

# Differentiation of the Body Composition in the Polish National Team Pentathletes\*

## Author's Contribution

A – Study Design  
B – Data Collection  
C – Statistical Analysis  
D – Data Interpretation  
E – Manuscript Preparation  
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G – Funds Collection

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## Abstract

Contemporary anthropological research confirms the fact that body composition is one of the elements differentiating athletes from persons not practising sport systematically. The differences in body composition – in many cases even extreme – also regard athletes in the context of the sports discipline they practise.

The aim of the study was to determine the properties of body composition of the Polish national team pentathletes in comparison to persons of the same population not practising competitive sport.

The research comprised members of the Polish national team in modern pentathlon ( $n=10$ ). The subjects were 18-23 ( $20 \pm 1.5$ ) years of age with their body mass from 64 to 80 kg ( $73.27 \pm 6.1$ ) and body height of 172-188 cm ( $180.11 \pm 6.22$ ). The athletes had had 6-13 years ( $10.38 \pm 2.07$ ) of training experience. Students of Warsaw Technical University (Poland) constituted the reference group. Measurements of 20 basic somatic features were made. The following indices were calculated: leanness, Rohrer's, BMI, Manouvrier's and pelvic-shoulder. Body density, total body fat, active tissue, the general body composition profile and internal proportions of the body composition were determined.

An analysis of internal proportions of the factors of athletes' body composition revealed differences in particular groups of features. The athletes' overall body size results from greater than mean values of the body height and the average ones of stoutness and the fat content.

The proportions of features within the analysed factors proved a significant advantage of the upper limb over the lower one and the significant predominance of the musculature of the forearm.

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## Introduction

Contemporary anthropological research confirms the fact that body composition is one of the elements which differentiate athletes from persons not practising sport systematically [1,2,3]. The differences in body composition – in many cases even extreme – also regard athletes in the context of the sports discipline they practise [4,5,6].

With the increase in the training experience, hence the level of sports mastery, the decrease in differentiation of morphological features within the given discipline or event occurs. That is why research on athletes classified as the world elite in a particular sports discipline provides the most accurate information on the characteristic properties of their build [4,7].

However, such properties are not easy to determine in all disciplines. This regards, among others, pentathlon, in which particular events substantially differ not only as far as the coordination structure is concerned but also with reference to the method of energy supply for the effort.

On the grounds of these general premises, the main aim of the study was an attempt to determine the properties of body composition of the Polish national team pentathletes in comparison to persons of the same population (reference group) not practising competitive sport and to answer the following questions:

Which somatic features determine the athletes' specific build?

Which internal proportions of the body composition are the most characteristic of them?

## Material and methods

The research comprised members of the Polish national team in modern pentathlon ( $n=10$ ). The subjects were 18-23 ( $20\pm1.5$ ) years old, with their body mass from 64 to 80 kg ( $73.27\pm6.1$ ) and body height 172-188 cm ( $180.11\pm6.22$ ). The athletes had had 6-13 years ( $10.38\pm2.07$ ) of training experience.

Anthropometric measurements were carried out in consistence with the generally adopted rules [8] using standard instruments. Furthermore, the following five indices were calculated: leanness, Rohrer's, BMI, Manouvrier's and pelvic-shoulder.

Total body fat in the percentage of body mass was calculated according to Brożek and Keys's equation [9] and body density on the basis of measurements of subcutaneous fat, with the application of Piechaczek's anticipating equation [10]. In total, 20 basic somatic features were measured. The general body composition profile of members of the national team was determined by means of the method of standardising features. Students of Warsaw Technical University constituted the reference group [11]. Moreover, the variation coefficient ( $V\%$ ) and the significance of differences were calculated by means of the Student test.

The assessment of internal proportions of the body composition was made through calculating Perkal's natural indices [12] with Milicerowa's modifications [13]. To do that the following were determined: composition factors ( $m$ ), index of the total body size ( $M$ ), internal proportions of the body composition (natural indices for each of the composition factors), evenness of the composition (the intrapersonal variability index), the code of internal proportions of the group (the point scale of Perkal's natural indices), internal proportions of the body composition within each of the factors.

## Results

Mean values of the studied features in modern pentathletes prove that the slightest differentiation regards body density ( $V\%=0.50$ ) and the leanness index ( $V\%=1.80$ ). The greatest variability was determined in reference to fat content ( $V\%=12.04$ ), the shank perimeter ( $V\%=9.47$ ) and body mass ( $V\%=8.37$ ) – Table 1.

The obtained results lay at the root of creating a profile of body composition of members of the Polish national modern pentathlon team (Fig. 1). Their body build is characterised by a substantial perimeter of the forearm – they exceed their peers in this respect by 0.78 of the stan-

Tab. 1. Features of body composition in members of the Polish national team in modern pentathlon and students of Warsaw Technical University and the significance of differences

| Feature                | Pentathletes, n=10 |      |       |        |        | Students, n=165 |       | Test t    |
|------------------------|--------------------|------|-------|--------|--------|-----------------|-------|-----------|
|                        | X                  | SX   | V%    | min    | max    | X <sub>2</sub>  | SX    |           |
| Standing body height   | 180.11             | 6.22 | 3.45  | 171.50 | 187.70 | 179.360         | 6.190 | 0.370     |
| Sitting body height    | 94.96              | 3.36 | 3.54  | 89.50  | 99.50  | 93.860          | 3.060 | ***4.618  |
| Upper extremity length | 80.19              | 2.94 | 3.66  | 76.20  | 84.00  | 78.300          | 3.510 | ***6.9167 |
| Lower extremity length | 85.15              | 4.29 | 5.04  | 77.30  | 91.50  | 85.500          | 4.100 | -1.097    |
| Shoulder width         | 40.39              | 2.05 | 5.08  | 37.50  | 44.50  | 40.670          | 1.590 | **2.262   |
| Pelvis width           | 28.35              | 1.03 | 3.65  | 27.00  | 30.00  | 28.440          | 1.460 | -0.792    |
| Elbow width            | 6.89               | 0.55 | 8.02  | 6.00   | 7.80   | 6.980           | 0.340 | ***3.400  |
| Knee width             | 9.63               | 0.45 | 4.67  | 9.00   | 10.60  | 9.820           | 0.450 | ***5.424  |
| Forearm perimeter      | 27.42              | 1.25 | 4.56  | 26.00  | 30.00  | 26.020          | 1.800 | ***9.991  |
| Shank perimeter        | 35.92              | 3.40 | 9.47  | 27.00  | 38.50  | 36.860          | 2.300 | ***5.250  |
| Body mass              | 73.20              | 6.12 | 8.37  | 64.00  | 80.00  | 72.110          | 8.960 | 1.563     |
| Density                | 1.06               | 0.01 | 0.50  | 1.05   | 1.06   | 1.058           | 0.007 | ***3.763  |
| Fat, %                 | 16.55              | 1.99 | 12.04 | 13.44  | 18.74  | 15.660          | 2.740 | ***4.173  |
| Active tissue, %       | 83.45              | 1.99 | 2.39  | 81.26  | 86.56  | 84.340          | 2.740 | ***4.173  |
| Body area              | 1.92               | 0.11 | 5.77  | 1.77   | 2.05   | 1.902           | 0.125 | *1.815    |
| Leanness index         | 43.71              | 0.79 | 1.80  | 42.22  | 44.54  | 43.210          | 1.660 | ***3.841  |
| Rohrer's index         | 1.25               | 0.07 | 5.53  | 1.18   | 1.39   | 1.250           | 0.150 | 0.213     |
| BMI index              | 22.54              | 1.01 | 4.47  | 20.73  | 24.35  | 22.400          | 2.460 | 0.713     |
| Manouvrier's index     | 89.72              | 4.54 | 5.06  | 78.72  | 95.31  | 91.093          | 2.820 | ***6.232  |
| Pelvic-shoulder index  | 70.31              | 3.43 | 4.88  | 65.06  | 75.20  | 69.929          | 2.400 | *2.015    |

\* p&lt;0.05 \*\* p&lt;0.01 \*\*\* p&lt;0.001

standardised Z value – and by the length of the upper limb (0.54 Z). Also worth attention is the knee width – here pentathletes are inferior to their peers by 0.42 Z and the shank perimeter (-0.41).

The proportions of studied athletes' bodies determined by means of the indices clearly indicate their leptosomatic build (Rohrer's index), more masculine one (pelvic-shoulder index), with correct body mass (BMI) and an average length of lower extremities (Manouvrier's index).

The values of the factors of body composition confirm on a larger scale the observations of standardised values of individual features. As far as the overall body size is concerned, pentathletes are the most similar to the control group (M=0.02). The most distinguishing factor for pentathletes is the length factor ( $m_1=0.23$ ). The fat content factor and the stoutness factor amount to -0.09.

An analysis of mutual proportions between the pentathletes' body composition factors reveals a relatively proportional build – the intragroup variability index is 0.33. Features of length (0.32) are a characteristic element of such body composition. The contribution of stoutness and fat content features (-0.11) is the most proportional.

Using Perkal's natural indices point scale [22], the following code of the athletes' internal proportions was obtained: 5-4-4. This means that the overall body size (M) results from greater than mean values of body length and the average ones of stoutness and fat content.

The calculation of internal proportions of body composition within each of the factors provides very important information on the Polish modern pentathlon national team members' body build. Natural indices of the somatic features within the factors were calculated by subtracting the m factor value from the standardised features. The dominance of the upper extremity length (0.31)

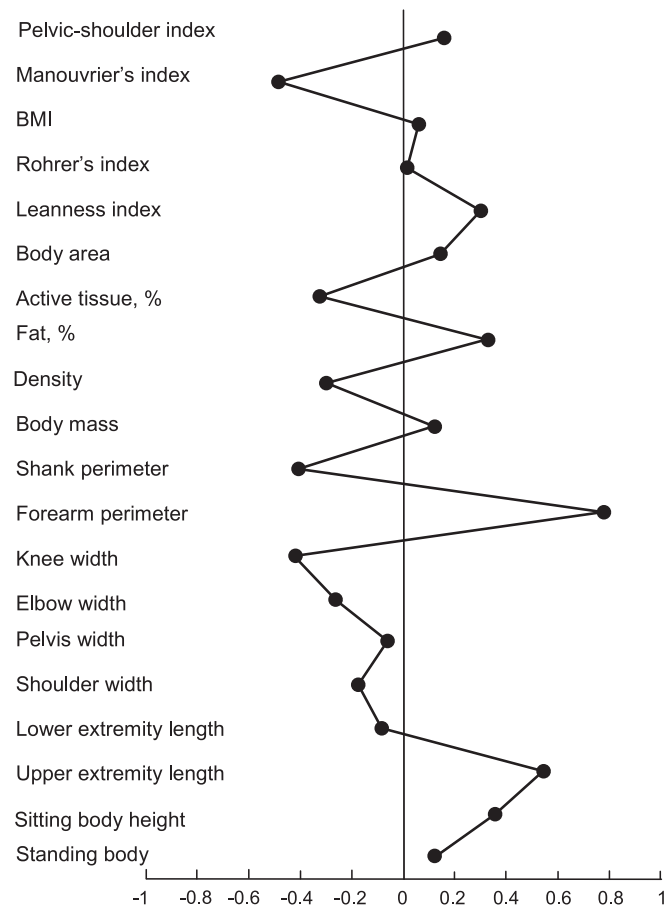


Fig. 1. The profile of body composition of members of the Polish national modern pentathlon team (n=10)

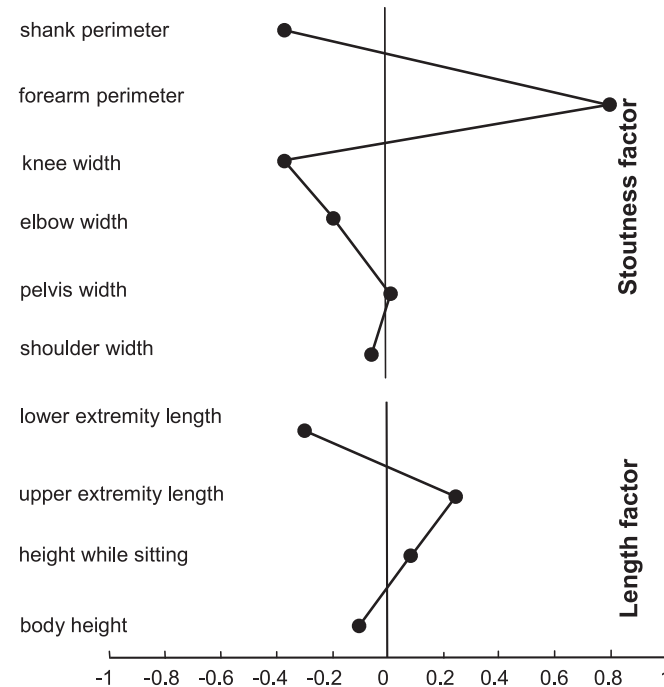


Fig. 2. Natural indices of the somatic features within factors among the Polish national modern pentathlon team (n=10)

over the lower extremity length (-0.32) is manifested in features expressing the length index. The contribution of the features of standing and sitting body height to the length factor is even (Fig.2).

There is a marked dominance of the forearm musculature (0.87) in features reflecting the stoutness index. The knee width (-0.33) and the shank perimeter (-0.32) are the least proportionate to the overall value of the factor.

## Discussion

The properties of body composition of Polish representatives in modern pentathlon revealed in course of the study are a resultant of two processes. On the one hand, the process of sports selection of the most talented athletes; on the other hand, the effect of the adaptation of the organism to affecting it external factors. In this context, mean values of the height and the body mass of Polish representatives in pentathlon are interesting when compared to data from literature. The mean body height of members of the Polish national modern pentathlon team was 180 cm and mass 73 kg and did not statistically differ in this respect from the reference group (students of Warsaw Technical University). One should remember, however, that students of Warsaw Technical University are characterised by the highest indices of biological development among academic youth [11].

Greater differences occur in reference to men training other sports disciplines. For example, the mean body height of Polish representatives in tennis was 182 cm and their mass was 71 kg [14]. Slightly lower values were also achieved in the group of the best Polish judokas – 180. Piechaczek and Łaska-Mierzejewska [18] obtained the mean body height of 178.3 cm and body mass of 76.8 kg in the Polish national football team. Slightly lower values were also obtained in the group of the best Polish weightlifters – 166.9 [19] and hockey players – 174.5 cm and 73 kg [20].

On the example of combat sports extensive scientific research confirms the general trend in body composition development revealed in this study, which points to well-built competitors with athletic body composition with a more masculine build [6,15,21].

Competitors of the Polish national modern pentathlon team are characterised by a much greater value of the forearm perimeter and the upper extremity length in comparison to non-training persons. In the case of athletes, surprising is also a greater value of the fat content (0.33Z) than in non-training persons. The difference between these groups is statistically significant. Probably such body composition in pentathletes is connected with the nature of effort in this sports discipline. The dominance of technical events and the fact of using sports equipment (épée, pistol) may influence the athletes' somatic build.

Pentathletes are the most similar to the control group in the overall body size. Still, the greatest advantage of the athletes is manifested in the length factor. Studies carried out on a group of national tennis team representatives [22] showed that the slightest differences in body composition (in comparison to students of Warsaw Technical University) regarded the fat content and the overall body size factors. The length factor proved to be the most distinguishing feature of the tennis players. The results of studies on Polish representatives in judo and wrestling [15,16] require a more complex comparative analysis. Taking the specificity of these sports disciplines into consideration (competing in strictly specified weight categories) one can conclude that Polish modern pentathlon representatives are the most similar in their body composition to judokas and wrestlers from mid-weight categories. In the other categories the differences are significant and concern all composition factors.

Natural indices of body composition factors of Polish national team competitors in modern pentathlon indicate their harmonious build – the code of internal proportions is 5-4-4. This is also confirmed by a low value of the intrapersonal variability index. With regard to the harmoniousness of the composition, pentathletes exceed both tennis players [23] and Polish national judo [15] and wrestling [16] representatives. The results of studies on pentathletes do not confirm, however, the tendencies revealed in Łaska-Mierzejewska's studies [24]. On the example of

sports games she found a tendency in highly-qualified female athletes to be characterised by a significant predominance of one factor over the other ones. National team representatives manifested very high values of the intergroup variability, while the third league athletes, especially volleyball players, had their indices close to zero. Top-class athletes' differentiation of body composition was also found by Claessens et al. [25].

Natural indices of the somatic features within the factors provide very important information on the specificity of body composition in athletes practising modern pentathlon. A marked dominance of the musculature of the forearm is the characteristic feature in the stoutness factor.

The dominance of the upper extremity length over the lower extremity one is apparent among features expressing the length factor. Similar results were obtained on the tennis material [22]. On the one hand, in both these disciplines athletes use sports equipment (a racket in tennis and an épée and a pistol in pentathlon) requiring precision and swiftness of action, which is connected with a firm and secure grip. On the other hand, athletes with distinctly longer upper limbs have a greater reach, which gives them an advantage during a fight.

The results of our studies have proved that, as far as their body composition is concerned, men with successes in modern pentathlon significantly differ from their peers not practising sports (reference to students of Warsaw Technical University) and from athletes practising other sports disciplines.

## Conclusions

Long-term training influence as well as the selection process of the most predisposed athletes have a great impact on the somatic build of the representatives of the Polish national modern pentathlon team. A larger forearm perimeter and the upper extremity length are characteristic features of their body composition. Slightly higher fat content is also noteworthy.

Body proportions of the studied athletes determined by means of indices clearly indicate their build, which is leptosomatic (Rohrer's), more masculine (pelvic-shoulder), with correct body mass (BMI) and average lengths of lower extremities (Manouvrier's).

An analysis of internal proportions of factors of the body composition in the representatives of the Polish national modern pentathlon team revealed differences in particular groups. The athletes' overall body size results from a more than average intensity of length features and the average ones of stoutness and fat content – (5-4-4).

The proportions of somatic features within the length factor show a significant advantage of the upper limb length over the lower one. The input of height features while standing and sitting into the length factor is equal.

Within features reflecting the stoutness factor, there is a marked dominance of the forearm musculature. The least proportional are the knee width (-0,33) and the shank perimeter (-0,32). The contribution of the remaining features of the factor is relatively proportional.

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