Palestrica of the third millennium – Civilization and Sport
Vol. 17, no. 1, January-March 2016, 39–45

Anthropometric indicators in young rugby players
Indicatorii antropometrici la jucătorii de rugby tineri

Radu Cîrjoescu, Simona Tache
"Iuliu Hatieganu" University of Medicine and Pharmacy, Cluj-Napoca, Romania

Abstract

Background. The current tendencies of modern rugby involve multilateral and specific high level physical training, adapted to the peculiarities of age and level of training.

Aims. The anthropometric indicators in the pre-competition period were studied in young rugby players with specific training and students with general sport training.

Methods. Our research was performed in 6 groups (n=10 subjects/group), 3 control groups CI (18 years), CII (19 years), CIII (20 years) and 3 groups of athletes AIV (18 years), AV (19 years), AVI (20 years). The monitored anthropometric indicators were: weight, height, arm span, palmar flexor strength for both hands and indirectly the body mass index.

Results. Significant increases in weight, body mass index, arm span and palmar flexor strength were found in the athlete groups compared to the non-athlete groups, except for the 18-year-old groups regarding weight. After a one-year period, athletes had significant increases in: weight (the 19-year-old and 20-year-old groups), height (the 18-year-old and 19-year-old groups), body mass index (the 20-year-old group) and arm span (all groups).

Conclusions. The changes in anthropometric characteristics of the rugby players can occur as an adaptive consequence to the specificity of the physical demands of the sport and can be influenced by training.

Keywords: rugby players, anthropometric indicators, physical exercise.

Rezumat

Premize. Tendințele actuale ale rugby-ului modern presupun o pregătire fizică multilaterală și specifică la un nivel ridicat, adaptată particularităților vârstei și nivelului de pregătire.

Obiective. S-au studiat indicatorii antropometrici în perioada de pregătire la jucătorii de rugby cu pregătire specifică și la elevi și studenți cu pregătire sportivă generală.

Metode. Cercetările au fost efectute pe 6 loturi (n=10 subiecți/lot), lotul CI (18 ani), lotul CII (19 ani), lotul CIII (20 ani) martori și lotul AIV (18 ani), lotul AV (19 ani), lotul AVI (20 ani) sportivi. Indicatorii antropometrici studiați au fost: greutatea, înalțimea, anvergura, forța flexorilor palmari pentru ambele mâini și indirect, indicele de masă corporală.

Rezultate. S-au observat creșteri semnificative ale greutății, indicelui de masă corporală, forței flexorilor palmari la loturile de sportivi față de loturile de nesportivi, mai puțin pentru grupul de 18 ani sub aspectul greutății. Pentru loturile de sportivi după o perioadă de un an, au fost observate creșteri semnificative ale: greutății (pentru loturile de 19, 20 ani), înalțimii (pentru loturile de 18, 19 ani), indicelui de masă corporală (pentru lotul de 20 ani), și creșteri ale valorilor anvergurii pentru toate loturile de sportivi.

Concluzii. Modificările indicatorilor antropometrici la sportivii care practică rugby-ul apar ca o consecință adaptativă fața de solicitările fizice specifice acestui sport și pot fi influențate prin antrenament.

Cuvinte cheie: rugbiști, indicatori antropometrici, efort fizic.

Introduction

Rugby is a sport in which anthropometric characteristics play a crucial role in the future development of sportsmen. Unlike many other sports, in rugby the players are in permanent contact with the opponent players, struggling and wrestling to carry the ball into the opposition line or to get in possession of the ball. Due to the high contact nature of this game, every player must be equipped with the necessary skills to deal efficiently with the physical challenge of an opponent, especially when he has the ball in his hands. The high requirements in modern rugby have led to a tendency towards an increase in real gameplay time, with fewer interruptions during the game, demanding the players to be better prepared and able to sustain high intensity efforts repeatedly, with little time to recover.

According to Drăgan's (2002) "biological model" of the player, the positioning of the players in the field is greatly influenced by: height, weight, the height/weight ratio, body composition, muscular development, arm span index and skill level.

Received: 2015, September 2; *Accepted for publication:* 2015, October 3;
Address for correspondence: Ambulatory Sports Medicine Clinic, 19 Ludwig Roth Str. Cluj-Napoca, Romania
E-mail: rcirjoescu@yahoo.com
Corresponding author: Radu Cîrjoescu: rcirjoescu@yahoo.com

Primary selection in rugby can begin at the age of 7-8 years. Children with good health, good physical development, good coordination, very good speed, combativeness, great courage and passion for the sport should be selected. These considerations should be used as guidelines and must not exclude a highly motivated child with a great desire for this sport, who can compensate through hard training and determination for the lack of some of the above characteristics.

Secondary selection occurs around the age 14. In a study carried out by Sedeaud et al. (2013) on the morphology of French elite rugby players during 2 different seasons 20 years apart, the tendency of the two groups of players (U21 - under 21 years, U15 - under 15 years) was to become "bigger and taller". The U15 backs had gained 5.1 cm in height and 6.5 kg in weight, and the forwards, 4.7 cm and 4.7 kg. This also reflects an early directional selection guideline.

Final selection is intended for players who have acquired well developed physiological and anthropometric qualities, game-specific skill qualities, combined with a wide range of offensive and defensive skills.

In the literature, many authors have studied the anthropometric characteristics of rugby players and their change in time from an early age, at various levels.

Determinations of anthropometric indicators may assist trainers in their pursuit of selecting the best individuals suitable for this sport and distributing them in the field according to their characteristics.

Our data are in accordance with the literature data regarding height for all athlete groups (Gurău, 2002), and weight for the A18 group (Cordun, 2009).

Fontana et al. (2015) studied anthropometric evaluation of professional rugby players. The athletes who took part in the study were players of the Italian national team, first division and second division. Body mass, stature, and body fat percentage were measured. In all three groups of players, the forwards were significantly heavier, taller and had a larger percentage of body fat and fat-free mass than the backs. The higher the lean body mass, the better the competitive level of the players. The data confirm the specificity of physical demands in rugby in different playing positions, at all competitive levels, which must be taken into account when performing selection and establishing training procedures.

In a study carried out by Lombard et al. (2015), following anthropometric determinations in 453 players aged under 20 years old, it was shown that the forwards were significantly heavier (22%), taller (5%) and stronger (18%) than the backs. However, when 1 repetition maximum strength scores were adjusted for body mass, the backs were stronger per kg body mass. Over a 13-year period, there were significant increases in muscular strength (50%), body mass (20%), and muscular endurance (50%). Changes in the physical characteristics of the players over time can occur as a consequence of adaptation to the specificity of the game and different training methods.

Studies carried out by Waldron et al. (2014), involving anthropometric changes in direct relation to performance (under-15 to under-17 age groups) in elite rugby league players, pointed out an increase in lean body mass percentage, which improves sprint time and jumping power. These findings demonstrate the importance of lean body mass gains in later adolescence, supporting the ability to generate horizontal speed and predicted vertical power, which are indispensable in this sport.

Till et al. (2014) tried to evaluate the anthropometric and physical characteristics of English academy rugby league players by annual-age category (under 16s - under 20s) and between backs and forwards. The study showed that anthropometric and physical characteristics develop across annual-age categories and between backs and forwards. The results offer comparative data for such groups and support the need to monitor the players' development and adapt training to their age.

Gabbett et al. (2011) investigated the differences in anthropometrics and skill qualities between the players that were selected in the National Rugby league team and the ones that were not selected. Players selected to play in the first National rugby league game of the season were older, more experienced, leaner, had faster 10 m and 40 m sprint times, superior vertical jump performance and maximal aerobic power compared to non-selected players. The study suggests that selected physiological, anthropometric and skill qualities may influence team selection in the professional rugby league.

A research performed by Fuller et al. (2013) regarding changes in the stature, body mass and age of rugby players in the first team squads of English Premiership rugby union teams from 2002 to 2011 showed that players were generally getting taller, heavier and younger.

A research conducted by Sedaud et al. (2012) indicates, using an anthropometric study, that the teams that most often manage to get to the advanced stages of a competition are the teams which have the heaviest forwards and the tallest backs. From 1987 to 2007, forwards and backs have become heavier by 6.63 and 6.68 kg and taller by 0.61 and 1.09 cm. For all Rugby World Cups, the highest performing teams have the tallest backs and heaviest forwards with the highest percentage of collective experience.

In a study performed by Sedeaud et al. (2013) following anthropometric determinations for French elite rugby players participating in the championship in two different seasons (1988-1989, 2008-2009) and for 145 of the best junior players (under 21), it was found that rugby players had become heavier and taller. This specific morphology is the result of a long process of selection and competition. The study demonstrates that the tendency to "large sizes" is already present at a young age.

A study carried out by Till et al. (2013) on eighty-one junior rugby league players, tracked for a two-year period and measured on three occasions following anthropometric and fitness characteristics, shows an improvement of these characteristics in junior representative rugby players. There is an interactive effect of the playing position and the development of characteristics that occurs during adolescence. The study also demonstrates the need for tracking the progression of characteristics longitudinally during adolescence instead of at one-off time points.

Quarrie et al. (1996) investigated the anthropometric and physical performance characteristics of New Zealand rugby players of different ages and both sexes. The results indicated significant differences between forwards and backs on anthropometric and physical performance variables. In terms of anthropometric characteristics,

forwards of a given grade were generally taller, possessed a higher body mass, and were more endomorphic and less ectomorphic than backs of the same grade. The backs tended to perform better on physical performance measures than forwards, being more aerobically fit, faster, more agile, and possessing a higher degree of muscular endurance. The greater body mass of the forwards allows them to obtain greater momentum when sprinting compared to the backs. The ability to obtain greater momentum is important in the body contact phases of the game. Forwards may compromise their aerobic fitness and speed to some extent in order to maintain a high body mass. The anthropometric and physical performance characteristics of the players appear to reflect the demands placed on them by the sport.

Gabbett et al. (2010) conducted a study that investigated the tackling ability of junior elite and subelite rugby league players, and tried to determine the relationship between selected physiological and anthropometric characteristics and the tackling ability. The results indicated that the strongest individual correlates of an efficient tackling ability were acceleration and lower body muscular power; therefore coaches should emphasize the development of acceleration and lower body muscular power qualities to improve the tackling ability of junior rugby league players.

Morgan et al. (2011) investigated the effects of a preseason training program on the anthropometric characteristics of semiprofessional players. Over the preseason, both backs and forwards reduced fat mass and increased muscle mass. The preseason training program that included testing and feedback, education, and a combination of resistance, speed, and cardiorespiratory training resulted in considerable anthropometric improvements. The study revealed the importance of a periodized preseason training program and its role in assisting players to achieve the desired body composition goals.

In a study carried out by Cheng et al. (2014) in 116 Australian junior elite rugby league players (average age 17 years), height, body mass, eight skinfolds, five girths and two bone breadths were calculated. The results indicated that higher mass, mesomorphy, adiposity and bone size in forwards are desirable for the tackling and attacking ability and may also protect against high impact forces in this position.

Hypothesis

Anthropometric characteristics may significantly contribute to the improvement of selection standards in the case of young rugby players, but they cannot predict individual sports performance in a high proportion, in the long term.

Material and methods

Research protocol

a) Period of research

The research took place in the Ambulatory Sports Medicine Clinic and was approved by its manager and by the Ethics Board of the "Iuliu Hatieganu" University of Medicine and Pharmacy Cluj-Napoca; the informed consent of the subjects was obtained. The determination period was (T_1) April 2013 for groups I, II, III, IV, V, VI, and also (T_2) April 2014 for groups IV, V, VI after training.

b) Subjects and groups

The determinations were performed in 6 groups (n=10 subjects/group);

- 3 control groups CI (18 years "+/- 0.0707"), CII (19 years "+/- 0.0677"), CIII (20 years "+/- 0.0693");
- 3 groups of athletes AIV (18 years "+/- 0.0915"), AV (19 years "+/- 0.0966"), AVI (20 years "+/- 0.0781").

The groups of young professional athletes were members of the "Universitatea Cluj" Club Cluj-Napoca; the control groups were pupils of the "Avram Iancu" High School in Cluj-Napoca and students of the "Babes Bolyai" University in Cluj-Napoca.

c) Tests applied

Anthropometric indicators

- Direct weight (G) in kg measured with a digital scale, height (H) measured in cm using a stadiometer, arm span measured in cm, palmar flexor strength for both the left and right hand measured in kgf with a FA-100 mechanical dynamometer. Indirect determinations – BMI, calculated using the formula G/H^2 (kg/m^2).

d) Statistical processing was performed using Excel application (Microsoft Office 2007) and StatsDirect v2.7.2 software. The results were graphically represented using Excel application (Microsoft Office 2007).

Results

Results are ilustrated in tables I to VIII.

Discussion

Comparative statistical analysis of anthropometric indicators in the studied groups.

The statistical analysis of age values indicated highly statistically significant differences between the following groups: control groups ($p=5.99 \times 10^{-7}$), athlete groups ($p=6.38 \times 10^{-14}$), for paired samples for control groups, between the C18 - C19, C19 - C20 groups ($p<0.001$) and for athlete groups, between the A18 - A19, A19 - A20 groups ($p<0.001$).

Weight (Table I)

The statistical analysis of weight values, considering all groups regardless of the moment of determination, showed highly statistically significant differences for all 18 and 20-year-old groups ($p=5.7 \times 10^{-14}$) and very statistically significant differences for the 19-year-old groups ($p=0.0069$).

The statistical analysis of weight values, considering paired samples (T_1 - T_2 moments), showed:

- statistically significant differences for group A19 ($p<0.05$);
- very statistically significant differences for group A20 ($p<0.01$).

The statistical analysis of weight values for unpaired samples (T_1 - T_2 moments) indicated:

- very statistically significant differences between groups C19 - A19 ($p<0.01$);
- highly statistically significant differences between groups C20 - A20 ($p<0.001$).

Height (Table II)

The statistical analysis of height values considering all 18-year-old groups evidenced statistically significant differences between at least two of the groups ($p=0.0302$).

The statistical analysis of height values, considering paired samples (T_1 - T_2 moments), evidenced very statistically significant differences for groups A18 and A19 ($p<0.01$).

Table I

Comparative analysis of weight values (measured in kg) in the studied groups and statistical significance.

Group	Mean	SE	Median	SD	Min	Max	Statistical significance (p)		
C18	61.9	3.8433	61.25	12.1536	46	84	C18-C19		0.0772
A18 (T1)	82.3	4.4398	81	14.04	62	100	C18-C20		0.4238
A18 (T2)	84.35	3.6553	83	11.5591	70	100.5	C19-C20		0.2686
C19	70.15	1.9279	72	6.0967	58.5	77.5		A18-A19	0.8836
A19 (T1)	83.15	3.6025	83.25	11.3921	68	98	T1	A18-A20	0.2498
A19 (T2)	86.65	4.5802	86	14.4838	68	114		A19-A20	0.2614
C20	65.95	3.106	63.25	9.8219	52	87		A18-A19	0.6996
A20 (T1)	89.6	4.2379	92	13.4015	72	109	T2	A18-A20	0.1242
A20 (T2)	93.55	4.3579	93.5	13.7809	72	113		A19-A20	0.2895
p	C18-C19-C20		C18-A18 (T1 & T2)		T1-T2	S18	C18-A18	T1	0.0027
	0.1822		0.0007			0.2112		T2	0.0005
	A18-A19-A20 (T1)		C19-A19 (T1 & T2)			A19	C19-A19	T1	0.0067
	0.4016		0.0069			0.0393		T2	0.0061
	A18-A19-A20 (T2)		C20-A20 (T1 & T2)			A20	C20-A20	T1	0.0003
	0.2918		5.7×10^{-14}			0.0027		T2	0.0001

Table II

Comparative analysis of height values (measured in cm) in the studied groups and statistical significance.

Group	Mean	SE	Median	SD	Min	Max	Statistical significance (p)		
C18	170.6	2.9822	169	9.4304	157	183	C18-C19		0.1949
A18 (T1)	180.05	2.8621	178.75	9.0506	164	193	C18-C20		0.0807
A18 (T2)	181.2	2.8821	180.5	9.1141	165	195	C19-C20		0.5888
C19	176.7	2.1137	178	6.6841	160	183		A18-A19	0.8431
A19 (T1)	180.7	1.4836	180.5	4.6916	175	191	T1	A18-A20	0.6448
A19 (T2)	181.8	1.5188	182	4.8028	175	192		A19-A20	0.9555
C20	177.3	2.0058	175.5	6.3430	170	191		A18-A19	0.8565
A20 (T1)	182	2.5210	179	7.9722	173	194	T2	A18-A20	0.9561
A20 (T2)	182.6	2.5131	180	7.9470	174	194		A19-A20	0.6712
p	C18-C19-C20		C18-A18 (T1 & T2)		T1-T2	A18	C18-A18	T1	0.0346
	0.2418		0.0302			0.0016		T2	0.0199
	A18-A19-A20 (T1)		C19-A19 (T1 & T2)			S19	C19-A19	T1	0.2853
	0.9303		0.2194			0.0067		T2	0.1129
	A18-A19-A20 (T2)		C20-A20 (T1 & T2)			S20	C20-A20	T1	0.1257
	0.9559		0.1362			0.125		T2	0.0718

Table III

Comparative analysis of BMI values (measured in kg/m^2) in the studied groups and statistical significance.

Group	Mean	SE	Median	SD	Min	Max	Statistical significance (p)		
C18	21.12	0.8788	21.31	2.7790	17.78	27.43	C18-C19		0.1976
A18 (T1)	25.33	1.1153	25.12	3.5268	19.79	30.30	C18-C20		0.7394
A18 (T2)	25.65	0.8022	26.20	2.5369	22.09	29.41	C19-C20		0.0304
C19	22.46	0.4558	22.79	1.4414	20.04	24.62		A18-A19	0.9482
A19 (T1)	25.43	0.9751	24.52	3.0835	21.95	31.28	T1	A18-A20	0.3023
A19 (T2)	26.22	1.3928	24.70	4.4043	21.46	36.39		A19-A20	0.3016
C20	21.04	1.1233	20.63	3.5521	17.18	30.10		A18-A19	0.7301
A20 (T1)	27.03	1.1518	25.98	3.6424	22.22	33.46	T2	A18-A20	0.1174
A20 (T2)	28.05	1.2104	27.39	3.8277	22.22	35.01		A19-A20	0.3326
p	C18-C19-C20		C18-A18 (T1 & T2)		T1-T2	A18	C18-A18	T1	0.0087
	0.0648		0.0031			0.4928		T2	0.0013
	A18-A19-A20 (T1)		C19-A19 (T1 & T2)			A19	C19-A19	T1	0.0163
	0.4691		0.0353			0.1505		T2	0.0264
	A18-A19-A20 (T2)		C20-A20 (T1 & T2)			A20	C20-A20	T1	0.0007
	0.3257		0.0008			0.0134		T2	0.0005

Table IV

Comparative analysis of arm span values (measured in cm) in the studied groups and statistical significance.

Group	Mean	SE	Median	SD	Min	Max	Statistical significance (p)		
C18	172.5	3.1737	174.5	10.036	158	184	C18-C19		0.3429
A18 (T1)	184.8	2.8394	184.5	8.979	168	196	C18-C20		0.4240
A18 (T2)	185.5	2.676	185	8.4623	171	196	C19-C20		0.4688
C19	177.7	2.0169	179.5	6.3779	163	183		A18-A19	0.7817
A19 (T1)	184.8	1.4126	185.5	4.4672	179	190	T1	A18-A20	0.8388
A19 (T2)	185.9	1.402	186.5	4.4335	179	192		A19-A20	0.8958
C20	177.8	2.444	175	7.7287	171	196		A18-A19	0.8965
A20 (T1)	185.6	2.6382	184	8.3427	173	196	T2	A18-A20	0.8753
A20 (T2)	186.1	2.656	184.5	8.3991	173	197		A19-A20	0.9478
p	C18-C19-C20		C18-A18 (T1 & T2)		T1-T2	A18	C18-A18	T1	0.0098
	0.4888		0.0055			0.0445		T2	0.0058
	A18-A19-A20 (T1)		C19-C19 (T1 & T2)			A19	C19-A19	T1	0.0091
	0.9656		0.0064			0.0313		T2	0.0029
	A18-A19-A20 (T2)		C20-A20 (T1 & T2)			A20	C20-A20	T1	0.0345
	0.9829		0.0379			0.015		T2	0.0244

Table V

Comparative analysis of left hand palmar flexor muscle strength (measured in kgf) in the studied groups and statistical significance.

Group	Mean	SE	Median	SD	Min	Max	Statistical significance (p)		
C18	27.8	3.5239	27	11.1435	15	52	C18-C19		0.6966
A18 (T1)	45.2	3.5553	42	11.2428	32	62	C18-C20		0.8604
A18 (T2)	48.2	2.5024	48	7.9134	38	62	C19-C20		0.8156
C19	29.4	1.9333	29	6.1137	18	40		A18-A19	0.3536
A19 (T1)	41.2	2.1949	40	6.941	26	52	T1	A18-A20	0.2788
A19 (T2)	40.7	2.1294	41	6.7338	30	50		A19-A20	0.0240
C20	28.6	2.7657	29	8.7458	18	46		A18-A19	0.0348
A20 (T1)	50.4	2.9933	50	9.4657	40	72	T2	A18-A20	0.4737
A20 (T2)	51	2.8944	49	9.153	38	68		A19-A20	0.0107
p	C18-C19-C20		C18-A18 (T1 & T2)		T1-T2	S18	C18-A18	T1	0.0027
	0.9227		0.0002			0.1934		T2	0.0002
	A18-A19-A20 (T1)		C19-A19 (T1 & T2)			S19	C19-A19	T1	0.0008
	0.1083		0.0005			0.839		T2	0.0010
	A18-A19-A20 (T2)		C20-A20 (T1 & T2)			S20	C20-A20	T1	4.39×10^{-5}
	0.0216		5.61×10^{-6}			0.7866		T2	2.61×10^{-5}

Table VI

Comparative analysis of right hand palmar flexor muscle strength (measured in kgf) in the studied groups and statistical significance.

Group	Mean	SE	Median	SD	Min	Max	Statistical significance (p)		
C18	30.8	3.6264	30	11.4678	12	56	C18-C19		0.3610
A18 (T1)	44.2	3.4183	41	10.8095	30	62	C18-C20		0.4529
A18 (T2)	49	3.5308	46	11.1654	38	74	C19-C20		0.8082
C19	34.4	2.2667	32	7.1678	26	46		A18-A19	0.5022
A19 (T1)	41	3.1868	40	10.0775	30	60	T1	A18-A20	0.4343
A19 (T2)	45.6	3.1805	43	10.0576	30	68		A19-A20	0.1117
C20	35	4.1015	34	12.9701	10	58		A18-A19	0.6401
A20 (T1)	47.4	2.045	46	6.467	40	58	T2	A18-A20	0.4009
A20 (T2)	50.4	2.4909	49	7.8768	42	68		A19-A20	0.2511
p	C18-C19-C20		C18-A18 (T1 & T2)		T1-T2	S18	C18-A18	T1	0.0150
	0.5054		0.0018			0.1953		T2	0.0009
	A18-A19-A20 (T1)		C19-A19 (T1 & T2)			S19	C19-A19	T1	0.1282
	0.3225		0.0419			0.0984		T2	0.0133
	A18-A19-A20 (T2)		C20-A20 (T1 & T2)			S20	C20-A20	T1	0.0180
	0.3364		0.0028			0.1054		T2	0.0059

Table VII

Statistical analysis of correlation between the values of the studied indicators for the control groups.

Indicator \Group		C18		C19		C20	
Weight	Height	0.7645	****	0.7746	****	0.0832	*
	BMI	0.8576	****	0.5447	***	0.8268	****
	Arm span	0.8271	****	0.5896	***	-0.1402	*
Height	BMI	0.3267	**	0.0500	*	-0.5046	***
	Arm span	0.9368	****	0.8636	****	0.9482	****
BMI	Arm span	0.4702	**	-0.1416	*	-0.5289	***
PFMS-LH	PFMS-RH	0.8630	****	0.4738	**	0.5936	***

Legend: BMI = body mass index, PFMS-LH = palmar flexor muscle strength - left hand, PFMS-RH = palmar flexor muscle strength - right hand. Correlation **** very good, *** good, ** acceptable, * weak.

Table VIII

Statistical analysis of correlation between the values of the studied indicators for the athlete groups.

Moment		T1						T2					
Indicator \ Group		A18		A19		A20		A18		A19		A20	
Weight	Height	0.6019	***	0.5207	***	0.3659	**	0.6990	***	0.2481	*	0.3293	**
	BMI	0.7929	****	0.9240	****	0.8091	****	0.6485	***	0.9481	****	0.8042	****
	Arm span	0.6157	***	0.1723	*	0.4705	**	0.7000	***	0.1499	*	0.3950	**
Height	BMI	-0.0072	*	0.1560	*	0.0182	*	-0.0896	*	-0.0714	*	-0.0610	*
	Arm span	0.9559	****	0.6339	***	0.9507	****	0.9451	****	0.6147	***	0.9509	****
BMI	Arm span	0.0523	*	-0.0614	*	-0.1001	*	-0.0241	*	-0.0321	*	-0.1843	*
PFMS-LH	PFMS-RH	0.8536	****	0.8006	****	0.8030	****	0.4118	**	0.6641	***	0.8754	****

Legend: BMI = body mass index, PFMS-LH = palmar flexor muscle strength - left hand, PFMS-RH = palmar flexor muscle strength - right hand. Correlation **** very good, *** good, ** acceptable, * weak.

The statistical analysis of height values considering unpaired samples (T_1 - T_2 moments) showed statistically significant differences between groups C18 - A18 ($p<0.05$).

Body mass index (BMI) (Table III)

The statistical analysis of body mass index "BMI" values showed statistically significant differences between at least two of the groups considering all 18, 19-year-old groups ($p=0.0031$), ($p=0.0353$) and highly statistically significant differences for the 20-year-old groups ($p=0.0008$).

The statistical analysis of BMI values, considering paired samples (T_1 - T_2 moments), evidenced statistically significant differences for the A20 group ($p<0.05$).

The statistical analysis of BMI values for unpaired samples (T_1 - T_2 moments) showed:

- statistically significant differences between groups C19 - A19 ($p<0.05$);
- very statistically significant differences between groups C18 - A18 ($p<0.01$);
- highly statistically significant differences between groups C20 - A20 ($p<0.001$).

Arm span (Table IV)

The statistical analysis of arm span values showed very statistically significant differences between at least two of the groups considering all 18, 19-year-old groups ($p=0.0055$), ($p=0.0064$) and statistically significant differences for the 20-year-old groups ($p=0.0379$).

The statistical analysis of arm span values, considering paired samples (T_1 - T_2 moments), evidenced statistically significant differences for A18, A19, A20 groups ($p<0.05$).

The statistical analysis of arm span values for unpaired samples (T_1 - T_2 moments) showed:

- very statistically significant differences between groups C18 - A18 and C19 - A19 ($p<0.01$);
- statistically significant differences between groups C20 - A20 ($p<0.05$).

Palmar flexor muscle strength

Left hand palmar flexor muscle strength (Table V)

The statistical analysis of left hand palmar flexor muscle strength values indicated highly statistically significant differences between at least two of the groups considering all 18, 19, 20-year-old groups ($p=0.0002$), ($p=0.0005$), ($p=5.61 \times 10^{-6}$).

The statistical analysis of left hand palmar flexor muscle strength values considering all athlete groups at moment T_2 indicated statistically significant differences between at least two of the groups ($p=0.0216$).

The statistical analysis of left hand palmar flexor muscle strength values for unpaired samples at T_1 showed:

- very statistically significant differences between groups C18 - A18 ($p<0.01$);
- statistically significant differences between groups A19 - A20 ($p<0.05$);
- highly statistically significant differences between groups C19 - A19 and C20 - A20 ($p<0.001$).

The statistical analysis of left hand palmar flexor muscle strength values for unpaired samples at T_2 indicated:

- statistically significant differences between groups A18 - A19 and A19 - A20 ($p<0.05$);
- very statistically significant differences between groups C19 - A19 ($p<0.01$);
- highly statistically significant differences between groups C18 - A18 and C20 - A20 ($p<0.001$).

Right hand palmar flexor muscle strength (Table VI)

The statistical analysis of right hand palmar flexor muscle strength values indicated very statistically significant differences between at least two of the groups considering all 18, 20-year-old groups ($p=0.0018$), ($p=0.0028$) and statistically significant differences for the 19-year-old group ($p=0.0419$).

The statistical analysis of right hand palmar flexor muscle strength values considering unpaired samples at moment T_1 indicated statistically significant differences between groups C18 - A18 and C20 - A20 ($p<0.05$).

The statistical analysis of right hand palmar flexor muscle strength values considering unpaired samples at moment T_2 showed:

- statistically significant differences between groups C19 - A19 ($p<0.05$);
- very statistically significant differences between groups C20 - A20 ($p<0.01$);
- highly statistically significant differences between groups C18 - A18 ($p<0.001$).

Conclusions

The following changes were found:

1. Significant increases in weight, body mass index, arm span and palmar flexor strength in the athlete groups compared to the non-athlete groups, except for the 18-year-old groups regarding weight.

2. After a one-year period (at T_2), athletes had significant increases in: weight (the 19-year-old and 20-year-old groups), height (the 18-year-old and 19-year-old groups), body mass index (the 20-year-old group) and arm span (all groups).

3. The changes in anthropometric characteristics of the rugby players can occur as an adaptive consequence to the specificity of the physical demands of the sport and can be influenced by training. These characteristics and the changes that follow in time must be taken into consideration for further athlete selection.

Conflict of interests

Nothing to declare.

Aknowledgements

The paper is based on the results of the first author's doctoral thesis, which is in progress at the "Iuliu Hatieganu" University of Medicine and Pharmacy Cluj-Napoca.

References

Chang HL, O'Connor H, Kay S, Cook R, Parker H, Orr R. Anthropometric characteristics of Australian junior representative rugby league players. J Sci Med Sport. 2014;17(5):546-551.

Cordun M. Kinantropometrie. Ed. CD Press, București, 2009;84

Drăgan I. Medicină sportivă. Ed. Medicală București 2002;178-186.

Fontana FY, Colosio A, De Roia GF, Da Lozzo G, Pogliaghi S. Anthropometrics of Italian Senior Male Rugby Union Players: From Elite to Second Division. Int J Sports Physiol Perform. 2015;10(6):674-680.

Fuller CW, Taylor AE, Brooks JH, Kemp SP. Changes in the stature, body mass and age of English professional rugby players: a 10-year review. J Sports Sci. 2013;31(7):795-802.

Gabbett TJ, Jenkins DG, Abernethy B. Physiological and anthropometric correlates of tackling ability in junior elite and subelite rugby league players. J Strength Cond Res. 2010; 24(11):2989-2995.

Gabbett TJ, Jenkins DG, Abernethy B. Relative importance of physiological, anthropometric, and skill qualities to team selection in professional rugby league. J Sports Sci. 2011;29(13):1453-1461.

Gurău A. Evaluarea dezvoltării fizice la sportivi. În Drăgan I (sub red.) Medicina Sportivă. Ed. Medicală București 2002;215-

226.

Lombard WP, Durandt JJ, Masimla H, Green M, Lambert MI. Changes in body size and physical characteristics of South African under-20 rugby union players over a 13-year period. J Strength Cond Res. 2015;29(4):980-988.

Morgan PJ, Callister R. Effects of a preseason intervention on anthropometric characteristics of semiprofessional rugby league players. J Strength Cond Res. 2011;25(2):432-440.

Quarrie KL, Handcock P, Waller AE, Chalmers DJ, Toomey MJ, Wilson BD. The New Zealand rugby injury and performance project. III. Anthropometric and physical performance characteristics of players. Br J Sports Med, 1995;29(4):263-270.

Sedeaud A, Marc A, Schipman J, Tafflet M, Hager JP, Toussaint JF. How they won Rugby World Cup through height, mass and collective experience. Br J Sports Med, 2012;46(8):580-584.

Sedeaud A, Vidalin H, Tafflet M, Marc A, Toussaint JF. Rugby morphologies: "bigger and taller", reflects an early directional selection. J Sports Med Phys Fitness, 2013;53(2):185-191.

Till K, Cobley S, O'Hara J, Chapman C, Cooke C. A longitudinal evaluation of anthropometric and fitness characteristics in junior rugby league players considering playing position and selection level. J Sci Med Sport, 2013; 16(5):438-443.

Till K, Tester E, Jones B, Emmonds S, Fahey J, Cooke C. Anthropometric and physical characteristics of english academy rugby league players. J Strength Cond Res, 2014;28(2):319-327.

Waldron M, Worsfold P, Twist C, Lamb K. Changes in anthropometry and performance, and their interrelationships, across three seasons in elite youth rugby league players. J Strength Cond Res, 2014;28(11):3128-3136.