Properties of body composition of female representatives of the Polish national fencing team – the sabre event

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ABSTRACT: Fencing is a combat sport whose form of direct confrontation involves hitting the opponent with a weapon. The purpose of the study was to determine the properties of body composition of female representatives of the Polish national fencing team. The study involved 11 female athletes of the Polish national fencing team. Their age was 16-22 years (19±2.32), body weight 52-78 kg (59.7±7.4), body height 158-183 cm (167.46±6.10) and the training experience 7.64±3.47 years. The reference group consisted of 153 students of Warsaw University of Technology (Poland). Twenty basic somatic characteristics were measured. The following indices were calculated: slenderness, Rohrer’s, BMI, Manouvrier’s, and pelvic-shoulder indices. Density of the body, total body fat, active tissue, the overall profile of body composition and internal proportions of the body were determined. Analysis of internal proportions of factors of the athletes’ body composition revealed significant differences in particular groups of features. The total size of the athletes’ bodies is due to less-than-average magnitude of the length and stoutness characteristics and a high magnitude of adiposity (M = 0.63) in the Polish female national team of fencers (sabre) calculated from the normalized values for the control group. The proportions of features within the analysed factors revealed a significant advantage of the length of the upper extremity over the lower one and a distinct advantage of forearm musculature. The specific profile of body composition of female athletes practising sabre fencing is most likely due to long-term effects of training as well as the system of selection of persons with specific somatic prerequisites developed in the course of many years of training practice.


Received: 2017-04-02; Reviewed: 2017-04-28; Re-submitted: 2017-05-03; Accepted: 2017-05-03; Published: 2017-10-08.

INTRODUCTION

Anthropologists’ current research attests that body composition is one of the elements differentiating athletes from people not regularly involved in sport [1–4]. The differences in body composition – in many cases even extreme ones – also refer to athletes varying in terms of the practised sports disciplines [5–7].

The conclusions of numerous studies support the claim that with an increase in training experience (typically also in the level of sports mastery), there is a reduction in the diversity of morphological features. It is for this reason that studies of athletes belonging to the world’s elite in a particular sport provide the most accurate information on intrinsic properties of their body composition [8–16].

The issue is gaining importance in combat sports – particularly in fencing. Many experts share the view that the type of body composition in combat sports is primarily associated with an individual combat style and the choice of techniques [17–19]. The knowledge of internal proportions of the body provides extremely relevant information. As the existing scientific publications confirm, knowledge of these proportions constitutes an important collection of empirical data about athletes [20–22].

Starting with these general premises and assumptions, we adopted the properties of body composition of female athletes from the Polish national fencing team in comparison to young women from the same population (reference group) who do not practise sport professionally as the main subject of the research. The precise purpose of the research is to answer the following questions:

– Is the body composition of women who practise fencing professionally determined by any specific somatic characteristics?
– Are internal proportions of body composition of women who practise fencing professionally characterized by a certain distinctiveness not revealed in the female population practising other sports and/or who do not train?

MATERIALS AND METHODS

The study involved 11 female athletes of the Polish national fencing team. Their age was 16-22 years (19±3.2 years), body weight 52-78 kg (59.7±7.4), body height 158-183 cm (167.46±6.10) and the training experience 7.64±3.47 years, and it was significantly diverse (V% = 45.47). The measurements were carried out during the national team camps in Spała (Poland).

The measurements were carried out in accordance with the adopted rules [23], using standard anthropometric tools. In addition, five indices were calculated: slenderness, Rohrer’s, Quetelet’s II, Manouvrier’s, and pelvic-shoulder indices.

Total body fat as a percentage of the body weight was calculated according to Brożek and Keks’s formula [24], and the body density on the basis of the measurement of subcutaneous fat, using Piechaczek’s anticipating formula [25]. A total of 20 measurements of basic somatic characteristics were carried out.

The profile of the representatives’ body composition was established by means of the feature standardization method. The reference group consisted of 153 students of Warsaw University of Technology [26].

Assessment of internal proportions of body composition (herein-after referred to as composition) was made by Perkal’s natural indicators method [27] with Milicerowa’s modifications [20]. In order to do this, the following were specified:
- composition factors m – by summing up the standardized values within each factor and dividing the sum by the number of features identifying the given factor. The adiposity factor, which is a standardized value of skin and fat folds: Z = m, is an exception.
- the total body size indicator (M) of the group: 
  \[ M = m_1 + m_2 + m_3 / 3 \];
- the assessment of internal proportions of body composition was made by calculating Perkal’s natural indicators for each composition factor: 
  \[ m_1 - M; m_2 - M; m_3 - M \];

– the evenness of the composition was determined by means of the intra-personal variability index – the difference between the natural indicator with the highest numerical value and the natural indicator with the lowest value;
– the code of internal proportions of the group was determined on the basis of the point scale of Perkal’s natural indicators (Table 1);
– the assessment of internal proportions of the composition features within each of the factors was made by taking away the value of the m factor from the standardized features.

RESULTS

Mean values of the studied fencing athletes’ features show the lowest variation for the body density (V% = 0.72) and the slenderness index (V% = 2.45). The greatest variability was found in relation to the forearm perimeter (V% = 15.36) and the body weight (V% = 12.8) (Table 2).

A characteristic feature of fencing female athletes’ body composition is a significant content of adipose tissue (the difference in comparison to female students: 1.17 of the standardized value Z) and, directly connected with this, significantly lower body density and mass of the active tissue (−2.33 Z and −1.17 Z, respectively).

<table>
<thead>
<tr>
<th>No.</th>
<th>Composition characteristics</th>
<th>Somatic indices</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>1</td>
<td>Standing body height [cm]</td>
<td>167.46</td>
</tr>
<tr>
<td>2</td>
<td>Sitting body height [cm]</td>
<td>88.75</td>
</tr>
<tr>
<td>3</td>
<td>Upper extremity length [cm]</td>
<td>72.38</td>
</tr>
<tr>
<td>4</td>
<td>Lower extremity length [cm]</td>
<td>78.72</td>
</tr>
<tr>
<td>5</td>
<td>Shoulder width [cm]</td>
<td>35.54</td>
</tr>
<tr>
<td>6</td>
<td>Pelvis width [cm]</td>
<td>27.94</td>
</tr>
<tr>
<td>7</td>
<td>Elbow width [cm]</td>
<td>8.88</td>
</tr>
<tr>
<td>8</td>
<td>Knee width [cm]</td>
<td>8.92</td>
</tr>
<tr>
<td>9</td>
<td>Forearm perimeter [cm]</td>
<td>23.85</td>
</tr>
<tr>
<td>10</td>
<td>Shank perimeter [cm]</td>
<td>36.23</td>
</tr>
<tr>
<td>11</td>
<td>Body weight [kg]</td>
<td>59.73</td>
</tr>
<tr>
<td>12</td>
<td>Body density [-]</td>
<td>1.03</td>
</tr>
<tr>
<td>13</td>
<td>Adipose tissue [%]</td>
<td>27.05</td>
</tr>
<tr>
<td>14</td>
<td>Active tissue [%]</td>
<td>72.95</td>
</tr>
<tr>
<td>15</td>
<td>Body area [-]</td>
<td>1.67</td>
</tr>
<tr>
<td>16</td>
<td>Slenderness index [-]</td>
<td>43.51</td>
</tr>
<tr>
<td>17</td>
<td>Rohrer’s index [-]</td>
<td>1.27</td>
</tr>
<tr>
<td>18</td>
<td>BMI index [-]</td>
<td>21.24</td>
</tr>
<tr>
<td>19</td>
<td>Manouvrier’s index [-]</td>
<td>88.76</td>
</tr>
<tr>
<td>20</td>
<td>Pelvic-shoulder index [-]</td>
<td>78.93</td>
</tr>
</tbody>
</table>

TABLE 1. Point scales of Perkal’s natural indicators.

<table>
<thead>
<tr>
<th>Points</th>
<th>Values of Perkal’s natural indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>X to −1.07</td>
</tr>
<tr>
<td>2</td>
<td>−1.06 to −0.57</td>
</tr>
<tr>
<td>3</td>
<td>−0.56 to −0.18</td>
</tr>
<tr>
<td>4</td>
<td>−0.19 to 0.18</td>
</tr>
<tr>
<td>5</td>
<td>0.19 to 0.57</td>
</tr>
<tr>
<td>6</td>
<td>0.58 to 1.06</td>
</tr>
<tr>
<td>7</td>
<td>1.07 to X</td>
</tr>
</tbody>
</table>

TABLE 2. Characteristics of body composition in female athletes from the Polish national fencing team (N = 11).
Properties of female body composition of national fencing team

Fencers exceed non-training women in circumference of the forearm by 1.69 Z, in the upper extremity length by 0.53 Z. In terms of the elbow width, athletes are inferior to students by 0.43 Z (Figure 1).

Body proportions of the studied athletes, identified by means of the indicators, clearly show their athletic (Rohrer’s index), more masculine build (the pelvic-shoulder index), with normal weight (BMI) and average length of the lower extremities (Manouvrier’s index).

The values of body composition factors confirm in a more generalized way the observations based on standardised values of individual characteristics. A high value of the adiposity factor \(m_3 = 1.36\) in the overall body size \(M = 0.63\) is a very distinctive trait in women training in fencing. The length factor \(m_1 = 0.27\) and the stoutness factor \(m_2 = 0.26\) are also slightly higher.

Analysis of the mutual proportions between athletes’ composition factors (natural indicators of the factors) reveals their clear diversity – the value of the intra-group variability index is 1.14 (Table 3).

A significant content of adipose tissue and proportionally low values of stoutness and length features are the characteristic elements of such a composition.

In accordance with the point scale of Perkal’s natural indicators, the code of internal proportions of female fencing athletes is as

<table>
<thead>
<tr>
<th>Natural indicators</th>
<th>Indicator value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (m_1)</td>
<td>– 0.36</td>
</tr>
<tr>
<td>Stoutness (m_2)</td>
<td>– 0.37</td>
</tr>
<tr>
<td>Adiposity (m_3)</td>
<td>0.77</td>
</tr>
<tr>
<td>Intra-group variability</td>
<td>1.14</td>
</tr>
</tbody>
</table>

TABLE 3. Natural indicators of the composition factors of female athletes from the Polish national fencing team (N = 11).

FIG 1. Composition profile of 11 female athletes from the Polish national fencing team (0 axis – results of the reference group).

FIG 2. Natural indicators of somatic traits within the length and the stoutness factor in female athletes from the Polish national fencing team (N = 11).
follows: 3-3-6. This means that the total body size (M) is due to lower-than-average values of body height and stoutness and high adiposity values.

Among the features expressing the length factor, the advantage of upper extremity length (0.27) over lower extremity length (−0.13) comes to the fore. The contribution of standing and sitting body heights to the length factor is equal. Within the stoutness factor there is a clear advantage of forearm musculature (1.43). The elbow width (−0.69) and the shoulder width (−0.52) remain disproportionate to the overall value of the factor. The contribution of the other characteristics of the factor is relatively proportional (Figure 2).

DISCUSSION

Properties of body composition of female athletes from the Polish national fencing team (the sabre event) revealed in the course of the study are a result of two processes: on the one hand, sports selection and, on the other hand, the effect of body adaptation to external factors (training) affecting it.

The average body height of representatives of Poland in fencing was 167 cm and weight 60 kg, and in this respect they did not differ statistically significantly from a comparative group (students of Warsaw University of Technology). However, Warsaw University of Technology students are characterized by the highest indicators of biological development among the Polish academic youth [26].

There are larger differences in relation to women training in other sports disciplines. For example, the average body height of female representatives of Poland in tennis was 172 cm and body weight 60 kg [28]. Slightly lower values of these features characterize the best Polish female judokas (168 cm and 66 kg [11]) and female wrestlers (166 cm and 62 kg [29]).

Previous research on women training in combat sports confirms the overall specificity of body composition, as also revealed in our research. Female athletes are well muscled, with an athletic, more masculine body structure [30-32]. In the case of fencers, there is much greater adiposity than in individuals not involved in training. The difference between these groups is statistically significant. Proboszczowicz et al. [16] drew attention to this regularity in studies of body composition factors empirically determined for female tennis players [28].

Observations of Polish representatives in tennis [28] confirm the similarity of these dependences.

A common element of sports activity in fencing and in tennis is that athletes use specialized equipment (sabre, racket) with one hand (fencing) or mainly with one hand (tennis). On the one hand, in both these disciplines athletes use sports equipment which requires precision and speed, which is associated with a strong and reliable grip. On the other hand, it needs to be stressed again that athletes with clearly longer upper extremities are in a sense at an advantage during the fight. Despite this similarity, the code of internal proportions of body composition factors empirically determined for female tennis players is 6-2-4 [34]. It is a reverse of this characteristic established for women training in sabre fencing. Another factor differentiating the body build of fencers is the various fencing weapons [35].

CONCLUSIONS

Body proportions of female fencers specializing in the sabre event clearly indicate their athletic (Rohrer’s index), more masculine build
(pelvicShoulder index) with normal weight (BMI) and an average length of lower extremities (Manouvrier’s index). In addition, a characteristic feature of their body composition is a greater forearm perimeter and the length of the upper extremity and a high content of adipose tissue.

A specific distinctiveness of women specializing in this fencing event is their adiposity in comparison to non-training women or those training in judo, wrestling and tennis.

The proportions of somatic features within the length factor show an important advantage of the upper extremity length over the lower extremity. Among characteristics reflecting the stoutness factor there is a clear advantage of forearm musculature.

This specific profile of body composition of athletes training in sabre fencing is most likely due to the long-term effects of training as well as the system of selection of persons with specific somatic prerequisites developed in the course of many years of training practice.

**Conflict of interest:** Authors have declared that no competing interest exists.

**REFERENCES**


