RELATIONS BETWEEN VERTICAL JUMP HEIGHT AND VOLLEYBALL PLAYERS' BODY COMPOSITION

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Abstract:

Introduction. Sportmen`s success is determined by many agents such as: body composition, motor capabilities, technical skills and abilities to cooperate with other members of the team. In different sport disciplines we are able to notice dominating importance of one factor over another, therefore it is favorable to make a hierarchy of their relevancy. Every sports discipline creates a characteristic player model. Volleyball players usually present an above average height, slim figure and great fitness, dependent on strength, power and jumping ability.

The aim of the work. The purpose of the work was to examine the relations between the vertical jump height and volleyball player's body composition.

The material and the methodology. In research participated 38 volleyball players at the age of 18-30. While conducting the Counter Movement Jump (CMJ), a three-dimensional accelerometer Myo Test Pro v.1.3.2. was used. Body composition analysis was examined by bioelectrical impedance method. The measurements were performed in the evening hours during players' starting period, at least 3 hours after the last meal and intense effort.

Results. Maximal vertical jump height correlates positively with muscle mass in all body (p=.009) and in lower limbs as well (p=.004) expressed in percentage value of body mass. Moreover, positive relationships with percentage value of water content were observed (p=.001). On the other hand, negative correlations were noticed related to fat content (p=.001) and BMI (p=.03).

Conclusions. In conclusion, we affirm existence of significant correlations between recorded parameters of a vertical jump and academic volleyball players` body composition.

INTRODUCTION

Sportsmen`s success is determined by many agents such as: body composition, motor capabilities, technical skills and abilities to cooperate with other members of the team [8,14]. In different sport disciplines we are able to notice dominating importance of one factor over another. Every sport discipline has created characteristic model of a player. Volleyball players usually present an above average height, slim figure and great fitness, dependent on strength, power and jumping ability [6,11,12] The balance of the above mentioned factors influences a given player's efficiency. In sport, there are disciplines in which the height of jump has tremendous impact on final outcomes, among others: long jump, high jump and triple jump. This parameter has also an indirect impact on the efficiency of sportsmen such as: volleyball, basketball, ~~or~~ handball or football players. The jump height is mostly determined by the power of lower limbs, as well as the body composition. This correlation was proved by Bartosiewicz and Wit [3], who noticed it only in sports for which jump was the basic specialized movement.

THE AIM OF THE WORK

The purpose of the work was to examine the relation between the vertical jump height and volleyball players' body composition.

THE MATERIAL AND THE METHODOLOGY

In research participated 38 volleyball players, representing Wroclaw`s academic teams. Characteristics of the examined players: age 18-30; body height 169-202 cm; body mass 61.4 – 101.5 kg.

The equipment used for the body composition analysis was Tanita Inner Scan V, BC-601 model (Japan). Researches on solidity of that method were conducted by Bosy-Westphal [4] The players, on whom the measurement was performed, had been instructed on the rules of the examination. Entering the scales, the sportsmen should have been barefoot and shirtless, so that the calcaneus was on rear electrodes, the lower limbs straightened in knee and hip joints, while the upper limbs in slightly abduction and flexion in arm joints, straightened in elbow joints, and all fingers touching the manual electrodes. The measurements were performed in the evening hours during players' starting period, at least 3 hours after the last meal, immediately before the training unit. Additionally, body height was measured by an anthropometer.

Through the bioimpedance method (BIA) one obtained information concerning body mass [kg], BMI, muscle mass [kg], muscle mass [%], muscle mass of lower limbs (LL) [kg], muscle mass of lower limbs (LL) [%], bone mass [kg, fat content [%] and water content [%].

While conducting the Counter Movement Jump (CMJ), a three-dimensional accelerometer MyoTest Pro v.1.3.2. (Switzerland) was used.). Researches on solidity of that method were conducted by Choukou et al. [7] The players were given instructions before taking the test and had an opportunity to have an experimental trial. The proper jump was done in sports shoes, on hard ground, after a previous dynamic warm-up. Every player had a belt with the accelerometer, to which body mass data was entered. The CMJ (Counter Movement Jump) test consisted on performing five maximum vertical jumps from the half knee bend position with hands on the pelvis. The cycle of all the jumps was regulated by the sound emitted by the accelerometer.

Results from conducted research are depicted in a form of mean, maximum value, minimum value and standard deviation. Distribution of data was verified due to Shapiro-Wilk test. Moreover, we used Pearson correlation coefficient in order to investigate relationship between indicators related to body mass and parameters characteristic for a vertical jump. Statistical significance was considered when $p \leq 0.05$. Statistical analysis was done by computer program Statistica 10.0 (StatSoft).

RESULTS

In table 1 and 2 we can observe characteristic of examined volleyball players taking into consideration anthropometric parameters and predictors of vertical jump height.

Table 1. Descriptive statistics of the anthropometric parameters.

PARAMETER	N	Mean	Minimum	Maximum	SD
Body height (cm)	38	189.5	169.0	202.0	8.1
Body mass (kg)	38	83.4	61.4	101.5	8.9
Fat content (%)	38	11.8	5.0	18.6	3.5
Muscle mass (kg)	38	69.4	55.4	80.0	6.4
Muscle mass (%)	38	83.4	77.3	90.4	3.5
Bone mass (kg)	38	3.6	2.9	4.1	0.3
BMI	38	23.2	18.5	27.2	1.7
Water content (%)	38	63.0	56.8	70.0	3.0
Muscle mass LL (kg)	38	23.6	19.4	28.8	2.1
Muscle mass LL (%)	38	28.3	26.1	31.7	1.2

Table 2. Descriptive statistics of parameters registered during the vertical jump.

PARAMETR	N	Mean	Minimum	Maximum	SD
Max. power (W)	38	58.1	32.2	104.7	14.4
Mean power (W)	38	49.8	28.3	75.8	11.9
Max. concentric force (N)	38	25.4	18.8	33.9	2.7
Mean concentric force (N)	38	23.7	18.0	29.1	2.3
Max. eccentric force (N)	38	20.2	12.3	26.5	3.5
Mean eccentric force (N)	38	18.4	12.1	24.3	2.8
Max. velocity (m/s)	38	295.6	208.4	718.3	82.2
Mean velocity (m/s)	38	262.0	150.0	404.0	51.3
Max. height (cm)	38	46.9	33.8	63.6	6.1
Mean height (cm)	38	45.7	33.4	62.0	5.9

Positive correlations were found between the maximum vertical jump height and muscle mass [%] ($r = 0.42$; $p = 0.009$), muscle mass of lower limbs (LL) [%] ($r = 0.46$; $p = 0.004$) and water content [%] ($r = 0.53$; $p = 0.001$) - table 3. Negative correlations between the maximum vertical jump height and fat content ($r = -0.52$; $p = 0.001$) and BMI ($r = -0.35$; $p = 0.03$) were also noted. Correlations between the mean vertical jump height, resulting in 5 jumps, and body composition parameters were analogous in nature as in the case of the maximum height.

Table 3. Relationships between body composition and maximal or mean height of vertical jump; r- Pearson`s linear correlation coefficient value, p- level of statistical significance.

PARAMETER	Max. height (cm)		Mean height (cm)	
	r	**p**	**r**	**p**
Body height (cm)	-.0143	p=.932	-.0299	p=.859
Body mass (kg)	-.2731	p=.097	-.2832	p=.085
Fat content (%)	-.5171	p=.001	-.5518	p=.000
Muscle mass (kg)	-.1421	p=.395	-.1357	p=.417
Muscle mass (%)	.4185	p=.009	.4594	p=.004
Bone mass (kg)	-.1525	p=.361	-.1505	p=.367
BMI	-.3483	p=.032	-.3423	p=.035
Water content (%)	.5318	p=.001	.5767	p=.000
Muscle mass LL (kg)	-.1236	p=.460	-.1186	p=.478
Muscle mass LL (%)	.4616	p=.004	.4968	p=.002

In case of lower limbs power, observations were connected only with positive relations between water content [%] and mean power (r = 0.33; p = 0.03) – table 4.

Table 4. Relationships between body composition and maximal or mean power generated during vertical jump, r- Pearson`s linear correlation coefficient value, p- level of statistical significance.

PARAMETER	Max. power (W)		Mean power (W)	
	r	**p**	**r**	**p**
Body height (cm)	.0149	p=.929	-.0465	p=.782
Body mass (kg)	-.0485	p=.772	-.1502	p=.368
Fat content (%)	-.2310	p=.163	-.2942	p=.073
Muscle mass (kg)	.0280	p=.868	-.0926	p=.580
Muscle mass (%)	.1990	p=.231	.2032	p=.221
Bone mass (kg)	.0293	p=.861	-.0882	p=.599
BMI	-.0450	p=.788	-.1449	p=.385
Water content (%)	.2681	p=.104	.3249	p=.047
Muscle mass LL (kg)	.0891	p=.595	-.0498	p=.766
Muscle mass LL (%)	.3174	p=.052	.3041	p=.063

Table 5. Relationships between body composition and maximal or mean force (concentric and eccentric) generated during vertical jump, r- Pearson`s linear correlation coefficient value, p- level of statistical significance.

PARAMETER	Max. concentric force (N)		Mean concentric force (N)		Max. eccentric force (N)		Mean eccentric force (N)	
	r	**p**	**r**	**p**	**r**	**p**	**r**	**p**
Body height (cm)	-.0431	p=.797	-.0280	p=.867	-.1031	p=.538	-.1066	p=.524
Body mass (kg)	-.0514	p=.759	-.0327	p=.846	-.1629	p=.328	-.0708	p=.673
Fat content (%)	-.0977	p=.559	-.1191	p=.476	-.3567	p=.028	-.2246	p=.175
Muscle mass (kg)	-.0142	p=.932	-.0099	p=.953	-.0493	p=.769	-.0046	p=.978
Muscle mass (%)	.1091	p=.514	.0732	p=.662	.3354	p=.040	.1950	p=.241
Bone mass (kg)	-.0033	p=.984	.0004	p=.998	-.0769	p=.646	-.0367	p=.827
BMI	.0209	p=.901	.0225	p=.893	-.0706	p=.674	.0539	p=.748
Water content (%)	.1328	p=.427	.1548	p=.353	.4278	p=.007	.2864	p=.081
Muscle mass LL (kg)	.0449	p=.789	.0476	p=.776	.0207	p=.902	.0787	p=.639
Muscle mass LL (%)	.2263	p=.172	.1932	p=.245	.4647	p=.003	.3557	p=.028

In the case of the force generated by the lower limbs, was only found a correlation between the eccentric force and components of body mass (table 5). There was a positive relationship of the maximum eccentric force with the water content [%] (r = 0.43; p = 0.007), muscle mass [%] (r = 0.34; p = 0.04), muscle mass LL [%] (r = 0.47; p = 0.003), while with the fat content [%] was obtained a negative relationship (r = -0.36, p = 0.03). The mean eccentric force correlated only with muscle mass LL [%] (r = 0.36; p = 0.03).

Table 6. Relationships between body composition and maximal and mean velocity of vertical jump, r- Pearson`s linear correlation coefficient value, p- level of statistical significance.

PARAMETER	Max. velocity (m/s)		Mean velocity (m/s)	
	r	**p**	**r**	**p**
Body height (cm)	.0273	p=.871	-.0497	p=.767
Body mass (kg)	-.0989	p=.554	-.1944	p=.242
Fat content (%)	-.3062	p=.062	-.3590	p=.027
Muscle mass (kg)	.0154	p=.927	-.1017	p=.543
Muscle mass (%)	.2952	p=.072	.2923	p=.075
Bone mass (kg)	.0151	p=.928	-.1106	p=.509
BMI	-.1155	p=.490	-.1728	p=.299
Water content (%)	.3257	p=.046	.3950	p=.014
Muscle mass LL (kg)	.0611	p=.715	-.0716	p=.669
Muscle mass LL (%)	.3761	p=.020	.3621	p=.025

Table 6 shows a positive correlation between maximum velocity and water content [%] (r = 0.33; p = 0.05) and muscle mass LL [%] (r = 0.38; p = 0.02). The mean velocity correlates negatively with fat content [%] (r = -0.36; p = 0.03), and positively with water content [%] (r = 0.4; p = 0.01) and muscle mass LL [%] (r = 0.36; p = 0.03).

DISCUSSION

Sportsman`s success is determined by many factors, therefore it is worth to prepare the hierarchy of their importance. Nowadays, plenty of researches have been conducted to provide information connected with this issue. Ćopić`s [9] results of the study confirm mentioned thesis. They have demonstrated influence of power of a lower limb and body composition on value of the vertical jump. Outcomes proved that the better power of a lower limb, the better value of the vertical jump. On the other hand, the higher measure of fat content, the lower value of vertical jump. Aouadi et al. [2] have focused on dependence between length of lower limbs and results received in CMJ test and capability of anaerobic work. Depicted data confirms positive correlation of mentioned variables. Nikolaidis [13] has analysed influence of body composition on physical fitness of adult and adolescent female volleyball players. Researches demonstrated negative reaction of high fat content on volleyball player`s efficiency. The author points out that not always high value of BMI indicator means obesity and overweight. We should also take into consideration ratio of muscle mass to fat content in the body. What is missed in this paper is a water content. Analysis of results prove the significance of this factor. Demonstrated positive relation devoted to force, power, velocity, height of jump is strictly connected with structure of muscle tissue. Appropriate workout allows adjusting and shaping proper traits to adequate sport disciplines. Therefore, it constitutes huge challenge for a coach and whole staff. They should be characterised by advanced competency and extraordinary experience in this field. Currently, analyses of impact of specific exercises on motor performance have been conducted. Karin et al. [15] indicated changes in parameters caused by plyometric workout. They recorded considerable increase in force, velocity and height of the jump. Adams et al..[1] Brown et al..[5], Eisenman et al.[10] were also involved in reseaches devoted to plyometric trainings.

CONCLUSIONS

In conclusion, we affirm existence of significant correlation between recorded parameters of a maximal vertical jump and academic volleyball players` body composition. The vertical jump height correlates positively with a muscle mass of lower limbs and whole body as well, expressed in percentage of body mass. Observed phenomenon seems to be easy to explain, however relationships between the vertical jump height and percentage water content need further research. In addition, our study has indicated negative correlation between vertical jump height and percentage fat content and BMI value.

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