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In seasonal body composition and jump performance variation in a second league male volleyball team

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Abstract

Volleyball has become a sport of the giants. Under these circumstances it is desirable that players of a very large stature also possess a corresponding vertical jump. The aim of the paper was to identify the values of some parameters that we considered crucial in limiting or maximizing the in-game performance of the athletes in the study. Our intention was to verify if the body composition indicators change significantly at different stages of a competition season and if the characteristics of the jump, crucial in performing the actions through which the points arescored, are relevant in determining the level of physical conditioning. Twelve players (n=12) were selected from the second league Romanian male volleyball team CSU UVT. The subjects were tested for body composition and their spike jump and counter movement jump was measured on three separate occasions, each corresponding to a different stage of training.

Study results highlighted a significant increase of 1.15kg (p=0.028) in weight at the intermediate testing compared to the initial values. There were no differences in muscle mass between the initial and the intermediate testing (p=0.88). The results have shown a significant increase of the average skeletal muscle mass in the final test by 0.77 kg over the intermediate test (p=0.012) and 0.81kg over the initial test (p=0.039).We recorded a considerable increase of body fat mass between initial and intermediate testing (p=0.0073) and there was an average decrease of 1.76 kg (p=0.0285) of body fat mass between intermediate and final testing.

We have seen a significant increase in the height of the spike jump at the final test compared to the intermediate testing (p<0.0001) respectively the initial testing (p<0.0001).The counter movement jump recorded a significant decrease in the intermediate test 37.58 cm, compared to the initial test 40.57 cm (p=0.014).. Final measurements of the counter movement jump height increase in relation to intermediate testing (p=0.037).

Measurements also indicate a direct correlation between the height and power developed during the jump in all the three tests: initial (r=0.76), intermediate (r=0.68) and final (r=0.84).

***Key words**: volleyball, body composition, spike jump, counter movement jump, vertical displacement, jump power.*

Rezumat

Voleiul a devenit un sport al giganților. În aceste condiții este de dorit ca jucatorii de statură mare sa dețină de asemenea o detentă corespunzătoare. Lucrarea își propune să identifice valorile unor parametri pe care i-am considerat determinanți în limitarea sau maximizarea exprimării în joc a sportivilor în studiu. Am intenționat să verificăm dacă indicatorii compoziției corporale vizați în studiu se modifică semnificativ în diferite etape ale unui sezon competițional și dacă valorile săriturii, determinante în execuția acțiunilor prin care se câștigă punctele, sunt relevante în stabilirea nivelului formei sportive. Au fost selectați doisprezece sportivi (n=12) componenti ai lotului echipei din liga secundă masculină CSU UVT din România. Subiecților le-a fost testată compoziția corporala si li s-a măsurat detenta și puterea săriturilor cu elan și de pe loc la trei date diferite corespunzătoare cu nivele variate ale conditiei fizice.

Rezultatele studiului au evidențiat o creștere semnificativă de 1.150 kg (p=0.028) a greutății la testarea intermediară față de valorile inițiale. Nu există diferențe semnificative de masă musculară între testarea inițială și intermediară (p=0.88) dar avem o crestere semnificativă a masei musculare scheletice la testarea finala depășind cu 0.77kg testarea intermediară (p=0.012) și cu 0.81 kg în medie testarea inițială (p=0.039). Se înregistrează o creștere considerabilă a masei de țesutului adipos între testările inițială și intermediară (p=0.0073) și o scădere a acesteia în medie cu 1.76 kg (p=0.0285) între testarea intermediară și finală.

Am observat o creștere semnificativă a înălțimii săriturii cu elan la testul final comparată cu testarea intermediară (p <0,0001), respectiv cu testarea inițială (p <0,0001). Săritura de pe loc a înregistrat o scădere semnificativă la testului intermediar 37.58 cm comparat cu testul inițial 40.57 cm (p = 0,014). Valoarea testului final crește semnificativ pe lângă valoarea testului intermediar (p = 0,037).

De asemenea masurătorile indică o corelație directă între înălțimea și puterea dezvoltată în timpul săriturilor la toate cele trei testări: inițială (r=0.76), intermediară (r=0.68) și finală (r=0.84).

***Cuvinte cheie**: volei, compoziție corporală, saritura cu elan, saritura de pe loc, detenta, puterea săriturii.*

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Introduction

Volleyball is characterized by short and explosive movements such as jumping and diving but also ball play [1,2].

Jumping movements can be devised in two separate categories, with horizontal approach such as the spike jump and without approach but involving a countermovement jump (blocking and jump setting)[1,3]. The most spectacular actions in volleyball, the spike, jump serve and block, all include the jump, the height of which constitutes an important selection criteria in the training of players.

Volleyball has become a sport of the giants. Under these circumstances it is desirable that players of a very large stature also possess a corresponding vertical jump. These factors lead to a high vertical reach which is essential in the effectiveness of either spiking or blocking the ball.

During a match, the vast majority of the jumps are counter movement jumps. Players of better performing teams present higher values of this type of jump [4,5].

The counter movement jump is commonly used to test jumping performance in volleyball players[6]. It is characterized by a stretch-shortening type of muscle contraction, thus, providing the advantage of storing elastic energy during the countermovement that precedes the concentric upward movement of the lower limb extensors [7].

Another idea suggested by Van Ingen Schenau states that the purpose of the countermovement is not so much to store energy but to take up "the slack of the muscle" or creating greater tension at the onset of contraction [8].

One of the factors contributing to sport performance is body composition. Its dynamic monitoring is an essential weapon in conducting the training process and the nutritional plan of athletes.

The component of the lean mass that records the highest variations is the skeletal muscle mass, which influences in direct proportions sports performance. We cannot state the same thing about the body fat mass. A percentage of adipose tissue that exceeds a certain sport specific limit is detrimental to performance.

However, a certain percent of body fat mass is necessary to maintain health. For male volleyball players it falls between 11% and 14%.There are correlations between physical fitness, training period and change in body composition. The percentage of body fat is inversely proportional to VO2 max, and skeletal muscle mass correlates with maximal strength sports. Excessive body fat mass negatively influences jump height, speed and resistance, all of which are key attributes of a volleyball player [9].

Aim

The aim of the paper was to identify the values of some parameters that we considered crucial in limiting or maximizing the in-game performance of the athletesincluded in the study. Our intention was to verify if the body composition indicators change significantly at different stages of a competition season and if the characteristics of the jump, crucial in performing the actions through which the points are scored, are relevant in determining the level of physical conditioning.

Material and method

The research was conducted at the sports gym and research laboratory within the Physical Education Faculty, Timisoara. 12 players were selected from the second league Romanian male volleyball team CSU UVT. The ones included in the study were subjected to tests and measurements in three different occasions. Each evaluation corresponds to a certain competitive period and a different level in terms of physical training.

Initial testing, December 21st 2015 coincides with the start of the winter holidaycompetition break. After three weeks of inactivity, intermediate testing takes place on January 11th 2016. Athletes are subjected to the final test 4 months and three weeks after the intermediate testing, in April 25 2016 just before the final four tournament for the promotion in the first league (which took place in May 6-8, 2016).

To determine the body composition we used the InBody720 (Seoul, Korea) body composition analyzer. Of the many measurements we have chosen, the following are representative for our study: body weight, skeletal muscle mass, body fat mass, body fat percent, visceral fat area.

Testing took place early in the morning on an empty stomach to avoid interference.

The jump height and jump power of the athletes were measured with theOpto-Jump (Microgate Engineering, Bolzano, Italy) optical measurement system. We considered the following values to be representative for lower limb strength: spike jump height (with approach), spike jump power (with approach), counter movement jump height (from standstill), counter movement jump power (from standstill).

The measurements took place in the gym where the volleyball players train all year round. The subjects performed three jumps with the classic volleyball spike approach, take-off and landing in between the rails of the measuring device. We also used the Counter Movement Jump test where the athletes executed three jumps from standingposition with the hands placed on the hips. The best values of

height and the power were recorded for each of the jumps.

Results

The results obtained from the measurements and tests were recorded in the following tables, and the average values were represented into graphs.

Table I. Body weight and muscle mass

Name initials	Body mass (kg)			Muscle mass (kg)		
	initial	ntermediate	final	initial	ntermediate	final
RE	89.5	90.2	86.1	44.9	43.9	44.7
RM	68	71.2	70.2	35.7	36	36.4
CS	74.1	73.8	75.7	38.7	38	38.7
BL	61.4	61.1	63.2	34.4	33.7	35.5
ML	89.6	89.9	89.9	43.3	43.5	44.1
SS	89.3	91.4	90.1	43	43.5	43.4
TB	92.3	94	94.4	44.2	45.1	45.8
RM	103.7	108.1	104.5	49.1	49.6	50.1
SV	79.4	80.9	79.6	38	38.9	41.6
KF	88.9	88.2	93.5	36.9	35.9	37.2
DD	81.6	83.3	80.2	40.7	41.6	42.4
DC	87.7	87.2	83.9	45	44.6	43.7
Mean value	83.792	84.942	84.275	41.158	41.192	41.967

Table II. Body fat mass, Body fat percent and visceral fat area

Name initials	Body fat mass (kg)			Body fat percent (%)			Visceral fat area		
	initial	intermediate	final	initial	intermediate	final	linitial	ntermediat	final
RE	12.4	14.2	8.7	13.9	15.7	10.1	78.3	82.2	53
RM	5.6	8.2	6.3	8.2	11.5	8.9	24.7	34.8	26.6
CS	5.9	7.2	7.5	8	9.7	9.9	10.3	24.6	19.8
BL	1.8	2.5	1.9	3	4.1	3	10.9	15.8	18
ML	14.6	14.6	13.5	16.3	16.2	15.1	84.7	86.1	82
SS	14	15.5	14.5	15.7	16.9	16.1	74.7	84.7	81.2
TB	15.8	16	14.9	17.1	17	15.8	74.6	77.9	68.2
RM	18	21.4	16.9	17.4	19.8	16.1	74.2	84.8	62.7
SV	12.5	12.6	7	15.7	15.6	8.9	48.8	55.3	38.8
KF	24.4	25.4	28.4	27.5	28.8	30.4	102.8	109.3	113.1
DD	10.9	10.7	9.3	13.3	12.9	11.6	69.3	67.1	58.3
DC	9.8	10.1	8.1	11.1	11.6	9.7	50	53.4	43.3
Mean value	12.142	13.200	11.417	13.933	14.983	12.967	58.608	64.667	55.417

Table III. Spike jump height and power (with approach)

Name initials	Height (cm)			Power		
	initial	intermediate	final	initial	intermediate	final
RE	71.4	66.6	75.2	54.42	51.12	60.38
RM	59.7	59.6	63.4	59.84	60.34	57.1
CS	67.9	64.3	69.5	63.15	61.47	65.97
BL	68.4	68.8	72.3	61.1	57.22	66.42
ML	60.9	61.3	65.9	49.33	48.87	54.69
SS	53.6	57.9	57.5	48.31	53.6	51.78
TB	55.9	54.5	59.4	44.98	48.65	54.38
RM	53.2	48.3	56	47.2	46.81	47.87
SV	53.7	52.3	59.8	42.32	41.33	49.12
KF	54.7	53.1	56.9	49.27	44.34	50.37
DD	64.6	61.6	68.7	61	53.45	64.28
DC	62.1	59	67.8	50.42	51.77	54.74
Mean value	60.508	58.942	64.367	52.612	51.581	56.425

Table IV. Counter movement jump height and power

Name initials	Height (cm)			Power (w)		
	initial	intermediate	final	initial	intermediate	final
RE	54.9	47.6	55.8	21.3	18.74	23.9
RM	46.1	39	41	22.24	16.75	17.3
CS	42.7	37.8	40.4	18.23	17.69	18.05
BL	42	38.3	45.7	18.31	16.24	19.85
ML	42.1	41.4	41.2	17.47	17.77	17.07
SS	37.1	39.7	36.8	16.3	16.2	16.9
TB	38.6	31.9	40.5	15.72	13.95	18.35
RM	32.6	31.4	31.7	14.21	14.31	15.66
SV	37.2	33.7	39.8	17.44	15.69	18.72
KF	36.3	33.4	29.8	16.7	15.31	14.43
DD	42.1	37.9	46.5	15.5	14.67	17.37
DC	35.2	38.9	38.9	15.36	16.1	20.79
Mean value	40.575	37.583	40.675	17.398	16.118	18.199

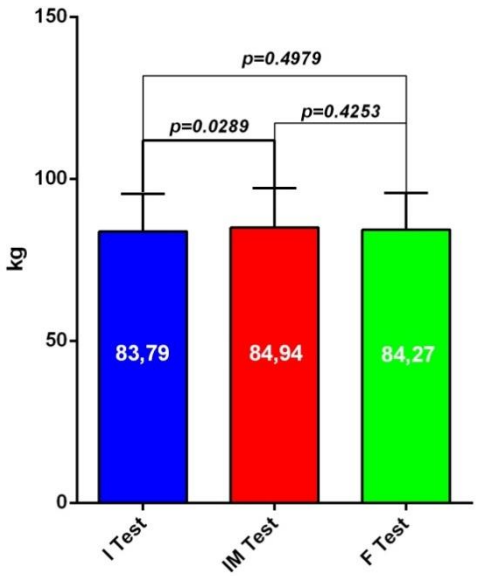

Fig 1. Body weight

We noticed a significant increase of 1.150 kg (p=0.028) in body weight at the intermediate testing compared to the initial values. There are no significant differences in players' weight between initial testing and final testing (p=0.49), respectively between intermediate values and final ones (p=0.42). However, there is a decrease of 670 g in body weight between intermediate and final measurements.

Athletes record an increase in body weight aftera 3 weekrest period followed by a slight decrease in weight at the final test. Also, the final values are on average lower than the initial ones but the difference is statistically insignificant (Fig 1).

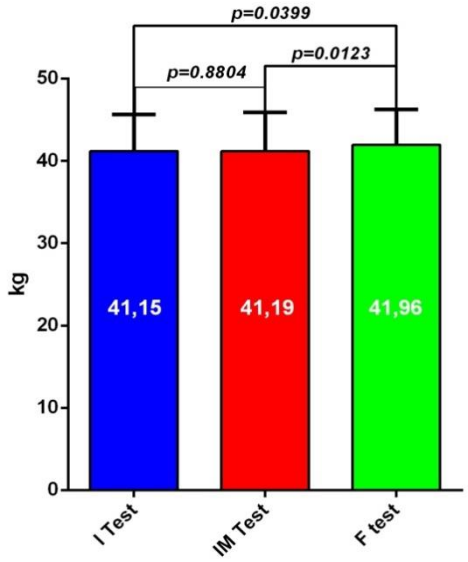

Fig 2. Muscle mass

We found that there are no differences in muscle mass between the initial and the intermediate testing (p=0.88). In contrast we have a significant increase of the skeletal muscle mass in the final test by 0.77 kg in comparison with the intermediate test (p=0.012) and by 0.81kg in comparison with the initial test (p=0.039).

Athletes do not experience skeletal muscle mass loss during the study period. The highest value is reached in the final test, which should coincide with peak athletic condition of the season (Fig. 2).

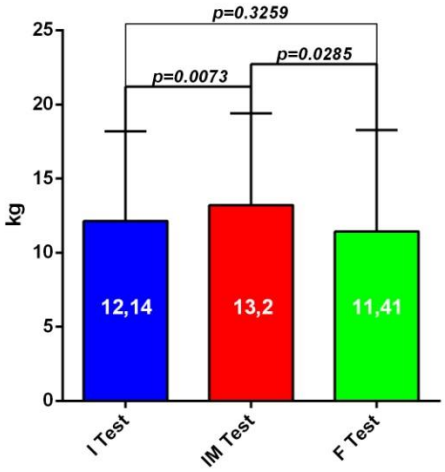

Fig 3. Body fat mass

We record a considerable increase of body fat mass between initial and intermediate testing (p=0.0073). We also found an average decrease of 1.76 kg (p=0.0285) of body fat mass between intermediate and final testing. On average, athletes have 0.73 kg less adipose tissue compared with the baseline testing without being a statistically significant decrease (p=0.32) (Fig. 3).

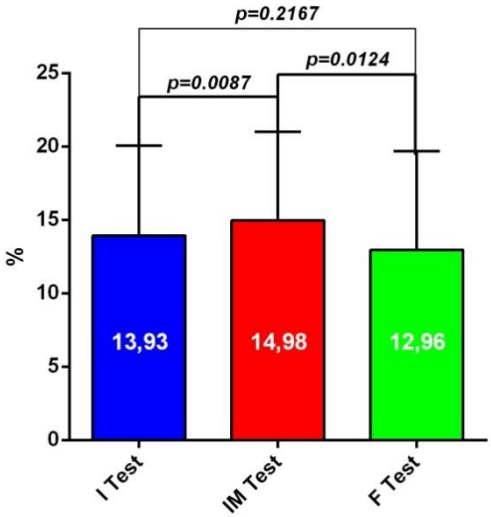

Fig 4. Body fat percent

In the case of body fat percentagewe noticed a significant increase between the initial testing and the intermediate test (p=0.008), followed by a substantial decrease between the intermediate and the final test (p=0.012). Even if there is a difference between initial and final testing of about one percent, it is statistically insignificant (p=0.21) (Fig. 4).

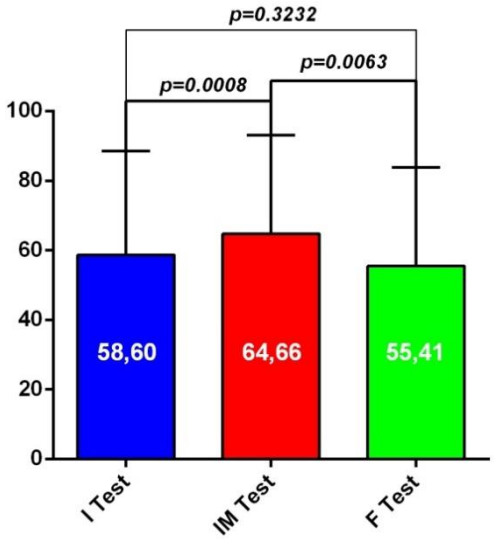

Fig 5.Visceral fat area

Visceral fat area follows the same pattern. Higher values are recorded in the intermediate test relative to initial testing (p=0.0008) and final testing (p=0.0063). We do not have a statistically significant difference between initial testing and final testing (p=0.32) (Fig 5).

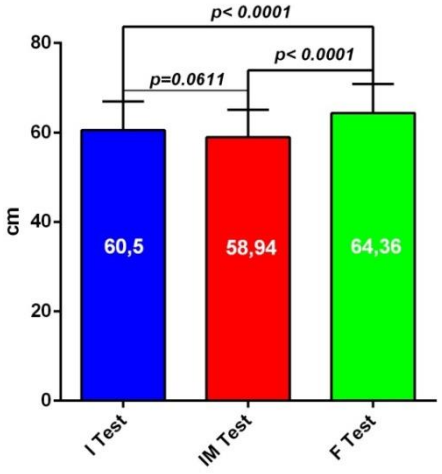

Fig 6. Spike jump height (with approach)

Regarding the height of the jump with approach, we did not record significant changes in the intermediate testing compared to the initial measurements (p=0.061). On the other hand, we can see a significant increase in the height of the jump at the final test compared to the intermediate testing (p<0.0001) respectively the initial testing (p<0.0001).

We noticed how the vertical jump displacement of the volleyball players insignificantly decreases after the 3 week break. The value reached in the final test exceeds the initial one by 3.86 cm and the intermediate by 5.42 cm (Fig. 6).

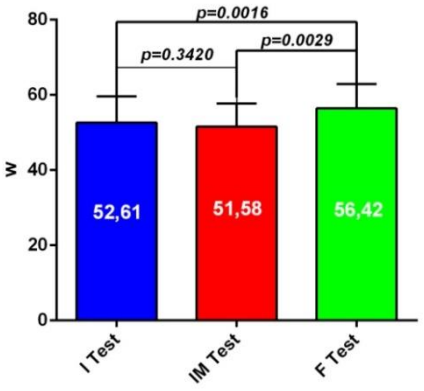

Fig 7. Spike jump power (with approach)

Just as in the case of vertical jump height, the power developed during this jump did not vary considerably between initial testing and intermediate testing (p=0.34). Significant increase occurred in the final testing compared to the intermediate testing (p=0.0029) and baseline (p=0.0016).

We observed a direct correlation between the height and power developed during the jump in all the three tests: initial (r=0.76), intermediate (r=0.68) and final (r=0.84) (Fig. 7).

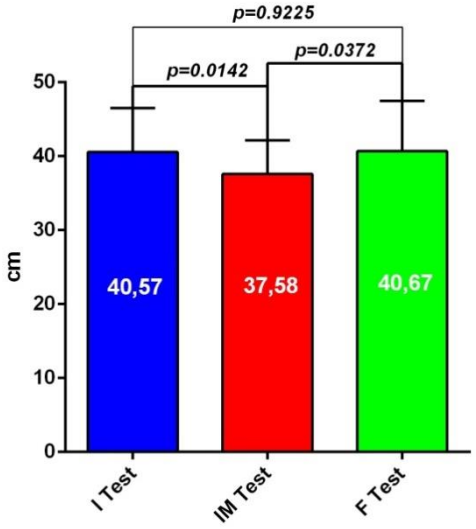

Fig 8. Counter movement jump height

Unlike the vertical jump performed with an approach, the counter movement jump executed from a standstill recorded a significant decrease in the intermediate test 37.58 cm, compared to the initial test 40.57 cm (p=0.014). The measurements taken duringthe final test increased significantly

compared to the intermediate test value (p=0.037). We didnot notice significant changes in the initial test values compared to the final ones (p=0.92) (Fig. 8).

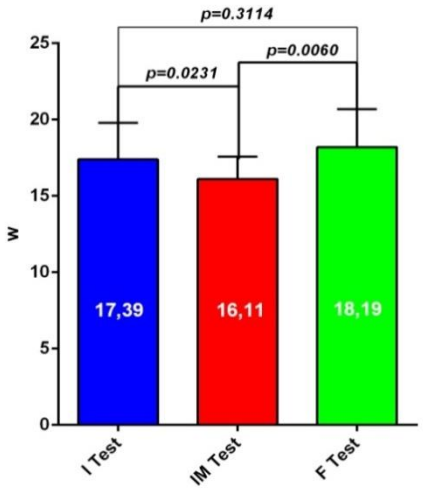

Fig 9. Counter movement jump power

Power developed during the counter movement jump follows the trend of its height. We noticed a significant decrease in the intermediate test values (p=0.023) followed by a slight increase in the final test (p=0.006). The final test revealed an increase in power of the counter movement jump compared to the baseline without being statistically significant (p=0.31) (Fig. 9).

Discussions

No single strength and power characteristic is paramount for the development of the volleyball players. It is important to recognize the influence of force-velocity qualities on each other and the need of understanding specific assessment techniques that identify the subcomponents of strength that influence jump performance [10].

A study conductedby M. V. Narici has shown that during strength training of the human quadriceps muscle, the increase in anatomical cross section area accounts for only 40% of the increase in force while the remaining 60% is attributable to an increased neural drive and possibly to architectural changes occurring within the muscle. The increase in quadriceps cross section area is non-uniform along its length and preferential hypertrophy of its constituent muscles is observed. The kinetics of changes in cross section area, force and neural drive during training and detraining are similar [11]. We can also state from our findings that although there is no loss in skeletal muscle mass during the three week break, the decrease of power of the counter movement jump can be attributed to changes of the neural drive and quality of muscle contraction.

KeijoHakkinen and Paavo V. Komi in the paper Electromyographicchanges during strength training and detraining state that early changes in strength may be accounted for largely by the neural factors with gradually increasing contribution of the hypertrophic factors. The same mechanism occurs also during detraining. Initial decrease in strength may be due to reduction in neural activity later decreasing with muscle atrophy. Magnitudes and occurrence of these changes may vary due to differences in conditioning periods, methods and individual muscle groups [12].

Conclusions

The studied team's stages of training in a competition season reveal aspects that are worth taking into consideration regarding the relation between body composition parameters (body mass, skeletal muscle mass, body fat mass) and lower limb strength indicators (vertical displacement and power of both types of jump).

The end of the first competition period has been set as the standing point for our initial test. It corresponds to the first peak of physical conditioning. While body composition parameters record higher values after a three week break, except skeletal muscle mass which was constant, we noticed a significant regression only in counter movement jump performance.

The team's level of expression is largely determined by the values of body composition and power. Tracking these parameters is important in determining the athletes' physical fitness. The reach of peak physical conditioning scheduled for early May 2016, reveals an increase in skeletal muscle mass, vertical jump height, both with approach and from standstill and also a significant reduction in body fat mass.

Comparing the values recorded at the beginning of the research with the final measurements, we noticed a significant increase in skeletal muscle mass as well as in the height and power of both types of jump (counter movement jump and volleyball spike approach jump).

We suggest a careful management ofthe holiday period (transition) by the athletes predisposed to weight gain. Maintenance of muscle tone and aerobic capacity by practicing complementary sports during the transition period is advised.

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