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Changes in body composition of high competition rugby players during the phases of a regular season; influence of diet and exercise load

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Abstract

Background: **Top athletes are subjected to intense training to achieve high performance. There are factors such as diet and strenuous exercise that affects body composition and can modify the performance. The aim of the study was to evaluate the effect of a personalized plan of diet and training on body composition.**

Methods: **We studied the body composition of 18 professional rugby players using Kinanthropometry parameters. The study was conducted from the preseason to the end of the season taking into account the position of the player for measuring exercise intensity, and developing a personalized nutritional and training plan to each player.**

Results: **At baseline the players were away from the internationally recommended body composition, with high percentages of body fat. Appropriate and personalized diet plans and training custom achieved fat percentages close to those recommended.**

Conclusions: **The personalized program of diet and training directed has adequate leverage to improve all parameters studied them bringing them as close to the ideal.**

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Key words: *Composition. Body. Training. Diet. Exercise. Performance.*

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CAMBIOS EN LA COMPOSICIÓN CORPORAL DE JUGADORES DE RUGBY DE ALTA COMPETICIÓN DURANTE LAS FASES DE UNA TEMPORADA HABITUAL: INFLUENCIA DE LA DIETA Y LA CARGA DE EJERCICIO

Resumen

Introducción: **Los atletas de alto rendimiento están sometidos a grandes esfuerzos para lograr un alto nivel. Hay factores como la alimentación y el ejercicio extenuante que afectan la composición corporal modificando el rendimiento. Sin embargo con un plan personalizado de dieta y entrenamiento se puede modificar la composición corporal y lograr un máximo rendimiento.**

Métodos: **Estudiamos la composición corporal de 18 jugadores profesionales de rugby por medio de bioimpedancia y kineantropometría. El estudio se llevó a cabo desde la pretemporada hasta el final de la temporada tomándose en cuenta la posición de juego para medir la intensidad del ejercicio, y desarrollando un plan personalizado de alimentación y entrenamiento a cada jugador.**

Resultados: **Los jugadores estaban lejos de la composición corporal recomendada internacionalmente, con altos porcentajes de grasa corporal. Con planes personalizados de dieta y entrenamiento se logró porcentajes de grasa cercanos a los recomendados.**

Conclusiones: **El programa personalizado de dieta y el entrenamiento dirigido, tiene una adecuada influencia para mejorar todos los parámetros de composición corporal estudiados acercándolos al ideal.**

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Palabras clave: *Composición. Corporal. Entrenamiento. Dieta. Ejercicio. Rendimiento.*

Background

Historically the prototype rugby player is a great, heavy and strong sportsman. But as in many other sports, the morphology of its practitioners has evolved dramatically. In the particular case of rugby, the entry into the world of professionalism has been the main cause of this event. It has gone from a sport college and amateur character to be one of the most followed disciplines worldwide. It should be noted that the Rugby World Cup is the third most viewed sport event behind only the Olympic Games and the football World Cup.

But the changes have not only come in monitoring and organizing the sport itself but also especially in the athletes themselves. The physical performance of the top players is very high currently. This change in athlete's morphology has produced significant increases in the game work rate, causing a considerable increase of the physical demands on the body. As shown in table I, the physical requirements for the practice of this discipline at the highest level are very high.

The analysis of body composition allows us to know the main functional human body tissues such as fat mass, muscle mass and lean mass. Thus, we can estimate its variation in different pathological (nutrition-related diseases) and physiological situations as age, growth or practice sports. This last point has attracted the interest of several research groups, with the goal of improving athletic performance. However, the study of body composition of athletes must confront two problems; the real significance of BMI in high level athletes and the generalized assumption as full weight exceeding the values determined by size-tables correspond to fat mass weight.

The meaning of BMI (Body Mass Index) is not a valid to measure the composition of subjects in high competition. This index has gained considerable influence in the field of public health and some areas of sport world and physical activity. The BMI is the most frequently used surrogate measure of adiposity. However, exhibits notable inaccuracies that not precisely reflecting body fat and changes in body composition that take place in the different periods of life or the sexual dimorphism characteristics of body adiposity[1,2].

Overweight especially in sports with a high strength component as in rugby may be due to increased fat, muscle or bone mass. Studies have shown the lack of correlation between BMI and percentage of body fat based on gender, ethnicity, sport or profession[3]. Jebb et al[4] have also studied the BMI validity in the two-compartment model based on densitometry techniques. This bicompartimental body composition model was called by Wilmore[5] as "gold rule".

This model argued that the density is constant for each of two compartments (fat mass and lean mass). So, fat mass would have a constant density of 0.90 g/ml, whereas lean body mass would have a constant density of 1.10 g/ml. Nevertheless, for total body density weight is used underwater weight, that is the weight corrected taking account the trapped residual volume in the lungs of a subject submerged in a water tank. From this corrected weight is assumed that the constant density predicts the percentage of adipose tissue of the subject under study. The problem of this method is that the fat is valid only for a part of the body as triglycerides ignoring the rest of body lipids, such as phospholipids and cholesterol. These lipids must have a density greater than 0.90 g/ml.

Even assuming that a certain density of adipose component is constant, it is difficult to assume that the lean compartment in humans has a constant density as 1.10 g/ml. Martin et al[6] in 1985 proved the lack of consistency of this assumption. They demonstrated that the fat free mass is not constant in terms of the proportion of bone tissue, muscle or residual mass because the three components are not in fixed proportions. To this data must be added that the density of each of these components is not constant as supposed by Wilmore[5], and we can add that these density variations are most evident in the bone tissue.

BMI is currently used as a mortality risk index for epidemiological field. This interpretation should be done in values just individual level considering that the assessment is relative. Moreover, you should not fall in error of extrapolating a valuation of BMI as an index of

Table I
Average distance covered during a rugby match

	Total distance covered during the math (km) *6.127 ± 724*		
LINE	*Distance at low intensity* **2.351 ± 287**	*Distance at medium intensity* **3.328 ± 288**	*Distance at high intensity* **448 ± 149**
	Total distance covered during the match (Km) **5.581 ± 692**		
FORWARD	*Distance at low intensity* **1.928 ± 234**	*Distance at medium intensity* **3.355 ± 351**	*Distance at high intensity* **298 ± 107**

adiposity. These data make us consider the low reliability of this index to study body composition in high-level athletes in a reliable way. Therefore, it is suggested that in athlete's body mass index should be used in combination with other procedures as bioimpedance and anthropometry.

The specificity of bioimpedance and his ability to perform the analysis in field, have led it to be the most widespread. On the other hand, the anthropometric study quantifies and provides information on the physical structure of an individual at a given time, and the differences arising from the growth and training. Players do not always have an extraordinary ability in all of the areas of physical exercise, but they should have a reasonable level in all areas. These make the individual differences in anthropometric and physiological characteristics among elite players and define the positional roles of a player is related to their physiological capacity.

The Kinanthropometry[7] is part of Sports Science that describes and quantifies the physical characteristics of the athletes. The athlete's functional assessments include the study of anthropometric profile as one of the factors that influence success in sport as both physiologically and biomechanically.

Material and methods

Athletes under study had a season that began in August with the start of the preseason. They played three matches and made an average of 8 weekly training sessions until the beginning of the league in mid-September. Other 7 games were played with an average of 6 weekly sessions until the Christmas break. The season would end in late May after 17 matches among the different competitions. Some of them play more games because of his presence with national teams, territorial or other club teams. In total these players have carried out a planned training period of 9 months, in which they have competed in about 27 times and have scored more than 200 training sessions. Without this training volume it would be impossible to compete in ideal conditions, and thus maintain a proper body composition to the needs and requirements of the sport.

This is a prospective study. The distribution of athletes has been made based on their playing position and the results of the initial assessment.

Study subjects

- *Inclusion criteria:* Athletes must belong to the senior first team Rugby Club Cajasol Sevilla for the 2009/10. They must have a professional contract with Sevilla Cajasol Rugby Club during the 2009/10 season for ensuring total dedication to high-level sports.
- *Exclusion criteria:* They must not suffer a prolonged injury more than 3 months that could avoid the tracking of physical activity program and discontinue participation in competitive activity.

The final group of athletes was formed by18 players from the senior professional staff Cajasol Rugby Club Sevilla (2009/10) belonging to the Spanish Honour Division that are the highest category of rugby in Spain. Notably, six of these players participated during the study period, to a greater or lesser extent with Spanish national team, both in friendly matches and official for the European Championship.

For the anthroprometic measures, we rely on the recommendations of the International Working Group of Kinanthropometry (ISAK) and the Spanish Group Kinanthropometry for precise evaluation of anthropometric measurements (GREC)[8,9]. We made three consecutive measurements on each of the locations specified in the protocol, the average value obtained from these three measures are accepted as valid data. The time spent in each measurement was approximately 20 minutes per subject.

The perimeter was measured using metal anthropometric tape, flexible, non-elastic, less than 7mm wide in the midpoint between two anatomical landmarks and location of skinfolds. The size was measured using a measuring board or stadiometer. The measurement of body segments, large diameters and vertical heights among anatomical landmarks using an anthropometer. Direct measurements of body segments were employed a segmometer. The subject's weight was obtained through an electronic bascule properly calibrated. Skinfold caliper was used to measure adiposity. The bone diameter was calculated by a caliper. Humerus and femur diameters were measured with a small sliding scale calibre, and finally we used a pencil to mark dermographic anatomical landmarks that allowed us to take measures later.

Detailed Clinical Record

First contact with athletes was before preseason work. Clinical history was made in order to seek the following information: date of birth, height, weight, labour occupation, sports history, forecast calls for national and/or territorial teams, injury history, recent illnesses, allergies, regular medications, usual dietary guidelines and nutritional supplementation.

Body-Composition

The following data were obtained as well by following the formula of Yusahz reviewed by Faulkner[10]: age, anthroprometic measurements, weight (kg) and height (m), BMI and folds (mm) of triceps, subscapular, suprailiac, abdominal, leg and middle leg and diameters of bistyloid, wrist, biepincodileo femur, humerus biepicondylar. Perimeters (cm) of arm

relaxed, contracted biceps, calves and thighs. These measurements were repeated during the preseason (18/08/09), in the early season (05/11/09), middle of the season (12/02/10) and the end of the season (10/05/10).

Nutrition Programme

In a generic way several authors have recommented widely as it should be the rugby player diet[11]. After performing medical history we detected the following nutritional problems: 1) Breakfast nonexistent or insufficient, 2) Training and matches with or without an inadequate previous feeding, 3) Poor food selection in quality and quantity, with large daily fluctuation (higher during the weekend) and insufficient daily hydration with low rehydration after training and matches. We divided the athletes in groups according to the body composition obtained after the first set of measurements. We gave them nutritional guidelines according to the group. *Group 1,* weight gain*;* high caloric diet: 5-6 daily intakes (like preventing catabolism), 60% CH, 20% protein, 20% fat, 3 liters of liquids daily and protein supplementation after training. *Group 2*, weight maintenance; Isocaloric diet: Varied diet. 4-5 daily intakes. 50% CH, 30% protein, 20% fat (vegetable), 3 liters of liquids daily and supplementation with creatine monohydrate. *Group 3*, weight loss; Hypocaloric diet: Varied diet. No more than 4 daily intakes. 50% CH, 35% protein, 15% fat (vegetable), 3 liters of fluids daily. The athletes in addition received the following guidelines:

Pre-competition Indications

It is no good to take a pre-game meal. Two hours before competition drinking 0.5 litres per hour of liquids. Last meal must be 3 hours before the event and based on low-glycemic carbohydrates. Fruit intake is according to bowel tolerance. Intakes should adapt to competition schedule. If the competition takes place in the morning, dinner will be enhanced with prior low-glycemic carbohydrates.

Indications during competition

Rehydration at all stops, trying not to delay them more than 20-25 minutes. For the rest of the competition drink at least 0.25 litres of liquids with fructose. Intercalate the water intake with sports drinks. Avoid very cold liquids.

Indications after competition

Drinking at least 0.5 litres of liquid immediately after the effort is completed. Eating simple carbohydrates in the 15-20 minutes after the competition is ended. Finally, take a protein supplement when the effort is over. All these different patterns are accompanied by meal-type sequences during the day, as guide for each of the scenarios. In addition, we worked with coaches during training for hydration routine implementation with the aim of automating adequate hydration guidelines.

Body composition measurements

Point	*Date*	*Challenge of the measurement*
Preseason		
Early season		
Middle season		
End of the season		

Training Programme

The first aspect to consider is the competition schedule. This section was planned with the coaches, looking for that would be in their opinion the most important moments of the season. We studied 18 players, 6 were regular with the Spanish and Andalusia team, and only 3 in Andalusia. Later, we divided the season in three macrocycles and each of them into three mesocycles following the model of Issurin-Kaverin[12,13]. Within of each mesocycle, workouts are divided into training microcycles, depending on the circumstances and objectives. The annual planning was distributed in 3 Macrocycles with different duration: 1) 18/08/09 to 29/11/09; 2) 07/12/09 to 28/02/10 and 3) 01/03/10 to 09/05/10 (table II).

Adaptation of training and nutritional programme in case of injury

In cases of injury for less than three months, we proceeded according to the following protocol: Medical team meet with coaches, trainer and physiotherapist to establish the recovery plan. The injured player was analysed to fix the adequate his diet and workout plan to follow. Personal meeting with the athlete to explain in detail the rehabilitation plan, diet, exercise, control and monitoring of the plan with progressive integration into the group training was always made. Once integrated into the normal rhythm, it is re-checked the diet and workout plan. The long-term injured player was excluded of the study.

Ethical criteria and study interruption

The study was performed according to the ethical principles in the Helsinki Declaration and the corre-

Table II
Microcycles through season

Type of mesocycle	*Number of microcycle*	*Duration in weeks*	*Sessions between week*	*Intensity range (% FC max)*	*Energy system priority*	*Microcyles type*
TYPE Accumulation	One	6	8 and 10	60 - 80%	Aerobic (aerobic-anaerobic threshold)	Activation and Load
	Two	5	7 and 10			
	Three	2	6 and 8			
Transformation	One	4	6 and 8	70 y 90%	Aerobic/ Anaerobic (VO2 max)	Load and Impact
	Two	3	6 and 8			
	Three	2	4 and 6			
Realization	One	4	4 and 6	80-100%	Anaerobic (alactic training)	Competitive and discharge
	Two	4	4 and 6			
	Three	4	4 and 6			

sponding rules of good clinical practice, laws and regulations. We obtained the personal approval of all athletes included in the study. Informed consent was used to explain the risks and the benefits derived from the participation in the study and to be sure that the patient has clearly understood these risks and benefits and want participate in the study.

Results

Players baseline situation before season begins

After first determination of body composition, it was given to all athletes an information with the levels of fat recommended for international players[15]:

The measurements were particularly negatives in all the forward players (forwards, 2nd and 3rd lines) except two that showed lower percentage of fat than recommended (JR and LV in table IV). The results of the other players were closer to normal and, especially, more homogeneous which facilitated the physical and technical work of the first part of the season.

Percentage body fat, BMI, muscle weight and total weight are the indicators that we use to follow the progress of athletes and the impact of diet and workout plans as show in table IV.

Table III
Fat percentage recommended by position

Position	*% Fat*
Forward (F)	<16
2ª Line (2ª)	<13
3ª y hookers (3ª)	<13
Half and centres (HC)	<12
Wings and full backs (WFB)	<10

Diet and training plans tailored to the baseline situation of the players

After these results athletes were clustered in one of the three diet programs, group 1 in weight gain, group 2 in maintenance and group 3 in weight reduction. Furthermore, within the first training macrocycle was made the following programming customizations (table V).

Changes in body composition and adequacy of diet and training plans tailored to changes

Throughout the season there were three new dates of measurements. The last of it was performed coinciding with the end of the competition. The other two were made in the first weeks without competition, and the second where only international players competed with Spanish national team.

At the start of the season, each measurement was accompanied with their subsequent adaptation of diet and physical programming in cases in which became necessary. The results obtained in these three measurements are summarized in table VI.

Aside to above, some players had injuries and the diet and workout change as show in table VII.

Discussion

Physical characteristics vary widely among Rugby players. The variability depends on positional roles, game level and range of skills required by the match. Playing styles could be altered to maintain or gain competitive advantage over opponents, so can be selected physical characteristics of the players to implement the game plan.

The most striking comparison of the anthropometric characteristics of rugby players is between the for-

Table IV
First measurement in 09/08/18

Athlete	*Age (years)*	*Height (cm)*	*Weight (kg)*	*BMI*	*Muscular weight (kg)*	*% Fat*
CS (HC)	27	180	92,3	28,5	52,9	11,80
LA (2ª)	29	193	119	31,9	69,11	19,88
MM (HC)	26	177	81,1	25,9	40,02	14,07
JLO (HC)	26	179	98,4	30,7	48,75	21,26
AR (F)	29	181	103,2	31,5	56,77	17,87
AA (HC)	25	180	84,2	25,9	41,08	15,52
AO (3ª)	24	189	111,8	31,3	63,85	18,55
AOz (WFB)	29	172	81,2	27,4	37,1	16,54
AB (3ª)	26	189	101,1	28,3	54,41	18,12
SH (F)	27	184	117,4	34,7	66,75	21,10
GG (2ª)	23	189	101,9	28,5	57,87	15,44
OD (2ª)	28	176	119,2	38,4	67,70	21,70
AB (HC)	32	180	85,3	26,3	45,85	12,54
JR (2ª)	22	198	106,8	27,2	64,91	12,48
LV (3ª)	26	186	98,2	28,3	61,98	12,33
RC (3ª)	31	192	100,7	27,8	58,35	13,73
CA (WFB)	25	165	78,6	28,9	40,71	11,73
CB (F)	33	178	114	36,0	66,19	18,25

Table V
Diet and training plans tailored to the baseline

Athletes	*Diet*	*Training*
JR.	Diet 1	1 weekly session extra muscle hypertrophy
CS, LV, RC and CA.	Diet 2	
AB.	Diet 2	Up Work injury
LA.	Diet 3	
MM.	Diet 3	1 weekly session extra muscle hypertrophy
JLO, AL, AA, AOz, AA, ABra, SB, GG, OD and CB.	Diet 3	1 weekly session extra aerobic

wards and line players as separate groups. On average, the forwards are 20 cm taller[14]. These average values tend to mask differences within each of the groups: the forwards of the second line (and number 8) for example, are higher than the remaining players of the unit, and its height gives a particular advantage of possession in the lateral release. The hooker tends to be the smallest of the forwards and the pillars are only a little bit higher. Most of teams use the hookers to throw the ball in launching side where player otherwise it would not have opportunities to contribute to gain possession.

The body mass is an important factor in Rugby matchs, particularly to tackle or to discard the tackle. This also confers an advantage in groupings, as it is difficult for forwards push back against a heavy opponent. It is better to have this weight as lean mass instead of fat, since the latter tissue may be an extra load to the muscles in locomotion and jumping[15]. The forwards can take advantage in terms of mobility in the field taking weight control programs, which reduce adipose tissue depots. The most weighty players in rugby, studied by Reilly[16] were forwards the second line (101 ± 7 kg), while the media were lighter with 24 kg less body mass. The wings and the full back are the lightest gamers, and it is the main requirement because of the speed.

A recent trend is the use of three quarters in line players with large body size and therefore they are eligible to contribute to other aspects of the game that involve physical contact. Therefore, in our study group these conditions are maintained further away from the described as ideal in body composition. This is a factor that in countries with a long tradition in this sport is studied in more detail than in Spain. In these countries, body composition, diet and training programs of players are considered a fundamental part of a subsequent success or failure in sports. This makes that team trainers are equally important in many cases than technical and tactical aspects of the sport itself. The evolution of the players demonstrated that the body composition of these athletes (increased lean body weight and decrease percentage of fat), bringing them closer to those shown by the best athletes on the planet do nothing but demonstrate the importance of both factors.

Table VI
Body composition and adequacy of diet and training plans tailored to changes

Athlete	*Date of measurement*	*Weight (kg)*	*BMI*	*Muscular weight (kg)*	*% Fat*	*Training programme*	*Type of diet*
CS	09/05/11	91,7	28,3	53,56	10,70		1
	10/02/12	90,9	28,1	52,65	10,88		1
	10/05/12	93	28,7	54,74	10,67		
LA	09/05/11	120	32,3	72,69	16,87		2
	10/02/12	119	32	71,81	16.78		2
	10/05/12	118,3	31,8	71,13	16,65		
MM	09/05/11	78,3	25,5	40,77	12,54	1 hypertrophy	2
	10/02/12	79,9	25	39,23	12,54	1 hypertrophy	2
	10/05/12	80,4	25,7	42,42	11,59		
JLO	09/05/11	95,9	29,9	51,64	17,89	1	3
	10/02/12	95,3	29,7	49,50	17,13	1	3
	10/05/12	94,6	29,5	49,13	16,85		
AR	09/05/11	101,4	31,0	57,66	15,26		2
	10/02/12	101,9	31,1	57,54	15,85		2
	10/05/12	101	30,8	57,38	15,19		
AA	09/05/11	83,9	25,9	42,36	14,19	1	2
	10/02/12	83,6	25,8	42,66	13,71	1	2
	10/05/12	82,6	25,5	42,19	13,13		
AO	09/05/11	112,5	31,5	65,32	17,61	1	2
	10/02/12	112,8	31,6	66,27	16,85	1	2
	10/05/12	112,1	31,4	65,95	16,50		
AOz	09/05/11	80,6	27,2	42,5	13,96		3
	10/02/12	81,5	27,4	37,48	16,16		3
	10/05/12	83,4	28,2	42,86	13,58		
AB	09/05/11	103,3	28,9	58,46	16,09	1	2
	10/02/12	104,1	29,1	59,78	15,67	1	2
	10/05/12	103,5	29	59,02	15,44		
SH	09/05/11	114,1	33,7	66,14	18,35	1	3
	10/02/12	112,8	33,3	65,19	18,09	1	3
	10/05/12	118,7	35,1	70,32	18,27		
GG	09/05/11	103,9	29,1	60,95	14,12	1	3
	10/02/12	99,2	27,8	56,74	14,12	1	3
	10/05/12	100,4	28,1	58,99	12,94		
OD	09/05/11	116,6	37,6	70,00	21,56	1	2
	10/02/12	112,4	36,6	68,11	20,36	1	2
	10/05/12	115,5	37,3	71,51	18,66		
ABra	09/05/11	85,6	26,3	45,85	12,54		2
	10/02/12	85,8	26,5	46,43	12,43		1
	10/05/12	86	26,5	47,51	11,67		
JR	09/05/11	108,9	27,2	64,91	12,48		1
	10/02/12	108,3	27,6	66,72	11,92		1
	10/05/12	108,3	27,6	66,70	11,95		
LV	09/05/11	97,3	28,3	61,98	12,33		2
	10/02/12	96,6	7,9	60,81	12,08		1
	10/05/12	94,1	27,2	59,15	11,54		
RC	09/05/11	100,2	27,8	58,35	12,61		2
	10/02/12	100,2	27,8	58,52	12,49		1
	10/05/12	99,8	27,8	58,52	12,54		
CA	09/05/11	78,9	28,9	40,71	13,84	1	2
	10/02/12	78,9	28,9	40,11	11,16		2
	10/05/12	73,9	28,9	40,11	10,88		
CB	09/05/11	110,5	36,0	66,19	16,31		2
	10/02/12	110,5	36	63,4	15,19		2
	10/05/12	107,3	36	63,4	14,19		

Possibly the ignorance of these matters by the current teams that perform these functions with the elite teams of domestic rugby, have led to the zero of studies in this regard.

At the beginning of the study (baseline), body composition, especially in terms of percentage of fat, was far from those identified as ideal[14]. When the season advanced, the differences in body composition

Table VII
Readjustment of the diet and workout plans in case o f injury

Athletes	*Injury*	*Physical plan*	*Diet during injury*
MM	Right acromioclavicular	Hypertrophy upper body for two months Subluxation	Weight gain diet to maintenance weight diet
AOz	Cubit fracture of the left arm	Extra Sessions muscle hypertrophy macrocycle 1 and 2	Keeping weight diet to gain weight diet, to macrocycle 3
GG	Sprained right ankle	During injury period, maximum strength in upper	Maintenance weight diet
OG	Cervical sprain	Objective extensive aerobic	Weight loss diet stricter with decreased fat intake and CH
LV	Right index finger fracture	Increased volume. Running Job	Maintenance weight diet
CA	Rupture of the left femoral biceps	Extra aerobic work with muscular hypertrophy for two months	Weight gain diet for two months

Table VIII
Mean percentage of fat in control group at 1st and 4th measure

Position	*% FAT ideal*	*Mean % fat in control group at 1st measure*	*Mean % fat in control group at 4th measure*
Forward	<16	20,22	17,37
2nd Line	<13	15,93	13,84
3th Line and hookers	<13	17,16	14,66
Midfield player	<12	13,89	12,10
Wings and forwards	<10	12,98	11,6

Highlighted in gray are the positions that compose the forward.

were significantly reduced by the effect of diet and exercise program, getting the stockings group studied in this section are very close to those established as ideal:

It should be noted as most negative aspect of the results the low average level at baseline. This fact would have to extend the measurements to the post-season period and resting periods. In contrast, positive aspects include the overall improvement obtained by all study subjects in body composition on tracking diet and exercise plans. Also remarkable is, although it was not one of the primary objectives of the study, the low number of injuries suffered by these athletes in a sport as demanding as rugby. The improvement in body composition with reduced "ballast weight" (percentage of body fat) and muscle weight gain is shown as a crucial factor in this regard.

With a view to future studies, these should make greater volume measurements, and continue them in the post season period, in order to analyse the changes in body composition, athlete's diet and training in competition period and rest.

Monitoring of the evolution of body composition of athletes, together with diet and personalized training plan, should become standard practice in all high performance teams.

Conclusions

1. The baseline situation of the players was far from ideal, especially in the group of forwards.
2. The influence of diet and personal training programs have improved all parameters studied, bringing them closer to the situations described as ideal.
3. These kind of studies should be performed in all sports with performance search, trying to implement them at early ages.
4. The multidisciplinary teams favor monitoring, analyzing results and implementing individualized programs in team sports.
5. It is important to guide the athletes in the offseason work, with the goal of basal conditions closer to those ideals at the start of the preseason. In this way is guaranteed more uniform body composition, avoiding major changes between competitive period and rest.

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