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Perkal's natural indicators method in assessing body composition properties in persons practising combat sports – an analysis research results

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C Statistical Analysis
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Abstract

Background & Study Aim: Contemporary scientific research confirms the fact that the body composition is one of the elements distinguishing athletes from persons not practicing sports systematically. Scientists mostly describe the body composition through various typological systems. Among the many typologies used in anthropology, the most widely used is Sheldon's somatotypology (1940), in Heath and Carter's modification (1967). Perkal's method of natural indicators (1953) is also a very interesting but unfortunately little-known in the world method of evaluating the body composition. In this context, the main research objective was to review studies on the assessment of body composition in combat sports using Perkal's natural indicators method. An additional goal was also recommendation of scientists involved in athletes' body composition qualities to the great advantages of this method.

Material & Methods: The basic method of research was an analysis of available literature which covered a period of ten years (2007-2017).

Results: The study found that articles related to the discussed issue were published in six journals. In total, it was 8 articles, the most in Archives of Budo (n = 4) and each remaining in a different journal. This research involved 104 Polish representatives in five sport disciplines.

Conclusions: Because Perkal's natural indicators are calculated from the values of the standardised features (standardised results), this gives a possibility to express all the characteristics in the same and thus comparable values of the same "weight". This opens up opportunities which other typological systems do not offer. It leaves a freedom of choice of such characteristics of which we know that they are of great importance in a particular sport discipline or whose usefulness we want to verify.

Key words: Sheldon's somatotypology • standardised results • typological systems

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INTRODUCTION

Combat sport – *noun* a sport in which one person fights another, e.g. wrestling, boxing and the martial arts [35].

Body composition monitor – *noun* a piece of personal equipment, like a set of bathroom scales, that also measures body [35].

Pentathlon – *noun 1.* same as modern pentathlon *2.* an athletics competition in chich the contestants compete in five different events, usually sprint, hurdles, long jump, discus and javelin. => **triathlon, heptathlon, decathlon** [35].

Modern pentathlon – *noun* an athletics competition in which the contestants compete in five different events and are awarded points for each to find the best all-round athlete. The events are swimming, horse riding, cross-country running, fencing and pistol shooting [35].

Contemporary scientific research confirms the fact that body composition (and body composition monitor) is one of the elements distinguishing athletes from persons not doing sports systematically [1-4]. Moreover, with an increase in training experience, thus the championship level, there is a decrease in differentiation of morphological traits. These properties can be evaluated from different perspectives: the total body size, proportions of individual parts (defined by various indices), tissue composition (determined by defining the percentage of specific tissues in body weight) and as body composition types.

Most often, however, authors describe properties of body composition through various typological systems – the so-called somatotype (a model type of body composition, characterized with several distinct factors). Among many typologies used in anthropology Kretchmer [5], Sheldon [6] ,Wanke [7]), whereas Skibińska [8] discusses the somatotype of Manouvier, Sigaud, Viola. The most widely used is Sheldon's somatotypology [6], which has had numerous modifications, e.g.: Heath and Carter [9], improving the objectivity of its assessment. This method is also of the greatest interest for scientists involved in combat sports [10–16].

Perkal's natural indicators method [17], used for the first time to assess the body composition by Milicerowa [18], constitutes a very interesting, yet unfortunately little-known, method of assessing body composition. This is not, however, a new system of typological classification, but a statistical method that allows characterizing internal proportions of body composition of an individual or a group of individuals.

In this context, the main research objective was to review studies on the assessment of body composition in combat sports using Perkal's natural indicators method [17]. An additional goal was also recommendation of scientists involved in athletes' body composition qualities to the great advantages of this method.

MATERIAL AND METHODS

Analysis of available literature was the basic research method (this overview is edited according to the structure of the original work). The study covered a period of ten years (2007–2017). The analysis was related to publications on body composition of combat sports athletes using Perkal's natural indicators method [17] with Milicerowa's modifications [18].

Assessment of athletes' body composition properties be means of this method takes into account calculating the following elements:

- 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 obesity factor is an exception, as it is the standardized value of skin and fat folds: Z = m.
- Index of total body size of the group (M): $M = m_1 + m_2 + m_3 / 3$
- Assessment of internal proportions of body composition was made through calculating Perkal's natural indicators for each composition factor: $m_1 - M$; $m_2 - M$; $m_3 - M$
- Evenness of the composition was determined by means of the intrapersonal coefficient

Table 1. Point scales of Perkal's natural indicators [17].

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	average value
4		
5	−0.19 to 0.18	values greater than average
6	0.19 to 0.57	
7	0.58 to 1.06	
	1.07 to X	

Table 2. Publications using Perkal's natural indicators method to assess features of body composition in persons practicing combat sports (fencing as well as part of the modern pentathlon).

Journal	Year of publication [references]	Sports discipline (number of athletes)	Gender	
			female	male
Archives of Budo	2007 [19]	Judo (n = 13)	x	
	2009 [20]	Wrestling (n = 13)		x
	2013 [21]	Judo (n = 14)		x
	2015 [22]	Taekwondo ITF (n = 21)		x
NeuroCentrum Lublin	2009 [23]	Wrestling (n = 11)	x	
Baltic Journal of Health and Physical Activity	2011[24]	Modern pentathlon (n = 10)		x
Archives of Budo Science of Martial Arts and Extreme Sports	2014[25]	Modern Pentathlon (n = 11)	x	
Biology of Sport	2017 [26]	Fencing (n = 11)	x	

of variation – 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 on the basis of the point scale of Perkal's natural indicators (Table 1).
- Assessment of internal proportions of the body composition within each of the factors has been made by taking away the value of factor m from the standardized feature.

RESULTS

As a result of the conducted analysis, five journals were found to have published articles related to the discussed issue during the period 2007–2017 (Table 2). In total, it was eight articles: the most (n = 4) in *Archives of Budo* and one in other journals each.

The examined athletes were members of the Polish national team: female (n = 46) in four combat sports disciplines – judo, fencing (as well as part of the modern pentathlon), wrestling (Table 3); male (n = 58) in five – judo, fencing (as well as part of the modern pentathlon), taekwondo ITF, wrestling (Table 4).

Table 3. Assessment of the properties of body composition in female athletes (n = 46) practicing combat sports by means of Perkal's natural indicators method [17] – literature review.

Sport discipline	WC	Composition factor: m_1, m_2, m_3	Total body size index, M	Natural indicators for the factors	Coefficient of variation	Code of internal proportions for the group
Judo [19]	1	−0.69, −0.79, −0.71	−0.72	0.04. −0.07, 0.01	0.11	4-4-4
	2	0.41, 0.68, 0.42	0.50	−0.09, 0.18, −0.08	0.27	4-4-4
	3	1.78, 2.69, 2.79	2.42	−0.64, 0.27, 0.37	1.01	2-5-5
Wrestling [23]	1	−1.08, −0.35, −0.38	−0.60	−0.48, 0.26, 0.22	0.74	3-5-5
	2	0.01, 0.61, 0.26	0.29	−0.29, 0.32, −0.04	0.61	3-5-4
	3	1.09, 1.95, 0.67	1.24	−0.15, 0.72, −0.57	1.29	4-6-2
Modern pentathlon [25]		0.78, 0.09, 0.85	0.58	0.21, −0.48, 0.27	0.75	4-1-4
Fencing [26]		0.27, 0.26, 1.36	0.63	−0.36, −0.37, 0.77	1.14	3-3-6

Legend: **WC** weight categories; **1** light; **2** middle; **3** heavy

Table 4. Assessment of the properties of body composition in male athletes (n = 58) practicing combat sports by means of Perkal's natural indicators method [17] – literature review.

Sport discipline	WC	Composition factor: m_1, m_2, m_3	Total body size index, M	Natural indicators for the factors	Coefficient of variation	Code of internal proportions for the group
Judo [21]	1	−0.62, −0.15, −2.79	−1.19	0.57, 1.04, −1.61	2.65	2-6-1
	2	−0.16, 1.39, 0.42	0.55	−0.71, 0.84, −0.13	1.55	2-6-4
	3	1.32, 3.04, 5.28	3.4	−2.07, −0.35, 2.42	4.49	1-3-7
Taekwondo ITF [22]	1	−1.10, −0.85, −2.38	−1.44	0.34, 0.59, −0.94	1.53	5-6-2
	2	−0.55, −0.27, −1.89	−0.90	0.36, 0.63, −0.99	1.62	5-6-2
	3	0.70, 0.32, −1.04	−0.02	0.72, 0.32, −1.04	1.76	6-5-2
	4	1.86, 1.28, 0.53	1.22	0.63, 0.06, −0.69	1.33	6-4-2
Wrestling Greko-Roman [20]	1	−2.08, −1.44, −0.45	−1.32	−0.76, −0.11, −0.45	0.65	2-4-3
	2	−0.75, 0.18, 0.96	0.13	−0.88, 0.05, 0.83	1.71	2-4-6
	3	1.26, 2.23, 1.91,	1.8	−0.54, 0.43, 0.11	0.97	3-5-4
Modern pentathlon [24]		0.23, −0.09, −0.09	0.02	0.32, −0.11, −0.11	0.33	5-4-4

Legend: **WC** weight categories; **1** light; **2** middle; **3** heavy; 4 super-heavy

Among the female athletes practising combat sports (judo, fencing, wrestling and modern pentathlon), female judokas (M = 2.42) and wrestlers of heavy weight categories (M = 1.24) are characterized by the largest total body size [27]. In this respect, they greatly outweigh non-athlete women. Female judokas and wrestlers are also distinguished by their smallest body size in lightweight categories (M = −0.72 and M = −0.60, respectively). The most similar group of female athletes, in terms of the total body size, are wrestlers of meddle-weight categories (M = 0.29).

Taking into account internal proportions of the body composition factors (natural indicators of factors), female judokas of lightweight classes are the most proportionally built (the coefficient of variation = 0.11, and the code for internal proportions for the group is 4-4-4).

Among men practicing the analysed combat sports, also judokas (M = 3.4) and wrestlers (M = 1.8) of heavy-weight categories are characterized by the largest total body size. In this respect, they significantly outweigh men not doing sports systematically [27]. The smallest body size characterizes taekwondo athletes (M = −1.44) and wrestlers (M = −1.32) of the lightest weight categories. Pentathletes (M = 0.02) are a group that is the most similar to men who do not practise sport systematically.

Taking into account internal proportions of the body composition factors (natural indicators of factors), male pentathletes are the most proportionally built (the coefficient of variation = 0.33, and the code for internal proportions for the group is 5-4-4).

DISCUSSION

Long-term training as well as the selection process of the most predisposed athletes exerts a significant influence on the somatic composition of members of national teams. In combat sports divided into weight categories [28] there is much greater differentiation of body composition than in other sport disciplines. As the weight increases, there is a clear change in athletes' composition towards growing massiveness, at the expense of a decrease in slenderness features. The greatest differences occur between heavy- and lightweight categories; the smallest between medium- and lightweight ones [19-21, 23]. This is particularly evident in the total body size index (M), which is the average of body composition factors (length – m_1, stoutness – m_2 and adiposity – m_3).

Analysis of the internal proportion of body composition factors of male and female athletes revealed significant differences between particular teams. The total body size of the examined athletes (except for two categories of taekwondo) results from the apparent severity of stoutness features. The contribution of the length factor and the adiposity factor is associated with the weight category and the discipline of sport [29].

In combat sports without division into weight categories [28], athletes' body composition is less diverse. A characteristic profile of body composition is evident among the representatives. This is confirmed by pentathletes, who are characterised by the lowest coefficient of intragroup variation (0.33), and in terms of the total body size (M), they are most similar to the comparative group [27]. A similar total body size also characterizes Polish representatives in tennis [30], baseball [31, 32], and swimmers [33].

The focus of our analysis was on the assessment of athletes' body composition using Perkal's natural indicators method [17] as modified by Milicerowa [18]. It offers many application possibilities and is particularly important in sports training – for instance because of a possibility to assess internal proportions of body composition (selection for a discipline, technique, etc.). It allows choosing characteristics that we know are of great importance in a particular sport or whose usability is to be checked. The number of factors and their type may also vary. For example, one can determine which somatic features or which factors are the most important in the specifics of body composition in a particular discipline (national team athletes are presented in comparison to a population not practising competitive – as in the analysed publications). One can also check: the suitability of a candidate or a competitor to a particular discipline from the point of view of his/her body composition (the national team of this discipline will be a reference group here) or body composition of individual athletes in comparison to the whole team (arithmetic means and standard deviations of this team will be a reference group) – [34].

Therefore, owing to the use of standardised features, there are more possibilities than in classic typological systems. This method also allows comparisons with other somatotypological methods. Since research using this method has been conducted since 1956, it is possible to compare athletes' body composition from a period of nearly 60 years.

CONCLUSIONS

Perkal's method of natural indicators is an interesting way to assess properties of athletes' body composition. It can be used by both scientists and coaches looking for non-standard methods of analysis. Since the indicators are calculated from the values of standardised features (standardised results), it gives a possibility to express all features in the same and thus comparable values with the same "weight". This opens up opportunities which other typological systems do not offer. It leaves the freedom of choice of such features that we know that they are of great importance in a particular sport discipline, or whose usefulness we want to verify. The number of factors and their type, not necessarily regarding body composition, may also vary. For example, one can determine which somatic features or which factors are the most significant in the specifics of body composition in a particular discipline or verify the suitability of a candidate or competitor for a particular discipline from the point of view of his/her somatic composition.

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