical fitness tests, the analysis was used Post hoc ANOVA and LSD, with statistical significance of $p<.05$.

The SPSS software package, IBM, version 26, New York, U.S.A., was used for statistical analysis of the results.

RESULTS AND DISCUSSION

The values for the basic statistical parameters of the morphological characteristics of elite football players are presented in Table 1. It includes: the minimum score, the maximum score, the arithmetic mean as the main central indicator and the standard deviation as the dispersive indicator.

Table 1. Descriptive analysis of anthropometric characteristics and physical fitness abilities in 3 age groups among male football players

Descriptives

		N	Mean	Std. Dev.	Minimum	Maximum
HEIGHT	UNDER18	17	175.8824	6.33327	167.00	190.00
	UNDER19	16	177.8125	7.35045	167.00	192.00
	SENIOR	24	184.0000	6.21582	172.00	194.00
	Total	57	179.7679	7.42475	167.00	194.00
WEIGHT	UNDER18	17	65.4118	7.30247	55.00	79.10
	UNDER19	16	67.8625	6.91741	59.80	79.20
	SENIOR	24	76.1717	6.65041	63.00	86.00
	Total	57	70.5313	8.35056	55.00	86.00
BMI	UNDER18	17	21.2438	2.10395	17.40	25.90
	UNDER19	16	21.4938	1.34436	17.90	23.40
	SENIOR	24	22.4130	1.14626	20.50	25.10
	Total	57	21.8055	1.59576	17.40	25.90
BF%	UNDER18	17	14.3875	3.12706	9.10	19.50
	UNDER19	16	13.3125	1.76895	11.10	16.60
	SENIOR	24	11.3174	3.33585	6.40	18.20
	Total	57	12.7909	3.14320	6.40	19.50
R10m	UNDER18	17	1.6076	.06591	1.50	1.74
	UNDER19	16	1.6440	.10412	1.52	1.98
	SENIOR	24	1.9100	.10484	1.72	2.11
	Total	57	1.7440	.17013	1.50	2.11
SQ	UNDER18	17	29.9647	4.07461	22.20	37.60
	UNDER19	16	33.3000	4.35722	26.60	41.20
	SENIOR	24	35.9542	4.89063	28.70	45.60
	Total	57	33.4228	5.10228	22.20	45.60
CMJ	UNDER18	17	35.9412	4.95959	27.20	47.90
	UNDER19	16	40.5750	6.07942	31.40	49.60
	SENIOR	24	42.1583	6.37556	33.50	59.00
	Total	57	39.8596	6.37920	27.20	59.00
BENCH1RM	UNDER18	17	54.7235	11.67629	42.40	80.00
	UNDER19	16	69.1688	10.54493	60.00	100.00
	SENIOR	24	76.5458	9.37054	60.00	93.30
	Total	57	67.9667	13.78399	42.40	100.00

In Table 1, we have reflected the basic statistical parameters of the variables of anthropometric characteristics and physical fitness among young players of the U18, U19 categories of the football academy K.F. Shkupi, as well as the senior or elite team. The values of the standard deviations are at a low level for all the investigated variables of anthropometric characteristics and physical fitness tests, which indicates that the discriminability of the results is at a low level and it is about homogeneous results, except for the physical fitness variable bench1RM , where the discriminability of the results is at a high level and it is about heterogeneous results.

Table 2. ANOVA analysis of 57 football players of the youth academy generation U18, U19 and senior team

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
HEIGHT	Between Groups	729.780	2	364.890	8.400	**.001**
	Within Groups	2302.202	53	43.438		
	Total	3031.982	55			
WEIGHT	Between Groups	1291.259	2	645.629	13.451	**.000**
	Within Groups	2543.989	53	48.000		
	Total	3835.248	55			
BMI	Between Groups	15.094	2	7.547	3.206	**.049**
	Within Groups	122.415	52	2.354		
	Total	137.508	54			
BF	Between Groups	95.077	2	47.539	5.638	**.006**
	Within Groups	438.428	52	8.431		
	Total	533.505	54			
R10m	Between Groups	1.100	2	.550	61.754	**.000**
	Within Groups	.463	52	.009		
	Total	1.563	54			
SQ	Between Groups	357.322	2	178.661	8.766	**.001**
	Within Groups	1100.538	54	20.380		
	Total	1457.860	56			
CMJ	Between Groups	396.028	2	198.014	5.679	**.006**
	Within Groups	1882.850	54	34.868		
	Total	2278.877	56			
BENCH1RM	Between Groups	4771.042	2	2385.521	21.949	**.000**
	Within Groups	5868.865	54	108.683		
	Total	10639.907	56			

Based on the obtained values of the results from the ANOVA analysis (Table 2.), it can be observed that there are significant statistical differences in all 8 variables used in this research, where significant differences are in the variables of anthropometric characteristics and physical fitness: body height, body mass, fat percentage, squat jump, countermovement jump and bench press 1RM with reliability $p<.01$, while the variable body mass index with reliability $p<.05$.

Table 3. More detailed differences with the method of post hoc LSD method - Multiple comparison

Multiple Comparisons

LSD

Dependent Variable	(I) CATEGORY	(J) CATEGORY	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
HEIGHT	UNDER18	UNDER19	-1.93015	2.29565	.404	-6.5346	2.6744
		SENIOR	-8.11765*	2.10802	.000	-12.3458	-3.8895
	UNDER19	UNDER18	1.93015	2.29565	.404	-2.6744	6.5346
		SENIOR	-6.18750*	2.14557	.006	-10.4910	-1.8840
	SENIOR	UNDER18	8.11765*	2.10802	.000	3.8895	12.3458
		UNDER19	6.18750*	2.14557	.006	1.8840	10.4910
WEIGHT	UNDER18	UNDER19	-2.45074	2.41319	.314	-7.2910	2.3895
		SENIOR	-10.75997*	2.21596	.000	-15.2046	-6.3153
	UNDER19	UNDER18	2.45074	2.41319	.314	-2.3895	7.2910
		SENIOR	-8.30924*	2.25542	.001	-12.8330	-3.7854
	SENIOR	UNDER18	10.75997*	2.21596	.000	6.3153	15.2046
		UNDER19	8.30924*	2.25542	.001	3.7854	12.8330
BMI	UNDER18	UNDER19	-.25000	.54246	.647	-1.3385	.8385
		SENIOR	-1.16929*	.49949	.023	-2.1716	-.1670
	UNDER19	UNDER18	.25000	.54246	.647	-.8385	1.3385
		SENIOR	-.91929	.49949	.071	-1.9216	.0830
	SENIOR	UNDER18	1.16929*	.49949	.023	.1670	2.1716
		UNDER19	.91929	.49949	.071	-.0830	1.9216
BF	UNDER18	UNDER19	1.07500	1.02660	.300	-.9850	3.1350
		SENIOR	3.07011*	.94527	.002	1.1733	4.9669
	UNDER19	UNDER18	-1.07500	1.02660	.300	-3.1350	.9850
		SENIOR	1.99511*	.94527	.040	.0983	3.8919
	SENIOR	UNDER18	-3.07011*	.94527	.002	-4.9669	-1.1733
		UNDER19	-1.99511*	.94527	.040	-3.8919	-.0983
R10m	UNDER18	UNDER19	-.03635	.03343	.282	-.1034	.0307
		SENIOR	-.30235*	.03018	.000	-.3629	-.2418
	UNDER19	UNDER18	.03635	.03343	.282	-.0307	.1034
		SENIOR	-.26600*	.03132	.000	-.3288	-.2032
	SENIOR	UNDER18	.30235*	.03018	.000	.2418	.3629
		UNDER19	.26600*	.03132	.000	.2032	.3288
SQ	UNDER18	UNDER19	-3.33529*	1.57246	.039	-6.4879	-.1827
		SENIOR	-5.98946*	1.43109	.000	-8.8586	-3.1203
	UNDER19	UNDER18	3.33529*	1.57246	.039	.1827	6.4879
		SENIOR	-2.65417	1.45704	.074	-5.5753	.2670
	SENIOR	UNDER18	5.98946*	1.43109	.000	3.1203	8.8586

		UNDER19	2.65417	1.45704	.074	-.2670	5.5753
CMJ	UNDER18	UNDER19	-4.63382*	2.05676	.028	-8.7574	-.5103
		SENIOR	-6.21716*	1.87186	.002	-9.9700	-2.4643
	UNDER19	UNDER18	4.63382*	2.05676	.028	.5103	8.7574
		SENIOR	-1.58333	1.90579	.410	-5.4042	2.2375
	SENIOR	UNDER18	6.21716*	1.87186	.002	2.4643	9.9700
		UNDER19	1.58333	1.90579	.410	-2.2375	5.4042
BENCH1RM	UNDER18	UNDER19	-14.44522*	3.63122	.000	-21.7254	-7.1651
		SENIOR	-21.82230*	3.30478	.000	-28.4480	-15.1966
	UNDER19	UNDER18	14.44522*	3.63122	.000	7.1651	21.7254
		SENIOR	-7.37708*	3.36469	.033	-14.1229	-.6313
	SENIOR	UNDER18	21.82230*	3.30478	.000	15.1966	28.4480
		UNDER19	7.37708*	3.36469	.033	.6313	14.1229

*. The mean difference is significant at the 0.05 level.

From Table 3., it can be seen that elite football players are statistically taller (p=.000; p=.006), have a greater body mass (p=.000; p=.001), a greater percentage of fat (p=.002; p=.040), have better results in 10m sprint (p=.000; p=.000), and bench press 1RM (p=.000; p=.033) than football players of the U18 and U19 categories, also the elites have differences and advantages in the body mass index tests (p=.023), squat jump (p=.000), and countermovement jump (p=.002) compared to the U18 category, while the U19 there are advantages and differences in the variables countermovement jump (p=.028) and bench press 1RM (p=.000) compared to the U18 category. In all other variables, the differences are negligible and do not have statistical significance.

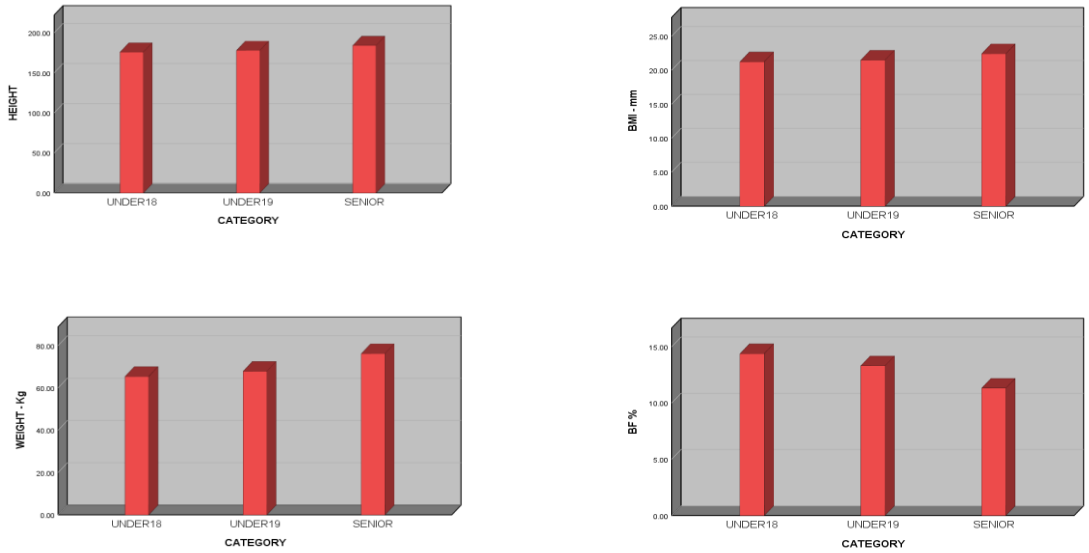

Figure 1: Differences by category in anthropometric variables (height, weight, body mass index and fat percentage)

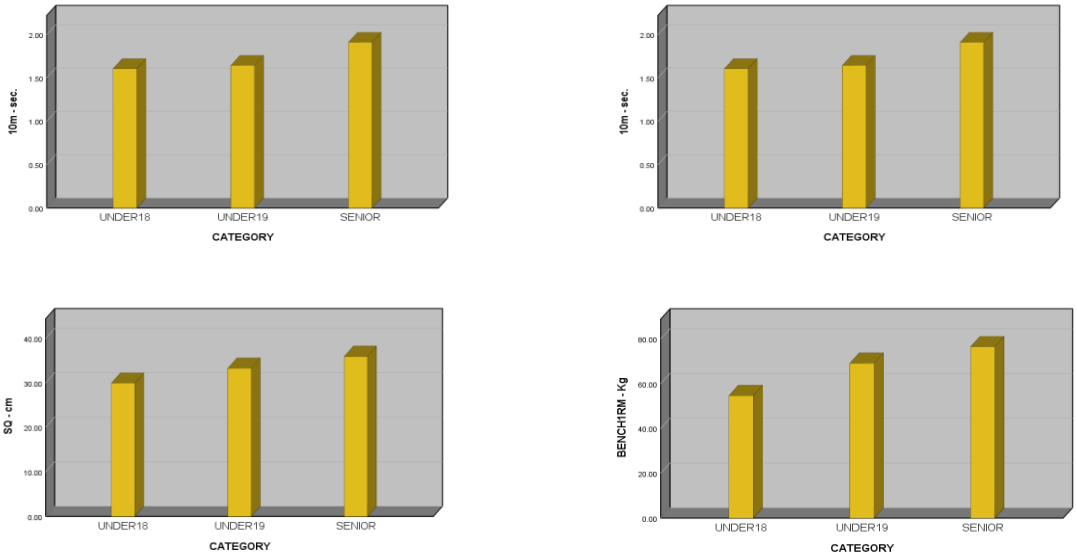

Figure 2. Differences according to categories in physical fitness variables (10m sprint, squat jump, countermovement jump and bench1RM)

DISCUSSION

The aim of this research was to compare anthropometric characteristics and physical fitness variables between three different categories in football players of the U18, U19 and elite age groups. Elite football players are statistically taller (p=.000; p=.006), have greater body mass (p=.000; p=.001), greater fat percentage (p=.002; p= .040), have better results in 10m sprint (p=.000; p=.000), and 1RM bench press (p=.000; p=.033) than U18 and U19 football players, also elites have differences and advantages in the body mass index tests (p=.023), squat jump (p=.000), and countermovement jump (p=.002) compared to the U18 category, while U19 have advantages and differences in the countermovement jump variables (p=.028) and bench press 1RM (p=.000) against the U18 category. We have the same identical findings in the authors' study (Kobal et al. 2016), where elite football players performed better than young U20 and U17 players in squat jump, countermovement jump, maximum strength (1RM) and yo-yo tests. , while in the 10 and 20 meter running speed tests there were no significant differences between elite and young football players. Also, significant differences (p>0.05) between elite football players and the U20 and U17 age groups were found in anthropometric variables such as body mass, body height, body fat percentage and the physical fitness test vital lung capacity (VO2max), all in favor of the elite group (Herdy et al., 2018). We have the same findings in the authors' study (Keiner et al., 2015), where professional football players performed better than amateur players and those of young age groups in physical fitness tests such as squat jump, countermovement jump and drop jump. After comparing 57 elite and young elite male football players who were assigned to three elite groups, U20 and U17, who performed in functional tests such as squat jump and 10 m sprint, the authors (Lehance et al., 2009) came to the conclusion that the professional group ran faster and jumped higher than the junior elite group, while no significant difference in isokinetic muscle strength performance was observed between the three groups. The authors (Burdukiewicz et al., 2014) compared the morphological characteristics of 22 university futsal players and 22 professional football players. The parameters tested in this study were: body height, body mass, thigh adipose tissue, leg length, hip width, knee width, and chest, waist, thigh, and calf circumferences, as well as somatotypes. They concluded that college futsal players were shorter, weighed less, had smaller limbs, narrower waists, and smaller chest circumferences than professional football players, whereas they showed higher of body fat percentage. Regarding the differences in the countermovement jump test between futsal players and elite football players, no significant difference was reported, while regarding the playing positions significant differences were found between defenders and midfielders (p=.02) (Silva et al., 2012). (Milsom et al., 2015) researched a sample of 83 examinees, football players of the first league, U21 and U18 of the English Premier League, aged 18-32 years, divided into three subsamples and the first team with 27 football players, U21 with 21 football players and U18 with 35 football players analyzed body composition using energy X-ray absorptiometry (DXA), and concluded that body fat percentage was lower in first team of football players (10.0 ± 1.6), compared to U21 (11.6 ± 2.5 , P = 0.02) and U18 (11.4 ± 2.6, P = 0.01). The data suggest that the way of training and intervention in the form of food can be decisive for reducing the percentage of fat in young football players. (Petridis et al., 2019) determined the normative values for three chronological age groups in elite football players in the categories U16, U17 and U18 in vertical jump performances. The authors concluded that jump height and relative values were the least sensitive discriminating variables between age groups, while maximal impulse, maximal force, and maximal power were the most sensitive variables to changes in maturity status in football players of all age groups. (Gucic et al., 2017) investigated age-related changes in speed, directional speed, and reactive agility skills in a group of highly trained U15, U17, and U19 adolescent football players. The main finding of this study was that no significant differences were found between players in different age categories for most variables. (Matta et al., 2014) described and compared the anthropometric profile, physical abilities, and soccer-specific skills

among young Brazilian football players under 15 and under 17 years of age, and assessed possible changes in these variables according to biological maturity. Results showed greater body size (height and body mass), and better performance in functional tests for under-17 players compared to under-15 players, while there were significant differences in subcutaneous adipose tissue.

CONCLUSION

Anthropometric characteristics and physical fitness abilities appear to be important factors that distinguish the categories of U18, U19 and elite football players. Elite football players are statistically taller (p=.000; p=.006), have greater body mass (p=.000; p=.001), greater fat percentage (p=.002; p= .040), have better results in 10m sprint (p=.000; p=.000), and 1RM bench press (p=.000; p=.033) than U18 and U19 football players, also elites have differences and advantages in the body mass index tests (p=.023), squat jump (p=.000), and countermovement jump (p=.002) compared to the U18 category, while U19 have advantages and differences in the countermovement jump variables (p=.028) and bench press 1RM (p=.000) against the U18 category. Elite football players exhibit better anthropometric profile, upper extremity speed and strength than the other two categories. The results of this study seem to follow the global trend, as the studies that have been analyzed show data similar to the current investigation.

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