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ORIGINAL ARTICLE

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Dependence between Body Tissue Composition and Results Achieved by Weightlifters[1]

Authors' Contribution:
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

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Key words: *weightlifting, body building, tissue composition*

Abstract

Background: *A literature review and an analysis of lifting techniques indicate that the tissue composition and structure of the body, and especially some of its elements have a decisive influence on the results. The objective of the reported study was to characterize tissue components of the best Polish male weightlifters in view of the age and sports results they achieve.*

Material/Methods: *Competitors of the Men's Polish Championships in Weightlifting in 2004 were subjects of this study. The study comprised 138 sportsmen evaluated in the following age categories: seniors, youth, older juniors, and younger juniors. Measurements that enabled estimating the tissue composition of the body were taken with Piechaczek's method by. In the evaluated groups, sports results achieved in the Championships were converted into points according to Sinclair's scale. Arithmetic means and standard deviation (SD) as well as the number of points scored were computed in each age category. The value of Pearson's correlation coefficient was computed between the discussed somatic traits and obtained results.*

Results: *Out of all the surveyed participants of the Polish Championships in Weightlifting only younger juniors were characterized by too high values of body height, which may affect their body mass to body height proportions.*

Conclusions: *The analysis of results of the tissue composition of the body in age categories and with consideration given to the level of achieved sports results demonstrated that along with training experience and its level, the content of real active tissue was increasing in the surveyed sportsmen.*

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Introduction

Nowadays, both sportsmen and coaches face growing demands which result from a high level of sports competition. Hence in contemporary sport, high results are achieved only by few sportsmen, i.e. those physically talented having sound fitness, technical, mental and theoretical training. Nevertheless, each sports discipline should possess a well-documented "model of champion", especially in terms of somatic composition [1]. The body mass of individuals with the same value of this parameter may be characterized by different content of muscle, adipose and osseous tissues. The contribution of particular tissue components in the total body mass plays a significant role in athlete's somatic build. Therefore, studies are undertaken to enable determining, among other things, somatic predispositions of athletes achieving the best results in a number of sports disciplines [2, 3, 4, 5, et al.]. An overview of literature on weightlifters' somatic traits [6, 7, 8, 9, et al.] indicates that these sportsmen should be characterized by appropriate proportions of body height and body mass. Longitudinal measurements, including stature, serve a minor role, for this is the "weight" discipline of sport. Therefore, sportsmen of lower weight categories should have small longitudinal measurements which should increase along with the increasing weight category. When considering the dependence on the tissue composition of the body, the most significant to weightlifters are a high mass of the active tissue, reflected in above-the-average skeleton stoutness and the well-developed muscle system, with a low content of the adipose tissue. In view of the above, the objective of the reported study was to characterize tissue components of the best Polish male weightlifters in view of their age and the sports results they achieve.

Material and Methods

Competitors of the Men's Polish Championships in Weightlifting in 2004 were subjects of this study. The study comprised 138 sportsmen evaluated in the following age categories: seniors, which included 31 men; youth (under 23 years) and older juniors (under 20 years), 34 sportsmen each, and younger juniors (under 16 years), which included 39 competitors.

Anthropometric measurements were performed with a use of an anthropometer (body height) and a skin fold caliper (the skin folds thickness on the left side of the body). The density of the body (D`) was calculated by Piechaczek's formula [10] using three skin folds thicknesses: the thickness of the arm, the shank and the chest.

$$D` = 1.124358 - 0.000120 \text{ x the arm skin fold (log)} - 0.000167 \text{ x the chest skin fold} - 0.000075 \text{ x the shank skin fold}$$

The total body fat percentage of body weight (FM%) was calculated by Keys and Brożek's formula [10]:

$$FM\% = 100x(\frac{4.201}{D`} - 3.813)$$

The total body fat in kilograms (FM_{kg}) was calculated using the formula:

$$FM_{kg} \frac{body \text{ mass (kg)} \; x \; \text{FM\%}}{100}$$

Active tissue of body mass in kilograms (FFM_{kg}) was calculated using the formula:

$$FFM_{kg} = body \text{ mass (kg)} - FM_{kg}$$

Active tissue of body mass in percentage (FFM%) was calculated from the formula:

$$FFM\% = 100 - FM\%$$

In the evaluated groups, sports results achieved in the Championships were converted into points according to Sinclair's scale [11]. This method enables evaluating a sportsman's result with no consideration given to the weight category. Arithmetic means and standard deviation (SD) as well as the number of points scored were computed in each age category. Next, all sportsmen were classified into three groups with arithmetic mean ± 0.5 SD used as the classification criterion. This procedure allowed selecting: group I achieving the best results in each age category ($\bar{x}$ + 0.5 SD and more points), group II with average results (from $\bar{x}$ – 0.5 SD to $\bar{x}$ + 0.5 SD), and group III including the weakest sportsmen (to $\bar{x}$ – 0.5 SD and less points).

The number of the weightlifters surveyed in respect of age categories and the achieved sports results was presented in Table 1. The value of Pearson's correlation coefficient was computed between the discussed somatic traits and the obtained results. The significance of differences was evaluated at $p \leq 0.05$. The same level of significance was used to determine differences between tissue components of the body as affected by age and sports results. These values were elaborated with the one-way analysis of variance ANOVA and the Newmann-Keuls test.

Results

The compilation of mean body height values of the sportsmen from particular age categories indicates that younger juniors were the tallest weightlifters with the average body height accounting for 172.6 cm. In the other age categories values of that trait reached as follows: 172.5 cm in the youth category, 169.8 cm in older juniors, and 168.3 cm in seniors. The mean body height of all contestants participating in the Polish Championships accounted for 170.9 cm (Table 2). Data collated in Table 3 enabled concluding that in all age categories the best results were achieved by the tallest sportsmen. Only among younger juniors, the boys achieving average results in this sports discipline turned out to be the tallest.

The mass of the active tissue of sportsmen exercising weightlifting was directly proportional to their calendar age. The highest value of this trait was recorded in seniors and accounted for 67.4 kg on average, whereas in young competitors – for 65.8 kg, in older juniors – for 60.8 kg and in younger juniors – for 57.5 kg, which when converted into percentage values reached: 84.0%, 84.4%, 85.2% and 84.4%, respectively. Also in respect of the achieved results, in each weight category the best results were scored by the sportsmen with the highest mass of the active tissues, whereas the worst ones – by those with the lowest active tissue mass. Completely different dependencies were observed, however, when the active tissue was expressed in percentage. In none of the age categories were there competitors achieving a high level of sports results characterized by the highest percentage of the active tissue. This was due to the content of adipose tissue (i.e. the passive tissue) in the body which does not contribute to achieving sports results, but is only unnecessary burden. The highest adiposity was determined in seniors, i.e. 13.4 kg which constituted 16.0%, followed by youth competitors – 12.9 kg (15.7%), older juniors – 11.0 kg (14.8%) and younger juniors – 10.7 kg (15.6%).

Not all the above-described dependencies between tissue composition of the body and the achieved sports results were, however, tangible. Statistically significant differences between the discussed somatic traits and the surveyed sportsmen's age were noted in few cases only (Table 4). Furthermore, when considering the sports result and tissue composition of the body, the statistical significance of differences was demonstrated only in the group of seniors in body height and active tissue expressed in kilograms between groups I and III as well as in fat content of the body between groups II and III. Values of Pearson's correlation coefficient confirmed that the achieved sports results were strongly correlated with the content of active tissue and adipose tissue expressed in kilograms.

Tab. 1. The number of evaluated players from the age category and the results obtained in Sinclair's scale

	I group		II group		III group	
	N	points	N	points	N	points
Seniors	12	> 390.6	8	> 357.7 < 390.5	9	< 357.6
Youth	10	> 342.4	13	> 292.0 < 342.3	9	< 291.9
Older juniors	7	> 342.5	11	> 301.2 < 342.6	9	< 301.1
Younger juniors	15	> 267.5	12	> 233.9 < 250.5	12	< 233.8

Tab. 2. Characteristics of tissue components of the body and the body type weightlifting class according to the athlete's calendar age

The test feature	Younger juniors (A)		Older juniors (B)		Youth (C)		Seniors (D)	
	N	$\bar{x}$ **±SD**	N	$\bar{x}$ **±SD**	N	$\bar{x}$ **±SD**	N	$\bar{x}$ **±SD**
Body height (cm)	39	172.6 ± 5.2	27	169.8 ± 6.8	32	172.5 ± 5.1	29	168.3 ± 8.9
FFM (kg)	39	57.5 ± 7.3	27	60.8 ± 9.1	32	65.8 ± 12.3	29	67.4 ± 12.1
FFM (%)	39	84.4 ± 2.1	27	85.2 ± 2.2	32	84.4 ± 4.1	29	84.0 ± 2.9
FM (kg)	39	10.7 ± 2.8	27	11.0 ± 3.8	32	12.9 ± 6.2	29	16.2 ± 4.8
FM (%)	39	15.6 ± 2.0	27	14.8 ± 2.9	32	15.6 ± 4.4	29	16.0 ± 3.2

Tab. 3. Characteristics of tissue components of the body weightlifting class, depending on the athletes' sports result

groups	Younger juniors		Older juniors		Youth		Seniors	
	N	$\bar{x}$ **±SD**	N	$\bar{x}$ **±SD**	N	$\bar{x}$ **±SD**	N	$\bar{x}$ **±SD**
body height (cm)								
I	15	172.4 ± 6.0	7	171.4 ± 7.3	10	174.2 ± 5.0	12	174.5 ± 7.6
II	12	176.1 ± 6.9	11	168.2 ± 10.1	13	171.3 ± 4.7	8	167.6 ± 9.8
III	12	169.5 ± 5.7	9	170.7 ± 2.4	9	173.2 ± 5.4	9	162.1 ± 10.9
FFM (kg)								
I	15	60.6 ± 10.5	7	65.6 ± 11.9	10	73.7 ± 10.6	12	78.3 ± 15.2
II	12	58.4 ± 6.9	11	62.7 ± 11.6	13	64.0 ± 10.1	8	66.3 ± 11.0
III	12	52.5 ± 5.7	9	55.0 ± 5.2	9	59.9 ± 15.8	9	56.0 ± 10.7
FFM (%)								
I	15	85.0 ± 2.3	7	85.8 ± 2.3	10	82.7 ± 4.9	12	83.9 ± 3.8
II	12	85.1 ± 1.8	11	84.7 ± 2.8	13	85.1 ± 3.5	8	84.2 ± 3.3
III	12	83.0 ± 2.4	9	86.0 ± 1.8	9	85.1 ± 4.5	9	83.9 ± 2.1
FM (kg)								
I	15	11.6 ± 4.1	7	11.2 ± 4.1	10	15.6 ± 6.0	12	15.7 ± 6.6
II	12	10.4 ± 2.6	11	11.4 ± 4.5	13	11.8 ± 5.3	8	12.9 ± 5.2
III	12	9.9 ± 1.9	9	9.5 ± 2.5	9	11.6 ± 7.2	9	19.8 ± 2.8
FM (%)								
I	15	15.0 ± 2.3	7	14.2 ± 2.3	10	17.3 ± 4.9	12	16.1 ± 3.8
II	12	14.9 ± 1.8	11	15.3 ± 3.8	13	14.9 ± 3.4	8	15.8 ± 3.3
III	12	17.0 ± 2.1	9	14.0 ± 1.8	9	14.9 ± 4.5	9	16.1 ± 2.1

Tab. 4. Statistical significance for differences calculated from the average tissue components of the body and the body type weightlifting class according to the athletes' calendar age

The test feature	Teams A-B	Teams A-C	Teams A-D	Teams B-C	Teams B-D	Teams C-D
Body height						
FFM (kg)		**	**			
FFM (%)						
FM (kg)			**		**	
FM (%)					**	

*** Significant differences at $p \leq 0.05$ (Newmann-Keuls test)*

Discussion

Results obtained in this study enable formulating some conclusions that can be used in recruitment and selection for the discussed sports discipline as well as constitute some useful hints in further coaching. Body height is a somatic trait having a great impact on the appropriate body height to body mass proportions. Because weightlifting is a sports discipline in which athletes compete in "weight" categories, when preparing for classification to a respective group of contestants, very tall sportsmen should reduce their muscle mass which out of all tissue components of the body is of the greatest significance to the achievement of sports result. Contemporarily, in terms of body height Polish seniors are not inferior to representatives of other countries [7] and are negligibly taller and slenderer than the finalists of the Olympic Games of 1998 [12]. Hence little comforting prognostic is the fact that out of all the examined age categories, younger juniors turned out to be the tallest, and additionally they were slightly taller than the juniors surveyed twenty years earlier [13]. Most of the boys at this age have not reached their final body height and the optimal development of the muscle tissue yet, thus they should still be growing. They are, therefore, still able to reach body height to body mass proportions appropriate for this sports discipline. This points to either inapt recruitment for this sports discipline in terms of this somatic trait or to the stage of preparations for competing in higher weight categories. These observations are confirmed by the fact in the youngest age category the tallest weightlifters did not achieve the best results. Of outmost significance to this sports discipline is a competitor's body mass, especially the contribution of particular tissue components in the total body mass. Results obtained in this study demonstrated that the best results were scored by the weightlifters characterized by the highest content of active tissue expressed in kilograms. Dependencies reported for this trait were, however, different when it was expressed in percentage.

Noteworthy is also the fact that the content of the adipose tissue is increasing along with the surveyed athletes' age and the training level. Their average adiposity was higher than that of Ukrainian weightlifters [7] and non-training individuals [14]. The content of fatty tissue and active tissue in the total body mass indicates that the sportsmen performing in competitions still possess some reserves that can be used for reducing adiposity in order to either increase the muscle mass or to prepare a sportsman for competition in a lower weight category. The differences noted in the tissue composition of the body were, undoubtedly, due to the selection of the sportsmen in view of the selected sports discipline or to their training which did not consider adipose tissue reduction through physical exercises. Physical activity seems to be an indispensable factor to assure appropriate tissue proportions. Nevertheless, a relatively high contribution of adiposity in the somatic built of the surveyed sportsmen may indicate that this trait was of lesser significance in the selection process for this sports discipline or that it has not been appropriately modeled in the training process. The reduction of this tissue should proceed through physical exercises and appropriate diet corresponding to calorific allowances.

Conclusions

Results obtained in this study enable formulating the following conclusions and observations:

1. Out of all surveyed participants of the Polish Weightlifting Championships only younger juniors were characterized by too high values of body height, which may affect their body mass to body height proportions.
2. The analysis of results of the tissue composition of the body in age categories and with consideration given to the level of achieved sports results demonstrated that along with advancement of training and its level, the content of real active tissue was increasing in the surveyed sportsmen.
3. Coaching methods and the sportsmen's diet should be verified in order to reduce their adiposity, for the value of this component is increasing along with age and the training level of the sportsmen.

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