

# 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 ( $19 \pm 2.32$ ), body weight 52-78 kg ( $59.7 \pm 7.4$ ), body height 158-183 cm ( $167.46 \pm 6.10$ ) and the training experience  $7.64 \pm 3.47$  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.

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## 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 ( $19 \pm 2.32$ ), body weight 52-78 kg ( $59.7 \pm 7.4$ ), body height 158-183 cm ( $167.46 \pm 6.10$ ) and the training experience  $7.64 \pm 3.47$  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 (hereinafter 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:  $m_1 - M$ ;  $m_2 - M$ ;  $m_3 - M$ ;

**TABLE 1.** Point scales of perkal's natural indicators.

Points	Values of Perkal's natural indicators
1	X to -1.07
2	-1.06 to -0.57 values less than average
3	-0.56 to -0.18
4	-0.19 to 0.18 average value
5	0.19 to 0.57
6	0.58 to 1.06 values greater than average
7	1.07 to X

- 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).

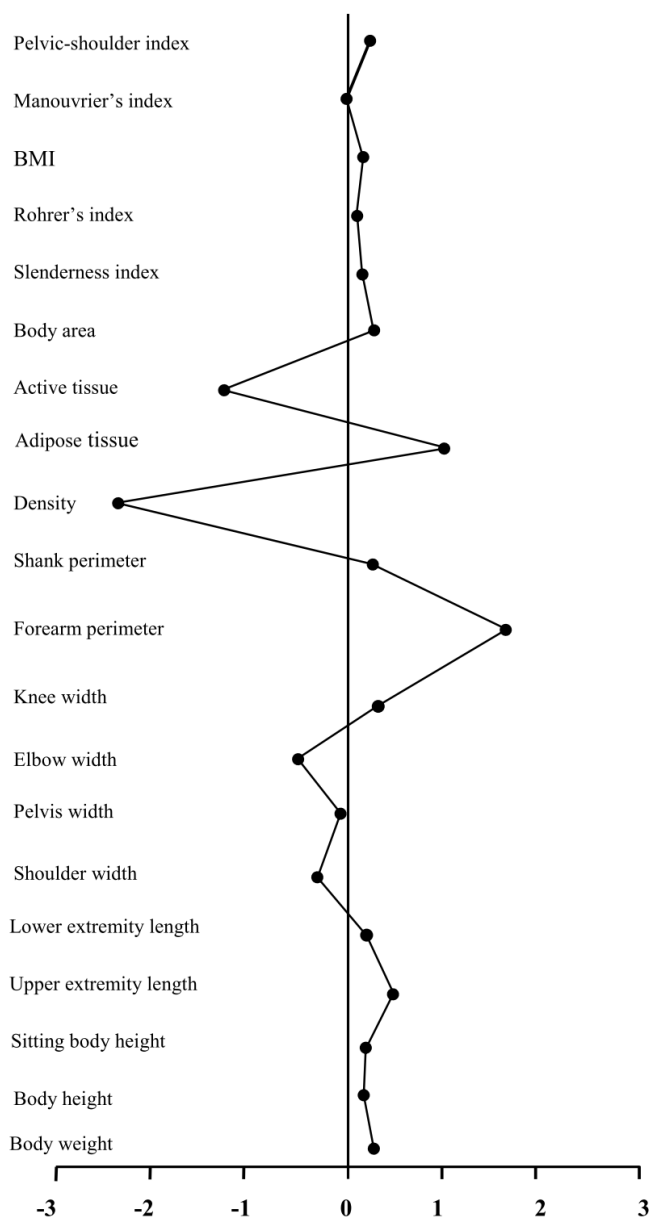
A characteristic feature of fencing female athletes' body composition is a significant content of adipose tissue (the difference in comparison to female students: 1.17 of the standardized value Z) and, directly connected with this, significantly lower body density and mass of the active tissue (-2.33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

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

No.	Composition characteristics	Somatic indices		
		X	SD	V%
1	Standing body height [cm]	167.46	6.10	3.64
2	Sitting body height [cm]	88.75	3.29	3.71
3	Upper extremity length [cm]	72.38	3.21	4.44
4	Lower extremity length [cm]	78.72	4.19	5.33
5	Shoulder width [cm]	35.54	1.75	4.93
6	Pelvis width [cm]	27.94	1.43	5.11
7	Elbow width [cm]	5.88	0.45	7.60
8	Knee width [cm]	8.92	0.745	8.39
9	Forearm perimeter [cm]	23.85	3.66	15.36
10	Shank perimeter [cm]	36.23	2.25	6.21
11	Body weight [kg]	59.73	7.39	12.38
12	Body density [-]	1.03	0.007	0.72
13	Adipose tissue [%]	27.05	2.92	10.70
14	Active tissue [%]	72.95	2.92	4.00
15	Body area [-]	1.67	0.13	7.65
16	Slenderness index [-]	43.51	1.06	2.45
17	Rohrer's index [-]	1.27	0.09	7.20
18	BMI index [-]	21.24	1.57	7.38
19	Manouvrier's index [-]	88.76	4.73	5.33
20	Pelvic-shoulder index [-]	78.93	4.43	5.62

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

Natural indicators	Indicator value
Length ( $m_1$ )	- 0.36
Stoutness ( $m_2$ )	- 0.37
Adiposity ( $m_3$ )	0.77
Intra-group variability	1.14



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

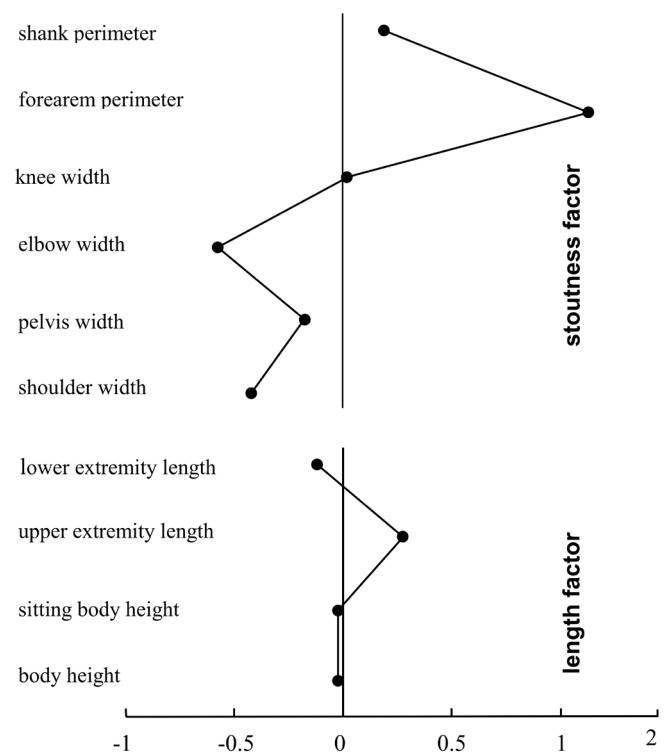
Fencers exceed non-training women in circumference of the forearm by 1.69 Z, in the upper extremity length by 0.53 Z. In terms of the elbow width, athletes are inferior to students by 0.43 Z (Figure 1).

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



**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 of the most talented girls 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. Probably the composition of the best Polish fencers is associated with the nature of effort in this sports discipline. Short-term very intense effort sequences characteristic of a fencing fight are carried out in anaerobic metabolism; hence there is little importance of fat as an energy source.

Polish representatives in fencing are the most similar to the control group in the following factors of composition: stoutness and length. The greatest distinctiveness of these athletes, however, is revealed in terms of adiposity with a simultaneously larger overall body size. Research on Polish representatives in tennis [28] showed that the smallest differences in body composition (with reference to female students of Warsaw University of Technology) related to indicators of length.

A comparative analysis of the results of research on these phenomena in representatives of Poland in judo and wrestling is more

complex [11,29,33]. In view of the specificity of these sports disciplines (competition in strictly specified weight categories), one is entitled to conclude that Polish representatives in fencing are the most similar in their composition to judokas and wrestlers of medium weight categories. The code of internal proportions of the factors (length-stoutness-adiposity) in women specializing in sabre fighting is 3-3-6, while in those representing medium-weight categories in judo it is 4-4-4 [11] and in wrestling 3-5-4 [33]. In other categories, this differentiation is already significant and refers to all body composition factors. However, code 6 (internal proportion factors referring to adiposity) is a specificity that is exclusively characteristic of Polish female representatives in sabre fencing. Natural indicators of composition factors clearly indicate that adiposity is the feature (with a high intra-group variability index) which most characterizes the Polish national team fencers' body composition. The wide diversity of composition may result from the athletes' very high sports level.

Łaska-Mierzejewska's research [21] on women training in team sports games clearly confirms this trend – female athletes with high sports qualifications exhibit a very significant advantage of one factor over others. National team players were characterised by high values of the intra-group variability index, and the third division players, especially of volleyball, had indices close to zero.

Also Claessens *et al.* [13] drew attention to this regularity in studies on the diversity of body composition in female gymnasts depending on their sports level. Gymnasts are distinguished by a very slim body build or a light weight in relation to their height. Athletes with the highest sports level exhibited greater slenderness than women with lower levels.

In considering the stoutness factor (i.e. averaged values of the somatic traits described as "width" and "circumference" adopted in this study), the clear advantage of forearm musculature is a characteristic feature. A distinct advantage of the upper extremity length over the lower extremity length is a property of the length factor. 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

(pelvic-shoulder 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 low-

er 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

- Carter JL. The Somatotypes of Olympic Athletes. Presented paper 1978;(13).
- Carter JEL, Heath BH. Somatotyping: development and applications. Cambridge Studies in Biological Anthropology. Cambridge-NewYork-Port Chester-Melbourne-Sydney, Cambridge University Press; 1990.
- Hattori K, Tatsumi N, Tanaka S. Assessment of body composition by using a new chart method. *Am J Hum Biol.* 1997;9:573-8.
- Raschka C. Sportanthropologie: Leitfaden der modernen, vergleichenden Sportanthropologie, Sportanthropometrie und trainingsrelevanten Konstitutionbiologie. 1st ed. Köln: Sportverlag Straus; 2006.
- Tanner JM. The physique of the Olympic athlete. London; 1964.
- Garay AIL Levine L, Carter JEL. Genetic and Anthropological studies of Olympic Athletes, Academic Press, New York-San Francisco-London; 1974.
- Leake CN, Carter JEL. Comparison of body composition and somatotype of trained female triathletes. *J Sport Sci.* 1991;9(2):125-135.
- Farmosi I. Body composition, somatotype and some motor performance of judoists. *J. Sports Med.* 1980;20:431-434.
- Skład M, Krawczyk B, Majle B. Effects of an intense annual training on body components and other somatic traits in young male and female rowers. *Biol Sport.* 1993;4:239-243.
- Baxter-Jones ADG, Helms P, Maffulli N et al. Growth and development of male gymnasts, swimmers, soccer and tennis players: a longitudinal study. *Ann Hum Biol.* 1995;5:381-394.
- Jagiello W, Kalina RM, Korobielnikow G, Morphological diversification of female judo athletes. *Arch Budo.* 2007;3(3):27-34.
- Jagiello W, Differentiation of the body build in judo competitors of the men's Polish national team. *Arch Budo.* 2013;9(2):117-125.
- Jagiello M, Jagiello W. Internal proportions of body composition in women practising modern pentathlon. *Arch Budo Sci Martial Arts Extreme Sport.* 2014;10:11-16.
- Jagiello W, Wolska B, Sawczyn S, Dornowski M. The similarity of training experience and morphofunctional traits as prediction criteria of the sports level in the subsequent stages of long-term women's judo training. *Arch Budo.* 2014;10:201-210.
- Sawczyn S, Jagiello W, Fetisov Vi, Mishchenko Vs. Dependence of work capacity recovery after strenuous training sessions upon individual predisposition of skilled wrestlers to work under different energy modes. *Arch Budo.* 2015;11:197-207.
- Jagiello W. Differentiation of the body composition in taekwondo-ITF competitors of the men's Polish national team and direct based athletes. *Arch Budo.* 2015;11:329-338.
- Tumanian GC, Martirosow EG. Tietoslozenie i sport. Fizkultura i sport. Moskwa; 1976.
- Marchocka M, Nowacka E, Sikorki W. Specific body build of judo athletes depending on the fighting technique used. *Biol Sport.* 1984;3-4:261-264.
- Socha M, Witkowski K, Jonak W et al. Body composition and selected anthropometric traits of elite Polish female judokas in relation to the performance of right-dominant, left-dominant, or symmetrical judo techniques in vertical posture (tachi waza). *Arch Budo.* 2016; 12:257-26.
- Milicerowa H. The use of Perkal's indicators in the characteristics of boxers' body build. *Materiały i Prace Antropologiczne* 1956; 20.
- Łaska-Mierzejewska T. Body build as one of the element of selection and adaptation of competitors in team games. In: Ostyn M, Beunen G, Simons J, editors. *Kinantropometry II: International Series on Sport Sciences.* Baltimore: University Park Press; 1980: p. 214-21.
- Jagiello W, Jagiello M. Wnutenrennyje proporcji strojenia tela czlenow mužskoj sbornoj komandy Polshi po tennisu. *Pedagogika, psychologija ta mediko-biologiczni problemi fizycznego wicowanija i sportu. Zb. nauk. Prac pid red. Ermakowa SS, Charków: HDADM (XXIII); 2006:141-145.*
- Claessens AL, Malina RM, Lefevre J et al. Growth and menarcheal status of elite female gymnasts. *Med Sci Sports Exerc.* 1992;755-763.
- Brożek J, Keys A. The evaluation of leanness fatness in man. Norm and interrelationships. *Brit J Nutr.* 1949;5:194-206.
- Piechaczek H. Oznaczanie całkowitego tłuszczu ciała metodami densytometryczną i antropometryczną. *Materiały i Prace Antropologiczne.* 1975;89:3-48.
- Piechaczek H, Lewandowska J, Orlicz B. Zmiany budowy ciała młodzieży akademickiej Politechniki Warszawskiej w okresie 35 lat. *Wych Fiz Sport.* 1996;3:3-14.
- Perkal J. O wskaźnikach antropologicznych. *Przegląd Antropol.* 1953;19:209-211.
- Jagiello M. Profil strojenija tela żeńskiej sbornoj komandy Polshi po tennisu. *Pedagogika, psychologija ta mediko-biologiczni problemi fizycznego wicowanija i sportu. Zb. Nauk. Prac Pid Red. Ermakowa SS, Charków: HDADM (XXIII); 2005: 135-139.*
- Jagiello W, Kruszewski A, Wolska B. Zróźnicowanie morfologiczne reprezentantek Polski w zapasach. XVI Międzynarodowa Konferencja Naukowo-Metodycznej – Kierunki doskonalenia treningu i walki sportowej. Program. Spała, 26-28 XI 2007.
- Skład M, Krawczyk B, Majle B. Body build factors and body components in greco-roman and free-style wrestlers. *Biol Sport.* 1995;2:101-105.

31. Jagiełło W, Kalina RM, Tkaczuk W. Morphological differentiation of judo competitors. In: SZOPA J, GABRYŚ T, editors. Sport training in interdisciplinary scientific researches. Faculty of Management Technical University of Czestochowa. Czestochowa; 2004:200-206.
32. Durkalec-Michalski K, Podgórski T, Sokołowski M *et al.* Relationship between body composition indicators and physical capacity of the combat sports athletes. *Arch Budo*. 2016;12:247–256.
33. Jagiełło W, Kruszewski A. Morfologiczne aspekty poziomu sportowego zawodniczek uprawiających zapasy. In: Kuder A, Perkowski K, Śledziwski D, editors. *Proces doskonalenia treningu i walki sportowej*. Warszawa; 2005:98-100.
34. Jagiełło M, Jagiełło W. Internal proportions of the body composition in members of the female national tennis team of Poland. *Ugdymas. Kuno Kultura. Sportas* 2009; 2:28-34.
35. Sterkowicz-Przybycień K. Body Composition and somatotype of the elite of Polish fencers. *Coll. Antropol* 2009;33(3):765–772.