

# Internal proportions of body composition in women practising modern pentathlon

## Authors' Contribution:

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

**Marina Jagiełło<sup>ABCD</sup>, Władysław Jagiełło<sup>ABCDE</sup>**

Faculty of Physical Education, Gdańsk University of Physical Education and Sport in Gdansk, Poland

**Source of support:** Departmental resources

**Received:** 11 October 2013; **Accepted:** 20 January 2014; **Published online:** 03 February 2014

**ICID:** 1089244

## Abstract

<b>Background &amp; Study Aim:</b>	Athletes belonging to the world elite in a particular sport, provide the most accurate information on intrinsic properties of their body composition. Knowledge of internal proportions of the body plays an important role in the assessment of athletes' body composition. The purpose of the study was the properties of body composition in athletes of the Polish national team in modern pentathlon in comparison to members of the same population not professionally engaged in sport.
<b>Material &amp; Methods:</b>	Eleven female athletes of the Polish National Team in modern pentathlon were tested. The competitors were 18-35 years old ( $23.37 \pm 5.2$ ), their body weight was from 54-65 kg ( $59.4 \pm 3.6$ ) and the body height 160-180 cm ( $170.2 \pm 5.6$ ). The athletes' training experience was 6-20 years ( $12.4 \pm 4.4$ ). One hundred and fifty female students of Warsaw University of Technology (Poland) constituted the reference group. Internal proportions of body composition were assessed by means of Perkal's natural indicators.
<b>Results:</b>	An analysis of internal proportions of factors of athletes' body composition revealed significant differences in individual groups of features. The total volume of the athletes' bodies results from low intensity of stoutness features and even one of length and of adiposity. The proportions of features within the analysed factors showed a distinct advantage of the length of the upper extremity over the sitting body height (the length factor) and the domination of musculature of the forearm (the stoutness factor).
<b>Conclusion:</b>	The specific profile of body composition in athletes practising modern pentathlon is most likely due to the long-term effects of training as well as the system of selection of persons with specific somatic predisposition developed in the course of many years of training practice.
<b>Author's address:</b>	Władysław Jagiełło, Department of Sport, Faculty of Physical Education, University of Physical Education and Sports, K. Gorskiego 1, 80-336 Gdansk, Poland; e-mail: wjagiello1@wp.pl
<b>Key words:</b>	combat sport (fencing) • Perkal's method • Perkal's natural indicators

**The modern pentathlon** – an Olympic sport that comprises five events: fencing, 200 m freestyle swimming, show jumping, and a final combined event of pistol shooting, and a 3200 m cross-country run. The sport has been a core sport of the Olympic Games since 1912, and since 1949 an annual World Championship has been held [19]

**INTRODUCTION**

Anthropologists' current research confirms the fact that body composition constitutes one of the elements of differentiating athletes from people not involved in sport regularly [1-3]. Differences in body composition – in many cases even extreme ones – also regard athletes differing in terms of practiced sports [4, 5].

This is why research on athletes belonging to the world's elite in a particular sports discipline provides the most accurate information on intrinsic properties of their composition [6, 7]. Knowledge of internal proportions of the body plays an important role in the assessment of athletes' body composition.

These issues gain a particular importance in pentathlon, a sports discipline with various fitness and technical demands. With these general assumptions in mind, the main aim of the study was the properties of body composition in athletes of the Polish national team in modern pentathlon in comparison to members of the same population (a reference group) not professionally engaged in sport and to settle the following questions:

What factors of body composition determine the athletes' specific body build?

What internal proportions of body composition are characteristic of them?

**MATERIAL AND METHODS**

The research involved representatives of the Polish national team in modern pentathlon (n=11). The competitors' age was 18-35 years (23.37 ± 5.2), their body weight 54-65 kg (59.4 ± 3.6) and the body height 160-180 cm (170.2 ± 5.6). The athletes' training experience was 6-20 years (12.4 ± 4.4).

Assessment of internal proportions of body composition (further referred to as composition) was made by Perkal's natural indicators method [23] with Milicerowa's modifications [16]. 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.

**Table 1.** Point scales of Perkal's natural indicators

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

The reference group consisted of 153 students of Warsaw University of Technology [10].

**RESULTS**

Athletes' somatic features indicate differences in their physique in comparison to the group of girls not practising sport (Tab. 2). A characteristic feature of body composition in the Polish representatives in modern pentathlon is a considerable forearm circumference (in this respect they outweigh their peers not practising sports by 1.49 of the standardised value *Z*) and in the length of the upper extremity (1.46*Z*). Noteworthy is also the thickness of skin and fat folds measured on the abdomen, under the lower angle of the scapula and the arm (55.2 mm) – in this respect they outweigh the non-training girls by 0.85*Z*.

The values of body composition factors confirm in a more generalized terms the observations about values of individual standardised features. In terms of body stoutness female pentathletes are the most similar to the control group ( $m_2 = 0.09$ ). The factor distinguishing female pentathletes the most is the adiposity factor ( $m_3 = 0.85$ ) – Table 3.

**Table 2.** Standardised somatic features of the Polish representatives in modern pentathlon (n=11)

Factors	Feature	Female students of Warsaw Technical University, n=153[10]		Female pentathletes, n=11	Standardised value
		x	s	x	z
<b>m<sub>1</sub></b> <b>length</b>	standing body height, cm	166.23	6.2	170.14	0.63
	standing body height, cm	88.1	3.18	89.46	0.43
	upper extremity length, cm	70.67	3.2	75.34	1.46
	lower extremity length, cm	78.14	4.09	80.67	0.62
<b>m<sub>2</sub></b> <b>stoutness</b>	shoulder width, cm	35.96	1.62	36.53	0.35
	pelvis width, cm	27.98	1.46	27.73	-0.17
	elbow width, cm	6.01	0.3	4.89	-0.40
	knee width, cm	8.81	0.43	8.59	-0.51
	forearm circumference, cm	22.36	1.42	24.48	1.49
	shank circumference, cm	35.32	2.66	34.78	-0.20
<b>m<sub>3</sub></b> <b>adiposity</b>	thickness of 3 skin and fat folds, mm	42.5	15	55.2	0.85

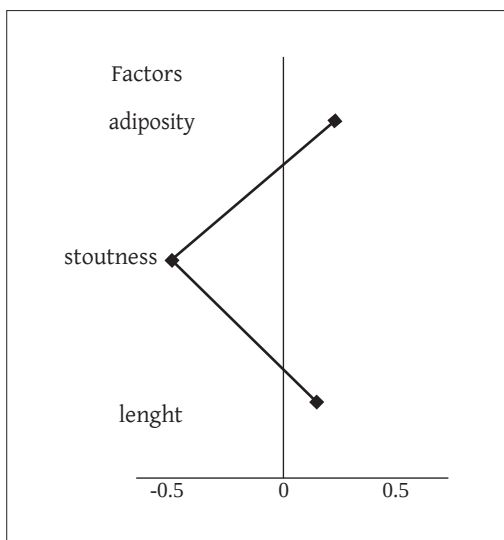
**Table 3.** Factors of body composition of female Polish representatives in modern pentathlon (n = 11)

Factors	Length m <sub>1</sub>	Stoutness m <sub>2</sub>	Adiposity m <sub>3</sub>	Total body size factor M
	0.78	0.09	0.85	0.58

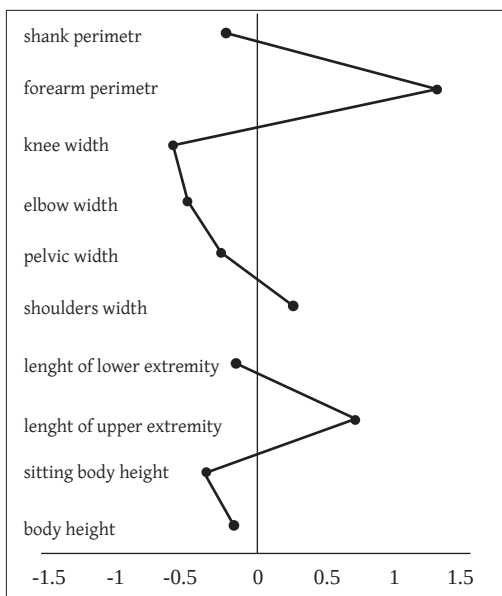
An analysis of mutual proportions of body composition in female pentathletes points to their small diversity – the intragroup variability index amounts to 0.75. A distinctive characteristic of such a composition are the stoutness features (-0.48). The contribution of length (0.21) and fat (0.27) features is the most proportionate (Figure 1).

Using the point scale of Perkal’s natural indicators [8], the following code of the athletes’ internal proportions was obtained: 4-1-4. This means that the total body size (M) is due to slightly larger than average values of body length and adiposity and very low ones of stoutness.

Calculation of internal proportions of composition features within each of the factors provides very important information on the body composition of athletes in the Polish national modern pentathlon team. In the features expressing the length factor there is a clear advantage of the upper extremity length (0.67) over the body height while sitting (-0.36). The contribution of characteristics of the body height while standing and the lower extremity length to the length factor is more even (Figure 2).



**Figure 1.** Natural indicators of body composition in female Polish representatives in modern pentathlon (n=11)



**Figure 2.** Natural indicators of somatic features within the factors in Polish female representatives in pentathlon (n=11)

Within the features reflecting the stoutness factor there is a clear advantage of the forearm musculature (1.40). The knee (-0.60) and elbow (-0.49) widths are the least proportionate to the overall value of the factor. The contribution of the remaining features of the factor is relatively proportionate.

**DISCUSSION**

The most commonly used method of assessing athletes’ body composition are so-called somatotypes

(patterns of specific types of body composition, characterized by means of several significantly different factors). Among many typologies used in anthropology, Sheldon’s somatotypology is the most widely used [11] and has gone through numerous modifications improving the objectivity of its evaluation, such as Heath’s and Carter’s [12].

Perkal’s natural indicators method [8] has a high relevance in the assessment of body composition, especially in the case of athletes. It allows characterizing internal proportions of body composition of each individual or group of individuals. It allows selecting such features of which we know that they are of major importance in a given sport or whose utility we want to check. Also the number of factors and their types may vary. Because the calculations are conducted on standardised values, we can specify, for example, the suitability of a candidate or a player to a given discipline from the point of view of his/her body composition (the national team in the discipline will constitute the reference group), or the body composition of individual players in comparison to the whole team.

Polish official representatives in fencing are the most similar to the control group in the stoutness and length factors. The greatest distinctiveness of this group, however, appears in terms of adiposity with simultaneously increased total body size (M = 0.58). Studies of Polish representatives in tennis [13] showed similar trends. The code of female tennis players’ internal proportions amounted to 6-2-1, and it was higher than the average values in length features and lower in stoutness features and very low in adiposity. The differences between these groups of athletes refer to a larger contribution of adiposity to the total body size of female pentathletes (4-1-4). In the body composition of female tennis players the advantage of the forearm circumference and the body height was also clear. The total body size index in both groups of girls was similar. However, it is pentathletes who represent a more proportional body composition (the intra-group variability is 0.75, and in the case of tennis players 1.4).

A study of internal proportions of Polish representatives (n = 13) in judo revealed slightly different trends [14]. In terms of internal proportions of factors, pentathletes are becoming the most similar to athletes of light-weight categories – the code of internal proportions amounted to 4-4-4, of middle-weight categories 2-6-4, and of heavy-weight categories 2-5-5. Internal proportions of features in the stoutness factor pointed

to a dominance of the forearm circumference and the elbow width. The pelvis width and the shank circumference had a disproportionately small role in female judokas, which was also the case of the shoulders width in heavy-weight categories. In addition, in heavy – and medium-weight categories a distinct advantage of the upper extremity length (the length factor) has also been observed. In terms of the uniformity of composition (the intra-group variability index), female pentathletes are inferior to judokas of light – (0.11) and medium-weight (0.75) categories. They are, in turn, more evenly built than female judokas of heavy-weight categories (1.01).

Results analogous to those of female pentathletes were obtained in studies of the Polish national team in men's pentathlon [15]. Male athletes of the Polish national team in modern pentathlon are characterized by a significantly higher value of the forearm circumference (0.78Z) and of the upper extremity length (0.54Z), and a lower one of the knee width (–0.42Z) in comparison to persons not involved in training. The code of internal proportions amounted to 5-4-4. Hence the greatest differences in internal proportions of factors related to stoutness. However, male pentathletes are more uniformly built (the intragroup variability index amounted to 0.33). In terms of the uniformity of composition, pentathletes surpass both tennis players (1.08) [16] and the Polish representatives in judo (light-weight categories 2.65, middle-weight categories 1.55, heavy-weight categories 4.49) [17] and in wrestling (light-weight categories 0.65, middle-weight categories 1.71, and heavy-weight categories 0.98) [18].

The results of our studies have proved that women successful in modern pentathlon differ significantly in their body composition from peers are not engaged in sport (a reference to students of Warsaw University of Technology) and players representing other disciplines.

## CONCLUSIONS

The specific profile of body composition in athletes practising modern pentathlon is most likely due to long-term effects of training as well as the system for the selection of persons with specific somatic predispositions developed in the course of many years of training practice.

Greater circumference of the forearm, the upper extremity length as well as slightly higher fat tissue content constitute specific distinctiveness of women specializing in this sport

Proportions of somatic features within the length factor show an important advantage of the upper extremity length over the lower one and disproportionately small contribution of the body height while sitting. Among the features reflecting the stoutness factor there is a clear advantage of the forearm musculature and a slight one of the shoulder width.

## ACKNOWLEDGEMENTS

The study was carried out within the research project „Comparative Analysis of Selected Features of Somatic Build and Physical Fitness Karate Fighters As Opposed to Other Sport Groups While Taking into Account Environmental Conditioning”. The study was approved by the Bioethical Commission of the Regional Medical Council in Rzeszów (Poland).

## COMPETING INTERESTS

Authors declare that do not have any financial or personal relationships with other people or organisations that could inappropriately influence paper.

## REFERENCES

- Garay AL, Levine L, Carter JEL. Genetic and Anthropological studies of Olympic Athletes, Academic Press, New York-San Francisco-Londyn; 1974
- Carter JL. The Somatypes of Olympic Athletes; 1978: 13
- Charzewski J, editor. Antropologia. Akademia Wychowania Fizycznego Józefa Piłsudskiego w Warszawie. Warszawa; 1999 [in Polish]
- Marchocka M. Budowa ciała a preferowane techniki walki judo. Sport Wyczynowy 1988; 9: 25-31 [in Polish]
- Łaska-Mierzejewska T. Antropologia w sporcie i wychowaniu Fizycznym. Biblioteka Trenera. Centralny Ośrodek Sportu. Warszawa; 1999 [in Polish]
- Drozdowski Z. Antropologia sportowa: morfologiczne podstawy wychowania fizycznego i sportu. PWN. Warszawa-Poznań; 1984 [in Polish]
- Baxter-Jones ADG, Helms P, Maffulli N et al. Growth and development of male gymnasts, swimmers, soccer and tennis players: a longitudinal study. Annals of Human Biology 1995; 5: 381-394
- Perkal J. O wskaźnikach antropologicznych. Przegląd Anty 1953; 19: 209-211 [in Polish]
- Milicerowa H. The use of Perkal's indicators in the characteristics of boxers' body build. Materiały i Prace Antropologiczne 1956; 20 [in Polish]
- Piechaczek H, Lewandowska J, Orlicz B. Zmiany budowy ciała młodzieży akademickiej Politechniki Warszawskiej w okresie 35 lat. Wychowanie Fizyczne i Sport 1996; 3: 3-14 [in Polish]
- Sheldon WH, Stevens SS, Tucker WB. The varieties of Human Physique. Parper and Grothers, New York; 1940
- Heath B, Carter L. Modified somatotype method. Am J Phys Anthropol 1967; 27(32)
- Jagiello M, Jagiello W. Internal proportions of the body composition in members of the female national tennis team of Poland. Education. Physical Training. Sport. Lithuanian Academy of Physical Education. Kaunas 2009; 2(73): 28-34

14. Jagiełło W, Wolowicz J. Body composition in junior Polish representatives in judo. *Pedagogics, Psychology, Medical-Biological Problems of Physical Training and Sports*. The scientific monography is edited by professor S. Yermakov. Kharkiv 2009; 12: 196-201 [in Russian]
15. Jagiełło W, Kalina RM, Jagiełło M. Differentiation of the Body Composition in the Polish National Team Pentathletes. *Baltic Journal of Health and Physical Activity* 2011; 3(2): 105-111
16. Jagiełło W, Jagiełło M. Internal proportions of body build of the Polish representatives in tennis. *Pedagogics, Psychology, Medical-Biological Problems of Physical Training and Sports*. The scientific monography is edited by professor S. Yermakov. Kharkiv 2006; 5: 141-145 [in Russian]
17. Jagiełło W. Differentiation of the body build in judo competitors of the men's Polish national team. *Arch Budo* 2013; 9(2): 117-123
18. Jagiełło W, Kruszewski A. Morphological Diversification of Competitors Training Greko-Roman Style of Wrestling. *Arch Budo* 2009; 5: 147-153
19. Branch J. Modern Pentathlon Gets a Little Less Penta. *New York Times* 2008

**Cite this article as:** Jagiełło M, Jagiełło W. Internal proportions of body composition in women practising modern pentathlon. *Arch Budo Sci Martial Art Extreme Sport* 2014; 10: 11-16

