MORPHOLOGICAL DIFFERENTIATION AND SPORT RESULTS OF MALE AND FEMALE WEIGHTLIFTERS

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Abstract. *Purpose* of this study was to analyze the types of body structure of elite Polish weightlifters of both genders, depending on their sports' achievements. *Material:* Somatic measurements of weightlifters were fulfilled during individual Junior and Senior National Championships. Overall, a total of 127 male athletes (66 juniors and 61 seniors) were examined, along with 63 female athletes (32 juniors and 31 seniors). The levels of endomorphism, mesomorphism, and ectomorphism were determined and compared to the reference values of adolescents and young adults who did not engage in any sports discipline. The scores achieved during the National Championships were converted into Sinclair scale points, and each athlete was classified into one of three categories of sports outcome (superior, intermediate, or poor). *Results:* The athletes were characterized by higher level of endomorphism and mesomorphism and lower level of ectomorphism than non-training individuals. This suggests that the level of body adiposity is not considered during the qualification and selection of examined weightlifters. Male seniors were the only group with lower adiposity than the reference group. Analysis of body structure in relation to sports results revealed a tendency towards increased mesomorphism and decreased ectomorphism associated with higher level of skills and training experience in studied men and women. This reflects the appropriateness of the training process. However, not all differences between analyzed groups proved statistically significant. *Conclusions:* Training methods and diet should be verified to reduce adiposity in athletes as aside from male seniors, this parameter proved higher than in the respective reference groups, and there was no tendency towards a decrease in this parameter in concert with age or sports level.
Key words: somatic type, weightlifting, ectomorphism, endomorphism, mesomorphism.

Introduction

High level of sport competition is associated with higher requirements faced by athletes and their coaching teams. Therefore, only a few athletes can achieve outstanding results in contemporary sports; this group includes individuals with superior motor skills, who are very well prepared with regards to fitness, technique, mentality, and theory, and are characterized by proper somatic predispositions. However, each sports discipline should possess a well-documented "model of champion", especially regarding body structure [13], as the same body weight can be associated with different percentage of muscle, adipose, and skeletal tissue. The fraction of various tissue components in the overall body weight plays an important role in athlete's body structure. Therefore, the aim of ongoing studies is to define the somatic predisposition of athletes who achieve outstanding results in various sports disciplines [4,8,9,16]. The review of literature dealing with the somatic characteristics of weightlifters [5,10,12,14,19,20] suggests that such athletes should be characterized by a proper proportion of body height and weight. Linear measurements, such as body height, are of lesser importance in the case of "weight" sports discipline. Consequently, individuals with lower values of linear measurements should be selected to lower weight categories, and the linear measurements should increase in concert with weight category. As regards the internal relationships pertaining to body structure, the most important features of weightlifters include large mass of active tissue manifested by outstanding endurance of the skeleton and well-developed muscular system (high mesomorphism), along with small adipose tissue content (low endomorphism). Therefore, the aim of this study was to analyze the types of body structure of superior Polish weightlifters of both genders depending on their sports achievements. The results of our study could be used as reference values during qualification and selection of candidates to this sports discipline.

Materials and Methods

Somatic measurements of weightlifters were fulfilled during individual Junior (up to 20 years of age) and Senior (above 20 years) National Championships. The best Polish athletes, including the members of the National Team, took part in this competition. Overall, a total of 127 male athletes were examined in 2005, among them 66 juniors and 61 seniors. The female athletes, 32 juniors and 31 seniors, were studied in 2006. The study included measurements required to estimate the type of body structure with Heath and Carter method [6]. The level of endomorphism was determined on the basis of the skin fold thickness on the arm, below the scapula, and over the hip. The level of mesomorphism was calculated from the elbow and knee width, arm and crural circumference, and the thickness of arm and crural skin folds. The analysis of ectomorphism was based on body height and weight, which were used to calculate the slenderness index. All measurements were taken prior to the warm-up on the day of the competition. This study also used the scores achieved during the competition, which were converted into Sinclair scale points [18], enabling the analysis of sports outcomes regardless of weight category. The characteristics of Sinclair points in each age category were presented as arithmetic means and standard deviations. Subsequently, each athlete was classified into one of three groups defined on the basis of arithmetic mean ± 0.5 standard deviation. This enabled us to identify three groups of athletes: group I characterized by the superior results in each age category (mean + at least 0.5 deviation (SD) from the Sinclair scale points), group II with intermediate results (mean – 0.5 SD to mean + 0.5 SD from the Sinclair scale

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points), and group III with the poorest results (mean – 0.5 SD from the Sinclair scale points). The number of athletes analyzed in various age categories is presented in Table 1, along with their biological age and sports results.

Table 1

Number of analyzed athletes in various age categories and their results expressed in Sinclair scale

Group of athletes	Total	Group I		Group II		Group III	
		n	points	n	points	n	points
Female juniors	32	10	from 155.35	14	from 135.06 to155.34	8	to 135.05
Male juniors	65	22	from 305.1	22	from 267.45 to 305.0	21	to 267.44
Female seniors	31	8	from 198.98	16	from 169.12 to 198.97	7	to 169.11
Male seniors	61	22	from 366.5	21	from 324.74 to 366.4	18	to 324.73
Total	189	62		73		54	

The statistical characteristics of groups defined on the basis of biological age and sports results were presented as arithmetic means and standard deviations. The results of this study were compared with the data obtained in non-training individuals. The results of male and female junior athletes were compared to the data of adolescents from Wroclaw [3], and the results of male and female senior athletes to the data of students from Zielona Gora University [1]. The statistical significance of differences between the body components of two groups was determined with the Student's t-test for independent variables, and the significance of differences between the structural body indices of three groups defined depending on age and sports result was analyzed with univariate ANOVA and the Newmann-Keuls test.

Results

The distribution of somatotypes amongst female and male weightlifters and non-training adolescents was presented on a somatogram (Figure 1). On the basis of this data, we concluded that our athletes were characterized by mesomorphic type of body structure. This corresponds to good development of musculature and high endurance of skeletal system. Female juniors were the only group which presented with structural endomesomorphy, indicating relatively high adiposity. The somatotypes of individuals from the reference groups placed within the central part of the somathogram, which is typical for similar values of all three analyzed structural components.

To perform detailed analysis of the body structure of weightlifters in relation to non-training adolescents, the values of endomorphism, mesomorphism, and ectomorphism were studied separately. The statistical characteristics of analyzed groups are presented in Table 2. Junior male weightlifters were characterized by the lowest level of mesomorphism, 2.69 on average, and were followed by male seniors (2.83). Women showed significantly higher average levels of this parameter, 4.44 and 4.89 in senior and junior athletes, respectively. Both in men and women, the levels of mesomorphism increased with age. Higher values of this parameter were observed in male senior athletes (6.05) as compared to juniors (5.26); similarly, female seniors scored better than the juniors with regards to the level of mesomorphism (5.21 vs. 4.93). Analysis of the latter parameter, i.e. ectomorphism, revealed that both male (2.09) and female juniors (1.81) were more slender than male (1.30) and female (1.61) senior weightlifters. The results of these comparisons suggest that athletes of all age and gender categories were characterized by higher levels of endomorphism and mesomorphism, and lower levels of ectomorphism as compared to relevant reference groups. With the exception of endomorphism in male juniors, which only slightly differed from that in non-training peers, the differences in all analyzed structural components proved significant at $p<0.01$.

The distribution of somatotypes of female and male weightlifters depending on their age category and sports results is presented in Figure 2. Female junior athletes achieving the worst sports results were the only group characterized by structural endomorphism, whereas their peers with intermediate achievements and the worst senior athletes represented structural endomesomorphism. The predominance of mesomorphism was observed in the remaining female athletes and all groups of male athletes. The details of the differences between various groups were revealed during further analysis of structural components.

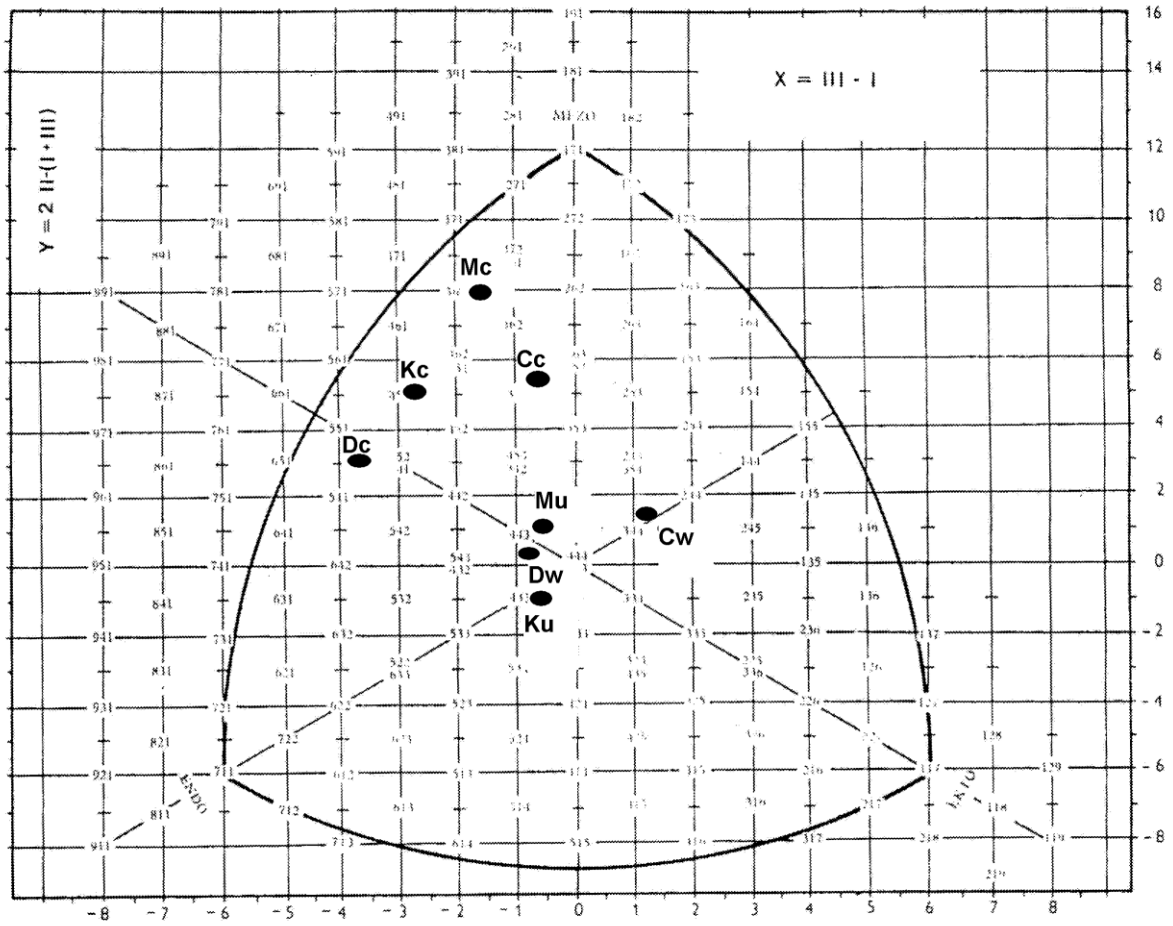

Fig. 1. Distribution of somatotypes amongst female and male weightlifters, adolescents from Wroclaw, and male and female students from Zielona Gora University. Kc – female seniors, Dc – female juniors, Mc – male seniors, Cc – male juniors, Ku – female students from Zielona Gora University, Dw – girls from Wroclaw, Mu – male students from Zielona Gora University, Cw – boys from Wroclaw.

Table 2

Type of body structure in female and male weightlifters depending on their biological age and in relation to non-training individuals

Parameter	Athletes			Reference group			t-value
	n	mean	SD	n	mean	SD	
	Female juniors			Women from Wroclaw			
Endomorphism	32	4.89	1.77	91	3.3	0.71	7.13*
Mesomorphism	32	4.93	1.48	91	2.94	0.89	9.03*
Ectomorphism	32	1.81	1.06	91	3.57	0.99	7.25*
	Male juniors			Men from Wroclaw			
Endomorphism	65	2.69	0.75	130	2.63	0.83	0.49
Mesomorphism	65	5.26	1.35	130	3.91	1.02	7.83*
Ectomorphism	65	2.09	0.95	130	3.74	1.02	10.95*
	Female seniors			Female students from Zielona Gora			
Endomorphism	31	4.44	1.74	95	3.64	0.84	3.44*
Mesomorphism	31	5.21	1.10	95	3.12	0.66	12.80*
Ectomorphism	31	1.61	0.98	95	3.08	1.23	6.05*
	Male seniors			Male students from Zielona Gora			
Endomorphism	61	2.83	1.35	43	3.53	0.76	3.07*
Mesomorphism	61	6.05	1.85	43	3.57	0.58	8.49*
Ectomorphism	61	1.30	0.59	43	3.00	1.11	10.12*

*$p<0.01$

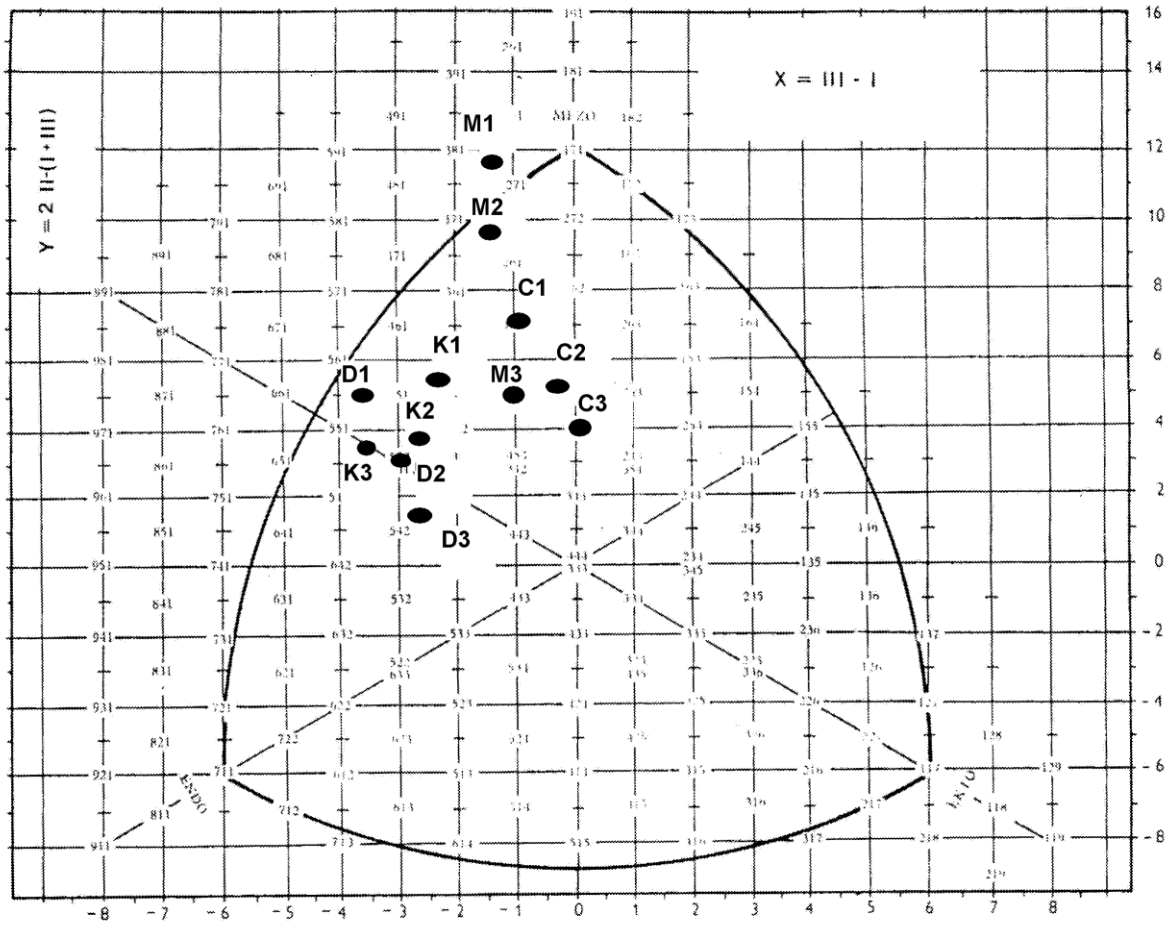

Fig. 2. Distribution of somatotypes amongst female and male weightlifters depending on their age category and sports results. K1 – group I female seniors, K2 – group II female seniors, K3 – group III female seniors, D1 – group I female juniors, D2 – group II female juniors, D3 – group III female juniors, M1 – groups I male seniors, M2 – group II male seniors, M3 – group III male seniors, C1 – group I male juniors, C2 – group II male juniors, C3 – group III male juniors.

Athletes with worst sports results were characterized by highest level of endomorphism, whereas the lowest values of this parameter were documented in outstanding senior athletes of both genders, as well as in male and female juniors presenting with moderate sports levels (Table 3). In all age categories, the level of mesomorphism was directly proportional to sport result. Therefore, the highest skeletal endurance and muscle mass were observed in outstanding athletes, while the worst athletes were characterized by the lowest level of mesomorphism. The lowest values of the latter analyzed parameter, i.e. ectomorphism, were documented in male and female athletes who received the highest scores in the Sinclair scale; the level of ectomorphism increased proportionally to the decrease in the result achieved during the National Championships. Female seniors representing sport group I and III were the only categories characterized by similar level of height to weight ratio.

Table 3

Types of body structure along with the statistical significance of differences in weightlifters depending on their sports results

Parameter	Group I	Group II	Group III	ANOVA	I-II	I-III	II-III
	Mean ± SD	Mean ± SD	Mean ± SD				
Female juniors							
Endomorphism	5.00±2.19	4.75±1.53	5.00±1.81	0.07	0.47	0.00	0.44
Mesomorphism	5.58±1.96	4.85±0.83	4.51±1.58	1.33	1.72	2.20	0.75
Ectomorphism	1.50±0.97	1.82±0.87	2.19±1.44	0.94	1.03	1.93	1.11
Male juniors							
Endomorphism	2.74±0.60	2.52±0.69	2.81±0.84	1.00	1.46	1.90	0.45
Mesomorphism	5.71±1.51	4.97±1.20	4.78±1.26	2.98	2.64	3.24	0.67
Ectomorphism	1.74±0.94	2.06±0.80	2.78±1.06	6.95*	1.62	5.15*	3.61*
Female seniors							
Endomorphism	3.69±2.19	4.63±1.51	4.86±1.68	1.04	1.77	1.84	0.41

Parameter	Group I	Group II	Group III	ANOVA	I-II	I-III	II-III
	Mean ± SD	Mean ± SD	Mean ± SD				
Mesomorphism	5.39±1.23	5.25±1.21	5.09±0.77	0.13	0.40	0.72	0.44
Ectomorphism	1.44±0.82	1.78±1.03	1.43±1.10	0.46	1.11	0.03	1.09
Male seniors							
Endomorphism	2.24±2.32	2.57±1.11	2.83±1.25	0.62	0.91	1.56	0.68
Mesomorphism	7.50±1.79	6.66±1.54	4.89±1.95	11.15*	2.21	6.60*	4.43*
Ectomorphism	0.93±0.59	1.21±0.63	2.06±0.90	13.35*	1.84	7.11*	5.29*

*statistically significant differences at the level of $p \leq 0.05$

The differences between analyzed structural components rarely proved significant on statistical analysis. The statistically significant differences were documented in the case of mesomorphism and ectomorphism of male seniors and ectomorphism of male juniors.

Discussion

The findings of our study can be employed during qualification and selection of candidates to weightlifting as well as during further training work. It should be remembered that weightlifting constitutes a discipline in which athletes compete in various "weight" categories. Therefore, both too slim silhouette and excessive obesity limit the amount of muscle mass; this proved to be the most important determinant of outstanding sport achievement amongst all other tissue components [2,7,11,20].

It should be emphasized that both men and women participating in our study were characterized by significantly higher endomorphism and mesomorphism, and significantly lower level of ectomorphism, as compared to the corresponding groups of peers who did not engage in any sports discipline. The only exception pertained to males of senior category, who showed lower adiposity than the reference group. The level of structural endomorphism documented in our athletes suggests that they still possess some reserve; it can be used for increasing muscle mass by reducing obesity or for preparing for competition in lower weight category due to the decrease in adipose tissue content. The results of previous studies by Saczuk et al. [17] suggest that in most female weightlifters reducing the adipose tissue content to the average level observed in non-training peers, would enable competing one (or even two) weight categories lower. High adiposity of examined athletes suggests that little attention was paid to this parameter during the sport selection process; moreover, it was not significantly modified during training. The content of adipose tissue could be reduced by physical exercise and proper, adjusted to energetic requirements, diet. These conclusions were further supported by the fact that the level of structural mesomorphism of examined athletes increased with age category, and the observation that the higher it was, the better were the results of male and female weightlifters. The increase in this structural component was not associated with a decrease in adipose tissue content, as suggested by the lack of statistically significant differences in this latter parameter. It should be emphasized that variable sport training enables obtaining proper body height to body weight ratio along with desired body composition, both predisposing athletes to outstanding achievements in a given sports discipline [2,11,15, 20].

Conclusion

The following conclusions and observations can be made on the basis of our findings.

1. The participants of National Weightlifting Championships were characterized by higher level of endomorphism and mesomorphism and lower level of ectomorphism than non-training individuals. This suggests that the level of body adiposity is not considered during the qualification and selection of examined athletes. Male seniors were the only group with lower adiposity than the reference group.
2. Analysis of body structure in relation to sports results revealed a tendency towards increased mesomorphism and decreased ectomorphism associated with higher level of skills and training experience in studied men and women. This reflects the appropriateness of the training process. However, not all differences between analyzed groups proved statistically significant.
3. Training methods and diet should be verified to reduce adiposity in athletes as aside from male seniors, this parameter proved higher than in the respective reference groups, and there was no tendency towards a decrease in this parameter in concert with age or sports level.

Conflict interests

The authors declare they have no conflict interests.

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