

# Morphological differentiation and body composition in female judokas and female weightlifters in relation to the performed sport discipline

## Authors' Contribution:

- A** Study Design
- B** Data Collection
- C** Statistical Analysis
- D** Manuscript Preparation
- E** Funds Collection

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## Abstract

### Background and Study Aim:

The phenotype body reaction to the long-lasting and intensive training in the various sport disciplines may differ. It is related to the adaptive changes in both morphological features and tissue relationship. In one hand it improves sport efficiency, but in the other it creates a threat of injuries and permanent abnormalities in body posture.

This research aimed to verify the hypothesis that specialist training triggers body build-oriented changes including those in proportions of tissue components in athletes. The verification of the hypothesis will enable to plan the training load better.

### Material/Methods:

The results of anthropometric measurements of female judokas (n=28) and female weightlifters (n=28) were analysed. The following somatic features were examined in female competitors, who participated in Polish Championships: body height and mass, circumferences of the upper and lower extremities, thickness of the skinfolds, fat mass, muscle mass and nonmuscle mass of fat-free mass. Basic statistics, significance of differences and correlation tests were applied. The development level of separate tissue components was presented on trilinear plot.

### Results:

The conducted analysis revealed that, the level of lean body mass development in female judokas, in comparison to female weightlifters, was higher. However, female weightlifters revealed higher means of body mass and skinfolds thickness, which was related to the greater extremities circumference in those subjects. In comparison to female judokas they also characterised with greater content of fat and muscle mass.

### Conclusions:

The distinctiveness of long-lasting and well-oriented training in different sport disciplines is reflected in differences in body build and tissue composition in subjects performing these sports.

### Key words:

body composition • body components • female judokas • female weightlifters • female athletes • BIA • fat distribution

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## BACKGROUND

Previous research revealed that body build in subjects practicing different types of sports differ both in proportions and **body composition** [1,2]. It results from two phenomena: preliminary selection to the concrete

sports discipline and long-lasting, well-oriented training – different in various disciplines. The influence of each elements in particular sport disciplines is different. Natural subjects' diversification depending on the genetic predispositions should be also considered [3–5]. Morphological diversification is not only determined

**Body composition** – contribution of particular tissues (eg. fat, muscle) in body mass, often shows in kilograms or percentages.

by the genotype and the form of body load but also by general conditions and rules which apply to the given sport discipline e.g. type of the equipment, clothes or even trainers or their lack [6]. Relatively often results of a long-lasting training are morphological asymmetry and body injuries, which also have a negative influence on everyday life [7,8]. Concerning these data it seems important to analyse morphological diversification of subjects with regard to their sport discipline and training specificity.

This paper presents diversification of the selected elements of somatic structure and body composition in female judokas and female weightlifters. The subjects selected to this research performed sports requiring intensive weight training. Such training resulted in the increase of muscle mass, hypertrophy and changes in i.e. spine and feet structure. Single techniques that are used in both disciplines differ both in dynamics and physical load. Specific interaction of training measures in weightlifting develops in young female dynamic and static strength.

However, many years of judo training stimulates not only a development of strength but also agility, coordination and stamina.

This research aimed to verify the hypothesis that specialist training triggers body build-oriented changes including those in proportions of tissue components in female judokas and female weightlifters. The verification of the hypothesis will enable to plan the training load better.

## MATERIAL AND METHODS

The analysis is based on the results of an anthropometric measurements of body proportions and body composition performed in female judokas (n=28) and female weightlifters (n=28) participated in Polish Championships. The subjects were examined slightly before the start. The following somatic features were measured: body height and mass, circumferences of the upper and lower extremities (arm, forearm, thigh and calf), thickness of the skinfolds (subscapular, abdominal, arm and calf) and parameters of the body tissue composition. On the basis of the measurements, quotient indices determining the proportions of the functional segments of the upper and lower extremity and the body **fat distribution** indices were computed.

Body measurements were performed by the usage of Martin-type anthropometer, anthropometric tape, skinfold calliper and electronic weight scale. The circumferences of the extremities and skinfolds measurements were taken from the right side of the body (all the subjects were right-handed).

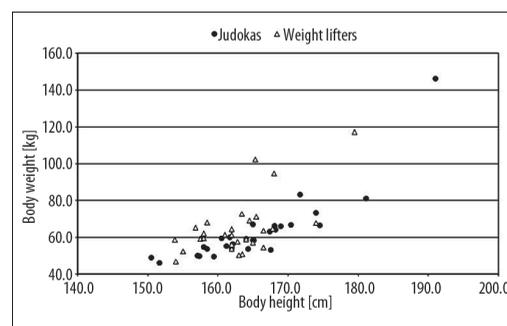
The tissue composition analysis was based on the double-element model:  $body\ mass = fat\ mass\ (FM) + fat\ free\ mass\ (FFM, lean\ body)$ . FFM included muscle mass (MM) and nonmuscle mass (NMM) [9]. The content of the fat tissue and muscle mass was estimated by analyser of bioelectrical impedance 101S Akern. The nonmuscle mass of FFM was estimated by subtraction muscle mass from lean body mass [10].

Female judokas and female weightlifters were in similar age, the mean age was 20,3 years (SD=2.88) and 20,4 years (SD=3.98), respectively. The minimal training experience was 5 years for all the subjects.

Basic statistical methods, parametric and nonparametric tests of significance of differences between independent groups and correlation tests were used in the analysis. The level of development of tissue components in subjects was presented on trilinear plots.

## RESULTS

Female judokas, in comparison to female weightlifters, were slightly slimmer, higher and their body mass was lower (Figure 1). Greater massiveness of female weightlifters is reflected by greater absolute values of arm, forearm, thigh and calf circumferences (statistically significant differences are related to the arm and forearm circumference, Table 1). However, width proportions of the upper and lower extremities are quite similar in both groups. It is expressed by nearly equal values of the circumference indices of the upper and lower extremity (Table 1).



**Figure 1.** The relationship between the height and body mass of the examined subjects.

Female weightlifters, in comparison to female judokas, revealed higher fat tissue level and greater mean values of subscapular, abdominal and extremities skinfolds (Table 1). In both groups the least fat tissue was observed in the calf. In female weightlifters the greatest amount of subcutaneous fat tissue occurred in the abdomen, while in female judokas in the arm. Fat distribution index ( $\Sigma trunk\ skinfolds / \Sigma extremities\ skinfolds$ ) takes similar values in both groups (Table 1). However,

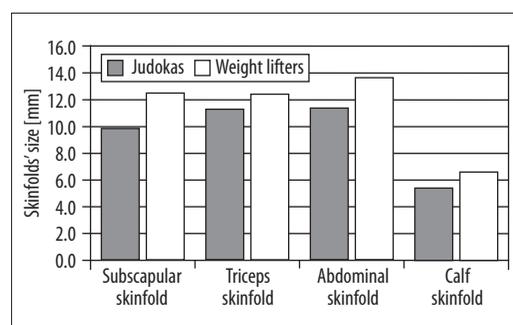
**Fat distribution** – distribution of subcutaneous fat tissue in particular body parts.

**Table 1.** Statistical characteristics of anthropometric traits of judokas and weightlifters.

Variable	Judokas (n=28)		Weightlifters (n=28)		
	Mean	SD	Mean	SD	
Body height [cm]	165.23	8.44	162.86	5.64	
Body mass [kg]	62.93	18.70	64.93	15.71	
Arm circumference [cm]	<b>*27.18</b>	3.06	<b>*29.32</b>	4.08	
Forearm circumference [cm]	<b>*23.93</b>	2.10	<b>*25.48</b>	2.31	
Thigh circumference [cm]	56.82	7.73	58.70	5.79	
Calf circumference [cm]	35.48	3.37	36.48	3.99	
Subscapular skinfold [mm]	10.32	4.24	13.49	7.71	
Triceps skinfold [mm]	11.90	4.62	12.78	4.45	
Abdominal skinfold [mm]	11.84	5.47	14.16	9.16	
Calf skinfold [mm]	5.73	2.82	6.96	3.77	
Indexes	Body mass index	22.69	3.91	24.33	4.69
	Arm circumference/forearm circumference	1.14	0.05	1.15	0.07
	Thigh circumference/calf circumference	1.60	0.17	1.61	0.07
	$\Sigma$ trunk skinfolds/ $\Sigma$ extremities skinfolds	1.27	0.23	1.34	0.33
Fat mass [kg]	16.65	11.39	18.04	9.69	
Fat mass [%]	24.99	6.36	26.45	7.04	
Muscle mass [kg]	<b>*31.55</b>	3.72	<b>*35.18</b>	5.72	
Muscle mass [%]	52.19	9.08	55.46	9.05	
Nonmuscle mass of FFM [kg]	14.74	6.81	11.71	4.09	
Nonmuscle mass of FFM [%]	<b>*22.82</b>	4.51	<b>*18.08</b>	5.41	

\* Bold font – significant values  $p < 0.05$ .

in the weightlifters greater trunk than extremities fatness can be observed (Figure 2).



**Figure 2.** Thickness of the skinfolds of the examined subjects.

Skinfolds thickness measured by the skinfolds caliper correlates significantly with the fat tissue content estimated by BIA. The greatest influence on fat tissue content (estimated by BIA) had scapula skinfold for both groups (the correlation coefficient for female judokas  $r_j^2 = 0.90$ , for female weightlifters  $r_w^2 = 0.81$ ; for both  $p = 0.0000$ ) and arm skinfold in female weightlifters

( $r_w^2 = 0.81$ ;  $p = 0.0000$ ). There is a slight correlation of scapula and abdomen fatness with muscle mass in female weightlifters, while in female judokas this fatness is not related to their muscle mass ( $r_w^2 = 0.23$ ;  $p = 0.0097$  and  $r_j^2 = 0.19$ ,  $p = 0.0200$  respectively).

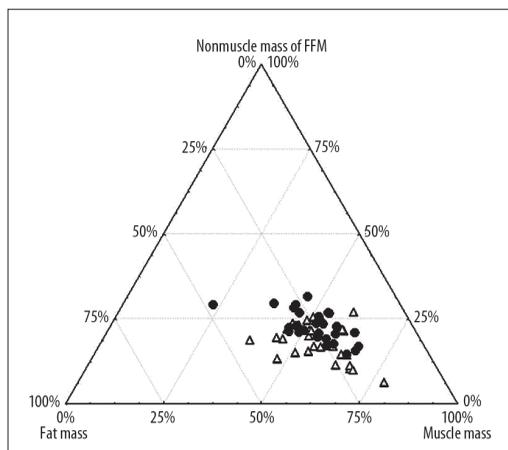
Female weightlifters, in comparison to female judokas, obtain significantly higher values of muscle mass, namely they have about 3.5 kg more muscles (Table 1). The correlation of muscle mass content with the arm circumference is greater in female weightlifters than in female judokas ( $r_w^2 = 0.61$ ,  $p = 0.0000$ ;  $r_j^2 = 0.23$ ;  $p = 0.0097$ ). Arm circumference in both groups is strongly related to the fat rather than muscles content.

The differences in body tissue composition in both groups were presented on trilinear post (Figure 3). Female weightlifters display greater muscle and fat mass development. Individual points representing female judokas display higher level of nonmuscle mass development (including skeletal mass). The significance of differences in distribution of individual points was estimated by chi-square test.

**BIA** – method of bioelectrical impedance analysis for body composition measurements.

**Body composition** – contribution of particular tissues (eg. fat, muscle) in body mass, often shows in kilograms or percentages.

**Body components** – particular tissues in body mass (eg. fat, muscle).



**Figure 3.** The distribution of individual points of female judokas (●) and female weightlifters (Δ).

## DISCUSSION

People performing sports professionally differ in body composition and proportions from those who don't train. Physical effort leads to structural and functional changes in the entire body [11–16]. The differences in body build can also be observed between athletes practicing similar sports [17].

In order to compare the body composition and proportions we selected to this research the competitors practicing two different sport disciplines which required intensive weight training but differed in training technique and load of the selected body parts [18].

Greater circumference of the upper extremity in the examined weightlifters showed that work performed by the upper extremities during weightlifting was the most intensive. The arm and forearm circumference was almost 2 cm greater in female weightlifters in comparison to the examined judokas. Values of arm and forearm circumferences obtained for the Australian female weightlifters were similar to those received in this research [19].

Judo is more dynamic sport discipline, since the entire body participates in the fight. During training or fight lower extremities are loaded for most of the time; however numerous techniques also require participation of the upper extremities. In contrast to weightlifting, where the success is in great extent related to the level of fat-free mass development, an important element of judo fight is agility and flexibility. Many research, regardless their methodology, revealed the high level of mesomorphy and fat-free mass in weightlifters [19]. In the analysed trial muscle mass in female weightlifters was significantly higher.

In the quoted research Keogh et al [19] noticed that female weightlifters who characterized with similar body mass values were slightly shorter.

In the investigated trial great amount of fat-free mass in female weightlifters is related to the greater amount of fat tissue than in female judokas. It can be observed in the results obtained by BIA and also in thickness of the skinfolds.

Both groups slightly differed in subcutaneous fat tissue distribution. In female weightlifters greater trunk over extremities fatness can be observed.

Female judokas displayed higher level of nonmuscle mass of FFM. Different research proved that female judokas characterised with meso-endomorphic body build [20].

This research showed how long-lasting and well-oriented training (minimal training experience 5 years, research during Polish Championships) influenced their different body build. The differences between female judokas and female weightlifters were mostly related to the upper extremities build and muscle mass content. Slight diversification in other analyzed anthropometric features may result from the fact, which is pointed by many coaches, that undertaking these sports in Poland is mainly based on willingness to participate in such trainings and only sometimes on the results of strength/fitness tests [21]. In this case subject's body build was not significantly important in the process of selection, which means that the observed variability between the female weightlifters and female judokas probably results from many years of well-oriented training.

The significance of the presented results was also influenced by a small number of subjects in the compared groups.

## CONCLUSIONS

The conducted research proved further necessity of broader examination of the body build variability in subjects practicing different sport disciplines. The research shall be conducted from the perspective of physical effort. The scientific information on these phenomena may be a starting point to rational selection of people willing to practice a specific sport discipline. This selection shall consider e.g. body's tolerance for the many years of specific physical effort.

## Acknowledgment

Senate Committee for the Ethics of the University School of Physical Education in Wrocław accepted the performance of the research.

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