Perkal's method of natural indicators in the assessment of internal proportions of body composition in persons practising combat sports – a review

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Abstract

Background and Study Aim: Perkal's method of natural indicators is very interesting and, unfortunately, the little-known method of assessing body composition. For the first time, it was used to assess body composition by Milicerowa in 1956. However, this is not a new system of typological classification, but a statistical method that allows characterizing internal proportions of body composition of each individual or a group of individuals. The main aim of the research is aspects of body composition in combat sports that use Perkal's method of natural indicators.

Material and Methods: The basic method of research was an analysis of available literature (n = 8 articles) which covered ten years (2007-2017). An assessment of the properties of athletes' body composition with this method takes into account calculating the following elements: composition factors; Index of total body size of the group; assessment of internal proportions of body composition; evenness of the composition; the code of internal proportions of the; assessment of internal proportions of the body composition within each of the factors.

Results: The stoutness factor has the most diversified contribution of somatic features in both men and women practising combat sports. The contribution of somatic features to the length factor is quite proportional in both women and men.

Conclusions: Perkal's method of natural indicators is an interesting alternative in assessing the properties of athletes' somatic composition. Owing to the use of standardized features, it gives greater possibilities of analysis than the classic typological systems. It also allows for a more free selection of those features that are considered important in a given sports discipline or event/weight category. Due to the possibility of assessing internal proportions, it is particularly important in sports training.

Keywords: Sheldon's somatotypology • standardized results • typological systems

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INTRODUCTION

Beside psychomotor properties [1-3], body composition is an important criterion of the selection process in sport [4-8]. Among many ways of assessing properties of athletes' body composition, the most commonly used is Sheldon's somatotypology [9], which has had numerous modifications improving the objectivity of its assessment, e.g. Heath, Carter [10]. This method also enjoys the unflagging interest of scientists involved in combat sports [11-14].

Perkal's method of natural indicators [15] is very interesting and, unfortunately, the little-known method of assessing body composition that was used for the first time by Milicerowa [16]. However, this is not a new system of typological classification, but a statistical method that allows characterizing internal proportions of body composition of each individual or a group of individuals. This publication continues the analysis of research [17] and concerns internal proportions of body composition in combat sports (proportions of factors and somatic features within the factors).

The main aim of the research is aspects of body composition in combat sports that use Perkal's method of natural indicators. Application aim: drawing the attention of scientists dealing with properties of athletes' body composition to the significant advantages of this method.

MATERIAL AND METHODS

The basic research method was the analysis of available literature. The research covered a period of ten years (2007–2017). The examined athletes were members of the Polish national team (46 women and 58 men) in five disciplines of combat sports – judo, pentathlon (due to fencing), fencing, taekwondo and wrestling. The analysis concerned publications presenting the assessment of the body composition of athletes practising combat sports that used Perkal's method of natural indicators [15] with Milicerowa's modifications [16].

An assessment of the properties of athletes' body composition with 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 the 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 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 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.

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

Points	Values of Perkal's natural indicators	
1	X do −0.07	values less than average
2	−1.06 do −0.57	
3	−0.56 do −0.18	
4	−0.19 do 0.18	average value
5	0.19 do 0.57	
6	0.58 do 1.06	values greater than average
7	1.07 do X	

RESULTS

Considering the internal proportions of body composition factors (natural indicators of the factors), expressed in points, female judokas of light and middle-weight categories are the most proportionally built (the code of internal proportions of the groups is 4-4-4) [18]. Female wrestlers of heavy-weight categories (4-6-2) and female fencers (3-3-6) [20] are the least proportional [19] – Table 2.

Among men practising combat sports, the most proportional in terms of internal proportions of body composition factors (natural indicators of factors) are pentathletes (the coefficient of variation = 0.33, and the code of internal proportions within the group is 5-4-4 [22]) – Table 3.

Internal proportions of somatic features provide the most important information regarding the properties of athletes' body composition within the factors (natural indicators of somatic features of body composition factors) – Table 4.

Considering the proportions of the somatic features of the length factor, the largest contribution to this factor is in the length of the upper limb (0.70) in female heavy-weight wrestlers [19], then in female judokas of the heavy-weight category (0.47) [18] and female pentathletes (0.67) [21]. Proportionally, the body height in wrestlers (−0.51) [19] and pentathletes (−0.36) [19] and the length of the lower limbs in judokas of the middle-weight categories (−0.50) [18] have the smallest contribution to this factor (among the analysed groups of female athletes).

Among the features having the most significant proportional contribution to the size of the stoutness factor among the examined female athletes, the following should primarily be mentioned: the elbow width (1.44) in the heavy-weight category judokas [18] and the forearm circumference in fencers (1.43) [20], pentathletes (1.40) [21], wrestlers of middle-weight categories (1.33) [19] and judokas of light-weight and middle-weight categories (1.17 and 1.18, respectively) [18].

Among the examined athletes, the length of the upper limb in judokas of middle-weight categories (0.93) [23] and wrestlers of the light-weight category (0.82) [25] has the most significant proportional contribution to the length factor – Table 5. The lower limb length in middle-weight judokas (−0.51) [23] and super heavy-weight taekwondo fighters (−0.48) [24] has the smallest proportional contribution to this factor.

Among the features that have the most significant proportional contribution to the size of the weight factor of the examined players, first of all, the forearm circumference should be mentioned in the vast majority of the examined athletes. The knee width in taekwondo fighters of all weight categories [24] and the pelvis width (−1.60) in heavy-weight judokas [23] and middle-weight wrestlers (−1.15) [25] has the smallest contribution.

Table 2. Codes of internal proportions of factors of body composition in women practising combat sports – Perkal's method.

Judo [18]			Wrestling [19]			Fencing [20]	Pentathlon [21]
1	2	3	1	2	3		
4-4-4	4-4-4	2-5-5	3-5-5	3-5-4	4-6-2	3-3-6	4-1-4

Table 3. Codes of internal proportions of factors of body composition in men practising combat sports – Perkal's method.

Judo [23]			Taekwondo [24]				Wrestling [25]			Pentathlon [22]
1	2	3	1	2	3	4	1	2	3	
2-6-1	2-6-4	1-3-7	5-6-2	5-6-2	6-5-2	6-4-2	2-4-3	2-4-6	3-5-4	5-4-4

Notation for weight categories: 1 – light-weight, 2 – middle-weight, 3 – heavy-weight, 4 – super-heavy-weight.

Table 4. Internal proportions of somatic features within the body composition factors among female athletes practising combat sports – Perkal's method.

Somatic features	Judo [18] (n =13)			Wrestling [19] (n=11)			Fencing [20] (n=11)	Pentathlon [21] (n=11)
	1	2	3	1	2	3		
Length factor (m_1)								
standing body height	−0.15	−0.12	0.02	−0.26	−0.08	−0.12	−0.07	−0.15
sitting body height	−0.13	0.27	−0.28	−0.10	−0.20	−0.51	−0.07	−0.36
upper limb length	0.23	0.36	0.47	0.40	0.25	0.70	0.27	0.67
lower limb length	0.05	−0.50	−0.21	−0.04	0.03	−0.06	−0.13	−0.16
Stoutness factor (m_2)								
shoulder width	−0.29	−0.05	−1.71	−0.56	0.29	−0.23	−0.52	0.26
pelvis width	−0.70	−0.43	−0.71	−0.53	−0.26	−0.28	−0.29	−0.27
elbow width	0.36	−0.30	1.44	0.53	−0.56	0.10	−0.69	−0.49
knee width	−0.16	0.17	0.48	0.56	−0.11	0.87	−0.01	−0.60
forearm circumference	1.17	1.18	0.93	1.15	1.33	0.79	1.43	1.40
shank circumference	−0.38	−0.57	−0.42	−1.15	−0.69	−1.25	0.08	−0.30

DISCUSSION

Modern anthropology research suggests the existence of specific correlations between body composition and a sports discipline. In cyclical sports and most team games, these indicators are one of the basic criteria of selection. They allow concluding the level of sports proficiency and predicting the effectiveness of competitive activity [26-29]. A more complex problem concerns acyclic sports, in particular, combat sports. The complexity of the structure of sports preparation as well as the division into weight categories, additionally complicates the problem.

In our research, the results of observations using Perkal's method of natural indicators [15] have been analysed. This method has a variety of applications and is particularly important in sports training – for example, due to a possibility to assess internal proportions of body composition (selection for a discipline, technique, etc.) [30]. An analysis of the internal proportions of male and female athletes' body composition factors revealed significant differences between particular teams. The overall body size of the examined athletes (except for two categories of taekwondo) results from the pronounced intensity of stoutness features. The contribution of the length factor and the adiposity factor is associated with the weight category and the sports discipline.

The contribution of somatic features to the length factor in the examined female athletes is quite harmonious (balanced). Fencers and judokas of light-weight categories [18, 20] particularly stand out in this respect. Wrestlers of heavy-weight categories and pentathletes [19, 21] manifest the most diverse contribution of somatic features to this factor. The upper limb length has the largest contribution to the length factor in all the examined female athletes. It is also the least diverse (from 0.23 to 0.7 – $V_\% = 43.7$). The sitting body height and the standing body height (in judokas and wrestlers of light-weight categories) as well as the lower limb length (in judokas of middle-weight categories and fencers) proportionally have the smallest contribution.

Table 5. Internal proportions of somatic features within the body composition factors among male athletes practising combat sports – Perkal's method.

Somatic features	Judo [23]			Taekwondo [24]				Wrestling [25]			Pentathlon [22]
	1	2	3	1	2	3	4	1	2	3	
Length factor (m_1)											
standing body height	−0.19	−0.38	−0.05	−0.27	−0.13	−0.06	0.15	−0.48	−0.08	−0.03	−0.11
sitting body height	−0.27	−0.04	−0.07	−0.32	0.15	−0.18	0.36	-0.43	0.10	−0.33	0.13
upper limb length	0.39	0.93	0.47	0.49	0.16	0.37	−0.02	0.82	0.01	0.45	0.31
lower limb length	0.07	−0.51	0.34	0.10	−0.18	−0.12	−0.48	0.09	−0.03	−0.10	−0.32
Stoutness factor (m_2)											
shoulder width	−0.30	−0.24	−0.54	−0.16	−0.60	−0.08	−0.29	−0.53	−0.08	−0.65	−0.08
pelvis width	−0.20	−0.66	−1.60	0.38	−0.13	−0.12	0.61	−0.56	−1.15	−0.42	0.03
elbow width	0.21	0.51	−0.04	0.26	0.86	0.40	0.63	0.26	0.17	−0.18	−0.17
knee width	−0.28	−0.16	0.78	−2.04	−2.06	−2.31	−1.77	−0.61	−0.22	−0.33	−0.33
forearm circumference	0.90	1.38	1.45	1.23	1.26	1.52	0.69	1.49	1.45	1.47	0.87
shank circumference	−0.31	−0.84	−0.02	0.33	0.69	0.59	0.14	−0.04	−0.17	0.12	−0.32

The stoutness factor, which consists of the width characteristics of the skeleton and circumferences, proved to be the most diverse in terms of the contribution of its somatic features. This differentiation is twice as high as for the length factor. Noteworthy is the overwhelming contribution of the forearm circumference to its overall size among all the examined women (except for judokas and wrestlers of heavy-weight categories in whom the elbow width and the knee width proved to be such a dominant feature). The contribution of the forearm circumference to the stoutness factor proved to be the least diverse (from 0.79 to 1.43 – $V_\%$ = 19.03). The shank circumference manifested a disproportionately small contribution in judokas of light-weight categories and wrestlers, and by the elbow width in pentathletes and fencers.

In males, the contribution of somatic features to the length factor is also fairly balanced. Significant disproportions in this respect only occur in judokas of middle-weight categories and wrestlers of light-weight categories [23, 25]. In men, even more clearly than in women, the predominant contribution of the upper limb length to this factor is manifested. Still, the differentiation

of its contribution is twice as high as the analogous one in women (from −0.02 to 0.93 – $V_\%$ = 73.98).

The stoutness factor, as in women, proved to be the most diverse in terms of the contribution of its somatic features. This differentiation in males is more than three times greater than that of the length factor. The most diverse contribution of somatic features to this factor characterises taekwondo fighters of all weight categories (except for the super heavy-weight one) [24]. On the other hand, pentathletes and judokas of light-weight categories show the most balanced contribution of somatic features to this factor [22, 23]. Noteworthy is an overwhelming contribution of the forearm circumference to the overall size of this factor in all the examined athletes. The contribution of this somatic feature has also proved to be the least varied (from 0.69 to 1.52 – $V_\%$ = 23.48). The knee width showed a disproportionately small contribution among taekwondo fighters, wrestlers of light-weight categories and pentathletes [22, 24, 25]. The shank circumference showed the smallest contribution among judokas of light- and middle-weight categories [23], while the pelvic width among judokas of heavy-weight

categories and wrestlers of middle-weight categories [23, 25] and the shoulder width among wrestlers of heavy-weight categories [25].

Thus, based on an analysis of studies on internal proportions of body composition that use Perkal's method [15], it can be concluded that the stoutness factor has the most diverse contribution of somatic features in both women and men practising combat sports. The contribution of somatic features to the length factor in both women and men is quite proportional.

of standardized features, it gives more possibilities of analysis than the classic typological systems. It also allows for a more liberal selection of the features that are considered relevant in a particular sports discipline or event/weight category. The choice of factors (sets of features) can also go beyond the somatic factors. They may include, for example, properties of physical fitness, technical preparation, mental performance, etc. This method, due to the possibility of evaluating internal proportions, is particularly important in sports training.

CONCLUSIONS

Perkal's method of natural indicators is an interesting alternative in assessing the properties of athletes' body composition. Thanks to the use

Research on the properties of body composition in combat sports with the use of this method [15] shows a particular significance and high variability (depending on the weight category) of features defining the stoutness factor (the width of bone heads) and musculature (muscle circumferences).

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