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Review Article

Performance Power and Body Composition in Athletes: Kinanthropometry and Correlations between Explosive Strength, Elastic Energy and Coordination

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Abstract

In rugby, as well as in sports of similar benefits, the increase in body mass is emphasized as an objective to improve sports performance. In professional practice, it becomes clear that there is no direct relationship between body mass and sport performance. The purpose of this study was to investigate the relationship between body composition and the strength of youth rugby players from a club in Argentina. In addition, our results will provide the foundations to educate athletes in habits (diet, health and care), in collaboration with the different institutional levels.

***Keywords:** Kinanthropometry; Sports Performance; Power; Explosive Strength; Coordination; Elastic Energy; Healthy Habits*

The sample consisted of 97 youth rugby players from a First Division Club from the city of Rosario (Argentina). Their ages ranged from 15 to 18 years and they played in all field positions.

From different anthropometric models, average values of age, weight, height, sitting height, size, somatotype (endo, meso and ectomorphism), body composition (percentages of adipose tissue, muscle, bone, residual and skin), body fat-muscle ratio (BFMR), muscle-bone index (M-B), body mass index (BMI) and wingspan index were calculated.

In order to assess the player's jumps, average height values were collected in the three jumps based on the Bosco protocol, Abalakov, CMJ and SJ, difference between Abalakov and CMJ to assess coordination (Dif1), difference between CMJ and SJ to assess elastic energy use (Dif2) [1-5].

Data analysis

We compared our results to the database of the top categories of the 2009 URBA tournament (Holway Francis., *et al*. "Kinanthropometry of Group I rugby players in Buenos Aires, Argentina". *Journal of Sports Sciences*, September 2009), to implement long-term strategies that allow developing programs associated with very specific goals.

The physiological parameters (jump tests) were related to the structural ones (kinanthropometry) to develop guidelines that allow improving individual performance based on general characteristics.

Correlations between variables

Simple correlations between variables

To assess the relationships between the studied variables, we ran simple correlations between the physiological variables (explosive strength assessed by jumps: Abalakov, CMJ, SJ, Dif2 and General Ranking) and the anthropometric variables (muscle mass, fat mass, mesomorphic component of the somatotype, body fat-muscle ratio, muscle index bone, weight and size).

It is intended to find relationships between the variables studied that allow making appropriate decisions in the individual training processes.

Correlations between jumps and anthropometric variables

Simple correlation between CMJ and muscle mass in U18 (r = 0.967).

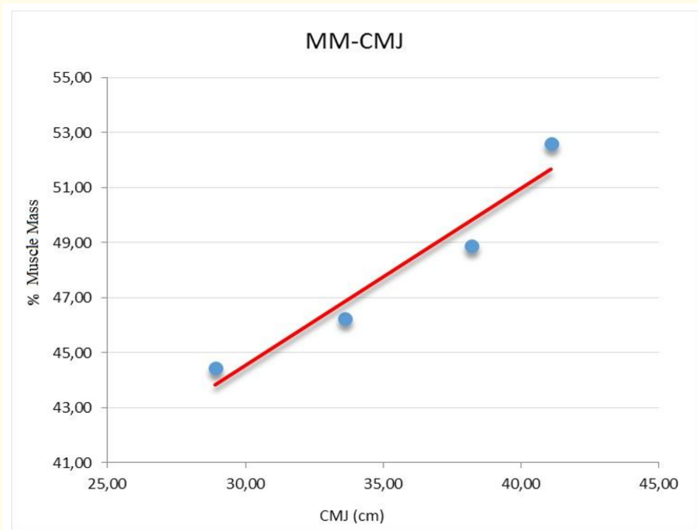

Figure 1

Simple correlation between CMJ and Fat Mass in U18 (r = -0.927).

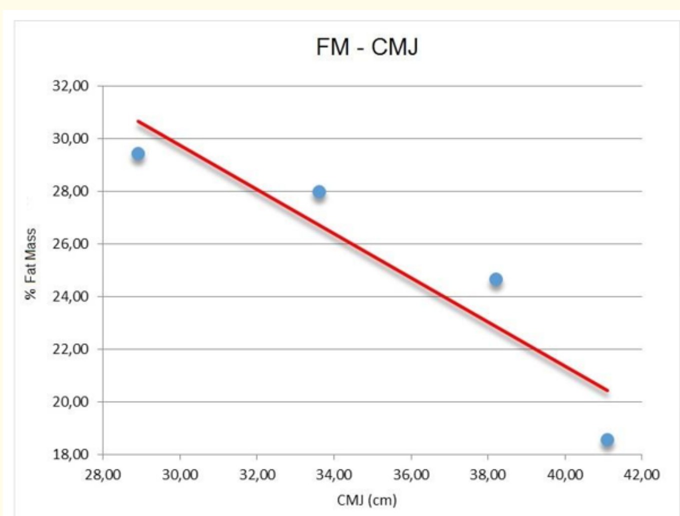

Figure 2

Simple correlation between and MESO (U17, r = -0.651).

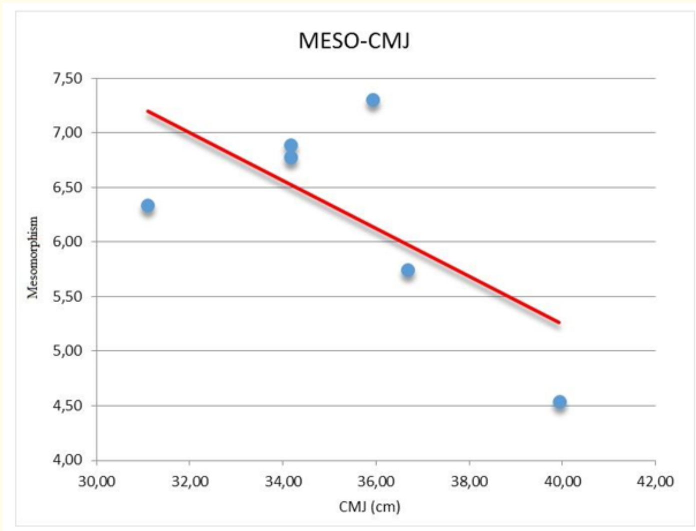

Figure 3

Simple correlation between CJM and BFMR (U18, r = -0.952).

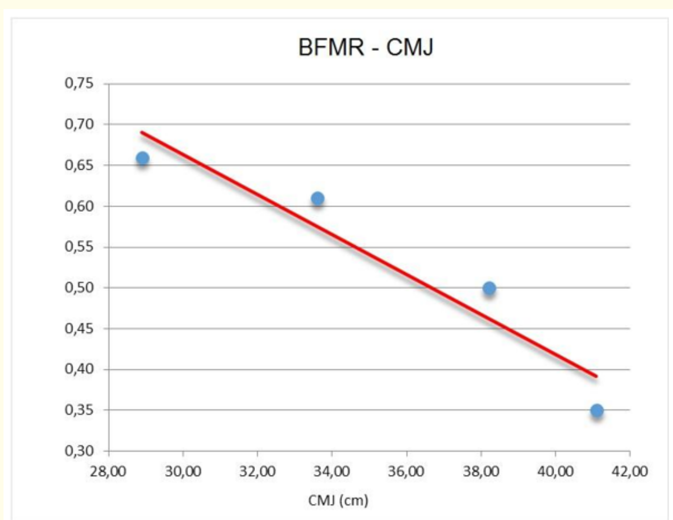

Figure 4

Simple correlation between Abalakov M-B index in U18 (r = 0.949).

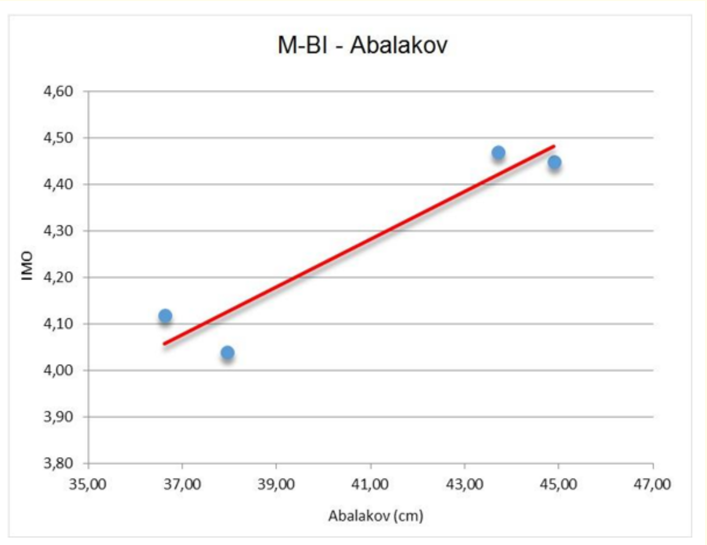

Figure 5

Simple correlation between Abalakov and Weight in U18 (r = -0.906).

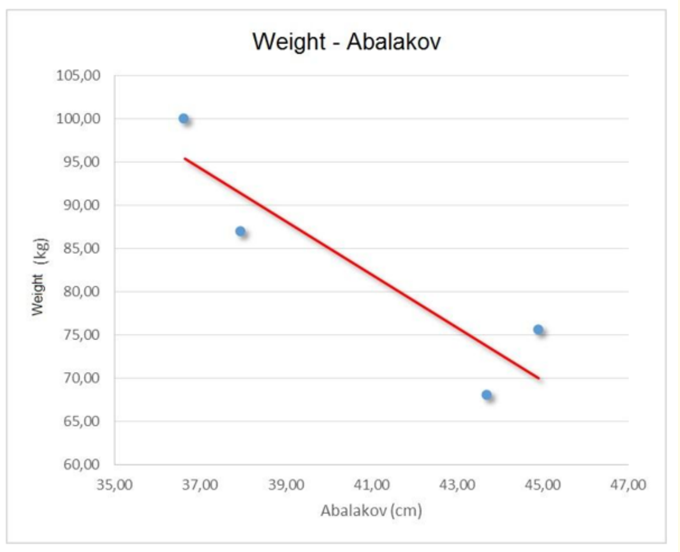

Figure 6

On this occasion and because of the number of players evaluated in some divisions, the trend we show in these graphs did not appear.

Overall, the Jumping Capacity and the Muscle Mass correlated positively (with a weaker trend in U15).

Jumping Capacity and Fat Mass correlated negatively in all populations (again U15 has a weaker correlation).

We found negative correlations between the Mesomorphic component of Somatotype and Jumping Capacity in all the populations studied.

BFMR is negative in all populations, but the B-M index behaves differently, appearing with positive correlations in most populations, except in U17 (negative) and U15 (no definite trend).

Weight and Jumping Capacity have negative correlations in all populations, except in U15 where it has positive correlations.

Finally, the correlations between Size and Jumping Capacity are negative in U18 and U16, positive in U17 and show no definite trend in U15.

If ALL the data obtained is averaged, the trends found are significant, except in the case of the Mesomorphic component of the Somatotype. Subsequent studies that contain more data will surely yield more concrete results.

Reference scale

The work done allows us to develop a theoretical reference scale for all the parameters evaluated.

These references, which can be modified according to different objectives, mark a trend line in the development of morphological capacities and some physiological capacities, in order to reach the Superior Category with optimal values.

This ensures, partly, the ability of athletes to respond to the demands of training and competition in which the rugby teams of the Club where the present work was carried out participate.

General comparatives - Reference scale															
	Age	**Weight R**	**Weight O**	**Talla R**	**Talla O**	**Endo R**	**Endo O**	**Meso R**	**Meso O**	**Ecto R**	**Ecto O**	**Musc R**	**Musc O**	**Fat R**	**Fat O**
REF. URBA		89,50		178,80		3,30		6,80		1,10		49,50		23,20	
S. Category	22,40	89,42	90,00	180,61	185,00	3,27	3,00	6,21	6,80	1,30	1,30	48,88	50,00	24,66	20,00
U-18	17,73	76,68	86,00	176,18	183,00	2,97	2,80	5,61	6,40	2,64	1,50	47,73	48,00	25,37	22,00
U-17	16,66	79,26	82,00	175,24	180,00	3,73	2,80	5,61	6,00	1,61	1,60	46,04	46,00	27,20	24,00
U-16	15,62	76,82	78,00	178,15	176,00	3,04	2,50	5,39	5,40	2,28	1,70	46,14	44,00	26,22	26,00
U-15	14,84	60,15	74,00	167,55	170,00	2,74	2,50	4,45	4,80	2,99	1,80	42,83	42,00	28,15	27,00
	BFMR R	BFMR O	M-Bi R	M-Bi O	Abal R	Abal O	CMJ R	CMJ O	SJ R	SJ O	D1 R	D1 O	D2 R	D2 O	
REF. URBA	0,47		4,58												
S. Category	0,51	0,45	4,60	4,80	50,17	55,00	42,44	45,00	36,15	38,00	27,56	30,00	25,27	30,00	
U-18	0,55	0,50	4,38	4,60	42,71	50,50	33,91	41,25	27,79	35,50	26,07	28,00	23,38	28,00	
U-17	0,61	0,55	4,26	4,30	36,98	46,00	30,94	37,50	26,63	33,00	19,51	26,00	16,65	26,00	
U-16	0,58	0,60	4,03	4,00	35,18	41,50	29,09	33,75	25,03	30,50	21,61	24,00	17,15	24,00	
U-15	0,67	0,70	3,63	3,70	38,43	37,00	32,26	30,00	27,75	28,00	33,28	22,00	24,53	22,00	

In the upper table the average values of the Reference (URBA, 2009) of the Superior Category and of the youth Category (U18, U17, U16 and U15) are shown. Identified with an R, the "real" values obtained from each population are observed in the 2013 evaluation.

Next to the real average, the "objective" values are shown, identified with an O. These represent the desirable values to be achieved by each population at each stage: U15, U16, U17, U18 and Superior Category.

The Objective values represent reference marks to achieve the adequate development of the anthropometric and jump capacity variables (explosive strength), to reach the Superior Category. The data in each population have been discriminated by field position, which implies that these general average values may show intra-population variation depending on the characteristics in each field position.

Conclusion

According to the values obtained we can partially conclude:

1) Regarding the anthropometric parameters and their evolutionary comparison in the different young populations:

- The weight evolves from 60,300 kg in U15 to 73,690 kg in U16, 80,160 kg in U17 and decreases to 78,800 in U18;
- The average size shows values of 167.82 cm in U15, 174.99 cm in U16, 175.72 cm in U17 and it shows another slight increase in U18 with 177.13 cm;
- The percentage of muscle Mass starts at 43.27 in U15 and increases to 46.73 in U16, stagnates in 46.80 in U17 and increases again to 47.84 in U18;
- A similar trend occurs in the content of Fat Mass, 27.72 in U15, 25.28 in U16, 23.32 in U17 and 25.30 in U18;
- The mesomorphic component of the somatotype shows an average of 4.53, 5.65, 5.75 and 5.81 respectively in U15, 16, 17 and 18;
- The BFMR is 0.60 in U15 decreases to 0.56 in U16 and goes back up to 0.58 in U17, showing the lowest value in U18, 0.54.

2) Regarding explosive strength tests (jumps):

- The average of the sample in Abalakov is 36.86 cm in U15, 38.39 in U16, 40.04 in U17 and 40.80 in U18, this value being 50.17 cm in Superior Category;
- The average of the top ten in CMJ is 29.88 cm (U15), 32.94 cm (U16), 34.46 cm (U17) and 35.45 cm (U18), respectively and 42.44 cm in Superior Category;
- The average of the top ten in SJ is 27.51 cm (U15), 29.84 cm (U16), 30.74 cm (U17), and 28.13 cm (U18), respectively, and 36.15 cm in Superior Category.

3) Regarding the correlations between jump tests and anthropometric variables:

a. There is a positive correlation between the percentage of muscle mass and jump values (in all versions), with coefficients that vary according to age;

b. There is a negative correlation between the percentage of fat mass and the values of jumps (for all variants of jumps), with inter-population variations;

c. There is a negative correlation between BFMR and jump values with variable coefficients, but of similar tendency for all populations and types of jumps;

d. There is a negative correlation between total body weight and jump values in most of the populations studied.

The displayed data suggest, among other things, that:

1) Muscle and fat mass values should be appropriately and periodically monitored, in order to, both, establish why youth populations are different, and to be able to act on them.

2) The positive correlations between jumps and muscle mass and the negative correlations between jumps and fat mass, jumps and BFMR and jumps and total body weight, indicate that, beyond body weight as a single variable, the control of body composition is essential, since positive relationships between explosive strength parameters are not given based the total weight, but on the muscle mass.

3) The study is completed with the results obtained according to field positions, in which intra-population differences are marked more or less noticeably (depending on age and field position). This differences will allow a more personalized monitoring of the evolution of each player.

Final Considerations and Suggestions

Based on the foregoing conclusions, it is suggested that/to:

1. Insisting on installing healthy habits related to invisible training (diet, hydration, rest, supplementation, avoidance of toxic substances).

2. Encouraging the discussion and exchange of ideas to agree on a unified training program, which meets different objectives at different ages, based on the values presented in the Table “Reference Scale” for the parameters studied here.

3. Analyzing possible personalized training strategies in specific cases, which allow a positive change in structural aspects (body composition, mainly increase controlled muscle mass and loss of adipose tissue), regardless of body weight.

4. Promoting the development of each player’s physical and morphological abilities in related groups, even if they belong to different Categories, to customize the training and to maximize the available resources. This implies that groups should no longer be considered “closed” categories.

5. Bearing in mind that the sudden increase in weight does not generate an adequate development of muscle mass and can lead to increased fat mass and fluid retention, opposite situations to those seeking to improve health and sports performance.

6. Establish a work methodology that systematizes the control of the training process, through the evaluations that athletes can undergo, such as the ones presented in this study, as a starting point, or many others that are generally used in sports of performance.

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