ORIGINAL ARTICLE

The similarity of training experience and morphofunctional traits as prediction criteria of the sports level in subsequent stages of long-term women's judo training

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

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Abstract

Background: & Study Aim: In every sport in which success is determined by the body type and human physical characteristics, monitoring of morphofunctional traits is an essential element of effective selection of candidates and of management of the training process. However, it has been repeatedly proved that along with longer training experience, especially in combat sports and team games, some athletes achieve excellent results despite the fact that the results of laboratory tests confirm lower values of their morphofunctional indices in comparison to younger athletes. The purpose of the research is knowledge about the possibility of accurate prediction of athletes' sports level on the basis of their morphofunctional traits in three consecutive stages of women's long-term judo training.

Material & Methods: Thirty-nine Polish female judo athletes were tested (Group A – comprehensive training stage, n = 14, age 13-15 years, training experience 5.5±1.9 years; group B – directed training stage, n = 14, age 16-18 years, experience 7.2 ± 2.5 years; group C – special training stage, n = 11, age 25.2± 3.7 years, experience 14.2 ± 4 years). The athletes' sports level was established on the basis of ranking lists of the Polish Judo Association from 2006 and 2007 as well as on coaches' opinions. Somatic characteristics were based on the measurement of body height and on indices defining its mass and the composition of its components. To evaluate general physical fitness, the Test of Physical Fitness (TPF) was applied, and to evaluate special fitness – Special Judo Fitness Test (SJFT). Aerobic capacity was measured with a test of increasing load until refusal to continue work. Anaerobic capacity was measured with the Wingate Anaerobic Test (30-second version). The analysis of results was based on multivariate statistical methods.

Results: Five clusters (groups) of athletes were distinguished due to similarity of specific morphofunctional traits. The most numerous cluster (n = 13) comprised six athletes from groups A and B each, ranked in identical positions of sports achievement: 5, 9, 11, 12, 13, 14, and only one from group C (ranked 5th in this group). The most homogeneous group (n = 6) comprised 5 seniors from the special training stage (ranking positions in the group 1, 3, 4, 8, 10) and one junior (4th in the ranking). Morphofunctional indices of athletes participating in three different stages of judo training are connected, in a sense discreetly, with their sports level (ranking position in the group). Both leaders of sports performance (within individual groups and generally) and athletes qualified for low ranking positions can be characterised with very similar profiles of body composition, fitness and physical performance.

Conclusions: The results confirm a thesis that it is impossible to accurately predict the future sports performance even on the basis of a number of systematically monitored morphofunctional traits of judo athletes at each stage of training. The applied method allows, however, determining factors which at particular stages of judo training are most strongly associated with efficiency during the most important judo tournaments.

Key words: cluster analysis · ranking of athletic achievement · multiple regression · science of martial arts

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Introduction

In every sport in which success is determined by the body type and human physical characteristics, monitoring of morphofunctional traits is an essential element of effective selection of candidates and of management of the training process. Awareness of this regularity makes trainers, strategic advisors and scientists attach great importance to athletes' physical preparation. The type and the level of this preparation is a result of natural development and deliberate shaping and improving motor skills [1, 2]. A training process of people, especially children and youth who dream of a sports career, is preceded by a screening stage, and then selection to a given sport or discipline. It happens that an adept begins training judo and achieves the greatest successes in other sports and vice versa – as, for example, Rafał Kubacki (Poland) a double world champion in judo in the open category (1993 and 1997), who first successfully competed in swimming.

Sport theorists are trying to determine the impact of particular elements, hence also physical fitness, on the sports result in order to help coaches make decisions concerning the selection of a suitable variant for the sports training process [3]. A dynamic development of sports sciences in the second half of the last century resulted, among others, in determining an optimal model of long-term training [4, 5]. The judo and wrestling training system in Russia is based on a structure developed by Tumanian [6]: stage I – basic preparation (age 9-11 years old), stage II – special preparation (12-15 years old), stage III – deepened special preparation (16-19 years old), stage IV – the highest athletic achievements (over 20 years of age), stage V – stabilization of athletic achievements (up to about 28 years of age), stage VI – gradual retiring from training (> 28 years old). In Poland a three-stage system of long-term judo training has been adopted: a comprehensive training stage (14-15 years old), a directed training stage (16-18 years old), and a special training stage (since 19 years old) [7].

One of the most important dilemmas is two questions: 1) is the candidate's high level of general physical fitness at the beginning of a long-term training period a condition for future achievement of high athletic performance? 2) does the athlete's level of general physical fitness significantly increase with the development of sports championship?

The profile of physical fitness of Polish children and youth who take up training judo is well documented [8-10]. Results of Kalina's et al. research [11] provide important empirical evidence that general physical fitness is not highly correlated with the results of test fights based on the sumo formula (in groups of 3 to 5 people) of both children starting judo training and adults enrolled in military training or being candidates for the security profession. The coefficient of determination (R^2) of both variables (the sum of points of the Test of Physical Fitness and the percentage of contests won) ranges from 2% to 15%. A modified experiment by Sertić et al. [12] (19-21-year-old male students conducted 5 fights each in a vertical judo posture – *tachi waza*, while physical fitness was measured with a battery of 15 motor tests) provided empirical evidence that, on average, only 15% of variance of the criterion variables was explained by the influence of motor variables.

In the available literature there is relatively ample information on body composition of adult judokas (men and women) [13-15], their physiological characteristics [16-19], and technical and tactical preparation [20-23]. There is, however, a lack of well-documented empirical data on changes in general physical fitness in the course of long-term judo

Cluster analysis – the basic idea is to break down the items into a number of sets of items "similar" to each other which simultaneously are not "similar" to items from the other sets [29]

Standard error of estimate – this is an estimate of the size of random deviations of the model, and in this paper it is interpreted as the mean deviation of the ranking position observed in the sample from the theoretical ranking position designated by the model.

Pinning techniques – *When you have your opponent pinned: 1. Keep all of your body in a position that contributes to keeping him pinned down. 2. Anticipate the important moves your opponent will make to try to break free, and control them.* [38, p. 19]

Strangle techniques *– The three most basic conditions to maintain for a good strangle hold are: 1. Make sure that your own body always has complete freedom of action. 2. Lead your opponent into a position in which it is most difficult to put up resistance, and control all of his actions. 3. Make your strangle work in a very brief time.* [38, p. 54]

The joint techniques – *The following are strictly forbidden: 1. Reverse holds on the joints of the wrists, ankles, knees, fingers, or toes. 2. Direct reverse holds on shoulder joints. 3. Any action that may be injurious to the neck and or spine. 4. Throwing down with force* an opponent, who is face up and whom have lifted off the floor. [38, p. 86]

training. However, it has been repeatedly proved that along with longer training experience, especially in combat sports and team games, some athletes achieve excellent results despite the fact that the results of laboratory tests confirm lower values of their morphofunctional indices in comparison to younger athletes.

The purpose of the research is knowledge about the possibility of accurate prediction of athletes' sports level on the basis of their morphofunctional traits in three consecutive stages of women's long-term judo training.

Material and methods

Participants

Thirty-nine Polish female judo athletes were tested (Group A – comprehensive training stage, n = 14, age 13-15 years, training experience 5.5±1.9 years, representatives of the Pomeranian voivodeship; group B – directed training stage, n = 14, age 16-18 years, experience 7.2 ± 2.5 years, representatives of Poland in the juniors category and representatives of the Pomeranian voivodeship; group C – special training stage, n = 11, age 25.2± 3.7 years, experience 14.2 ± 4 years, representative of the Polish Olympic team or its direct backup). Particular tests were carried out in 2007, in identical periods of the annual training cycle (this met the criterion of similarity of training means influence on the body). The research was approved by the local Bioethics Committee.

Methods

The athletes' sports level was established on the basis of ranking lists of the Polish Judo Association from 2006 and 2007as well as on coaches' opinions.

Somatic characteristics were based on the measurement of body height and on indices defining its mass and the composition of its components (body fat (FAT [kg], FAT [%]), fat-free body mass (FFM [kg], FFM [%]), while water content in the body (TBW [kg], TBW [%]) was measured with a Tanita Body Composition Analyzer, TYPe TBF-410 HAS a III. Also BMI was calculated [$kg \cdot m^{-2}$].

To evaluate general physical fitness, the Test of Physical Fitness (TPF) was applied [24], and to evaluate special fitness – Special Judo Fitness Test (SJFT) [25].

Aerobic capacity was measured with a test of increasing load until refusal to continue work [26]. Anaerobic capacity was measured with the Wingate Anaerobic Test (WAnT), 30-second version of full resistance of the flywheel from the beginning of the effort [27, 28].

The analysis of results was based on multivariate statistical methods using STATISTICA 6.0. But first, basic statistical indicators were calculated: the arithmetic mean (M), standard deviation (SD ±), the correlation coefficient (r) (Pearson's), the level of significance of differences between means (p). For each group of contestants and for each cluster of indices multiple regression was performed. Five clusters of indicators were taken into consideration (cluster 1: age, experience and somatic indices; cluster 2: the level of general physical fitness; cluster 3: the level of special physical fitness; cluster 4: the level of aerobic capacity; cluster 5: the level of anaerobic capacity). The applied multiple regression allowed examining correlations of the distinguished clusters of indicators with the athletes' sports level. The sports level was presented as the contestants' ranking positions in three experimental groups. In addition, cluster analysis was applied according to Ward [29], which enabled evaluation of certain similarities of the features (indices) of contestants from the three examined groups, taking into account their ranking position.

Using Ward's method, the athletes were grouped according to all the clusters of indicators (in the figure and the table, e.g. code 1A means a leader of the group of the youngest athletes, and code C11 an athlete classified in the final ranking position in the group of seniors). Due to editorial limitations, there is no detailed presentation of the study results. We have limited ourselves to the most general results of multivariate statistical analysis.

Results

Five clusters (groups) of athletes were distinguished due to similarity of specific morphofunctional traits – the line of identification not greater than 16 (Figure 1). The most numerous cluster (n = 13) comprised six athletes from groups A and B each, ranked in identical positions of sports achievement: 5, 9, 11, 12, 13, 14, and only one from group C (ranked 5th in this group) (Table 1). The most homogeneous group (n = 6) comprised 5 seniors (group C) from the special training stage (ranking positions in the group 1, 3, 4, 8, 10) and one junior (4th in the ranking – group B). In the cluster comprising 6 people the greatest similarity of characteristics concerns contestants C1 and C3 (linkage below the 6th line of identification – Figure 1), namely the leader among seniors and an athlete classified in the third ranking position

Effort safety – is consciousness of the person who starts physical effort or consciousness of the subject who has the right to encourage or even enforce from this person the physical effort of a certain intensity and duration, who it is able to do so without risking life or health [39]

Motor safety – is consciousness of the person undertaking to solve a motor task or consciousness the subject who has the right to encourage and even enforce from this person that would perform the motor activity, who is able to do it without the risk of the loss of life, injuries or other adverse health effects [39].

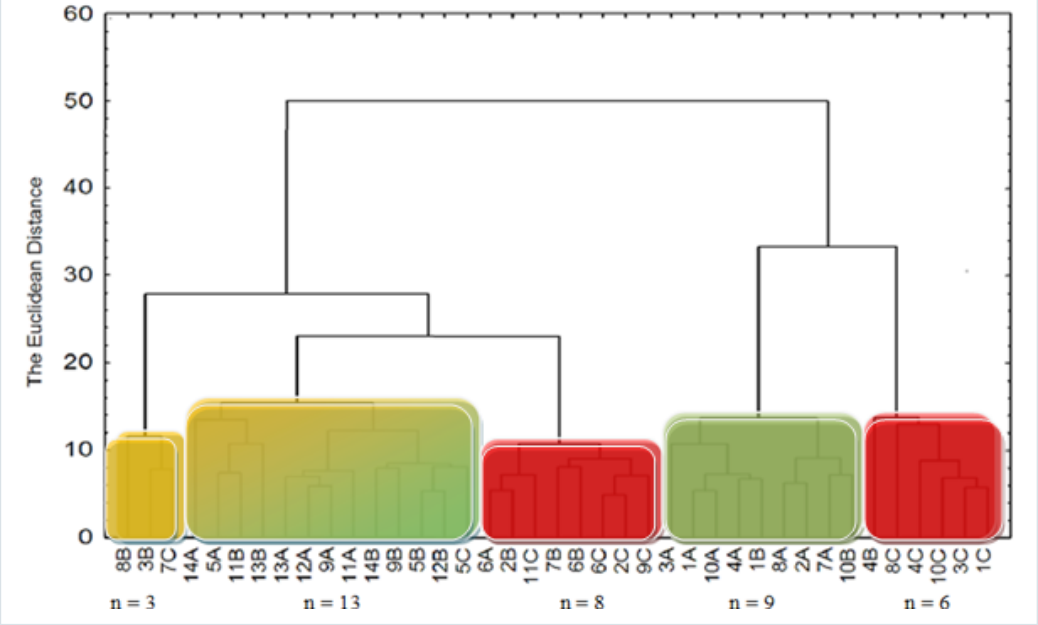

Figure 1. Designated by Ward's method dendrogram of judo athletes (n = 39) the most similar to each other in terms of the analysed indicators, classified in particular ranking positions in groups that belong to the subsequent stages of training – colours designate the majority of the cluster of athletes from the given stage the judo training: green A – comprehensive training stage (the youngest athletes); yellow (B) – directed training stage (juniors); red C – special training stage (seniors)

Table 1. Particular clusters of judo athletes (n = 39) most similar to each other in terms of the analysed indicators from three groups (with a distinguished ranking position in the group) eligible for various stages of training: A – comprehensive training stage (n = 14), B – directed training stage (n = 14), C – special training stage (n = 11)

1 cluster (n = 3)	2 cluster (n = 13)	3 cluster (n = 8)	4 cluster (n = 9)	5 cluster (n = 6)
3B	5A	6A	1A	4B
8B	9A	2B	2A	1C
7C	11A	6B	3A	3C
	12A	7B	4A	4C
	13A	2C	7A	8C
	14A	6C	8A	10C
	5B	9C	10A	
	9B	11C	1B	
	11B		10B	
	12B			
	13B			
	14B			
	5C			

among them. A contestant with code 10C, namely the last but one in the ranking of achievements among seniors, is characterized by a close linkage of indicators with them (Figure 2-6) (linkage on the 7th line of identification – Figure 1).

Among all the surveyed judo athletes, seniors 2C and 6C are characterized by the biggest similarity of indicators (8-person cluster of individuals with similar characteristics) – linkage on the 5th line of identification (Figure 1).

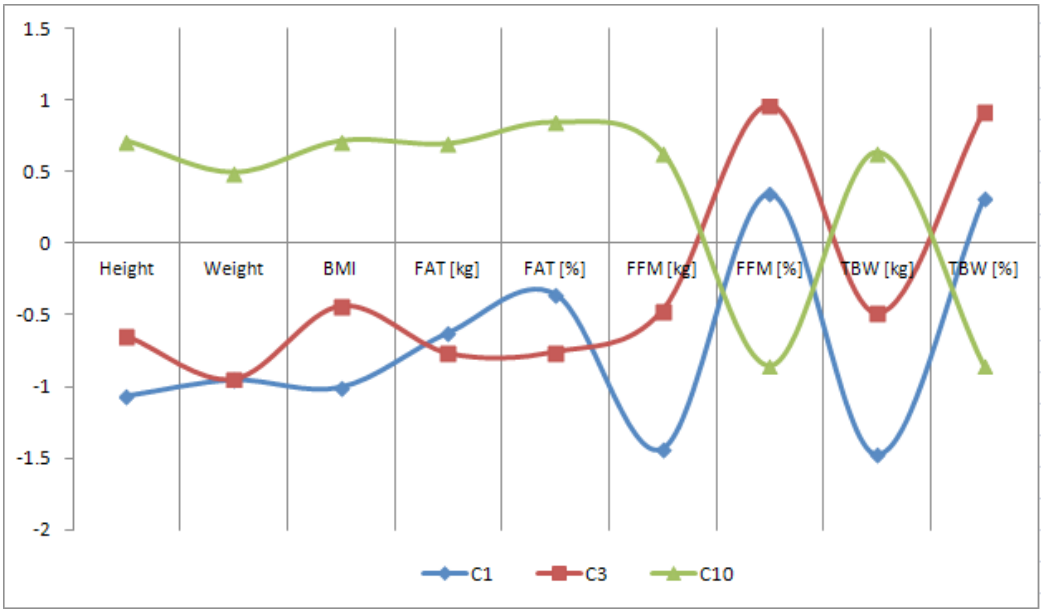

Figure 2. Standardized on the arithmetic mean and standard deviation profiles of judo female seniors (classified at 1-, 3- and 10 positions in the ranking of sports achievements) based on somatic indicators (standardizing incl. absolute values of indicators)

Leaders of all three rankings and most athletes classified in top ranking positions (2 to 4) are grouped in contiguous clusters (sets) of persons in a given stage of judo training: n = 9 (majority of the youngest athletes – green colour) and n = 6 (majority of the oldest athletes – red colour) (Table 1). The similarity of characteristics of athletes of the two groups, however, is revealed only on the 34th line of identification, while of the other contestants on the 28th line of identification of the analysed indicators (Figure 1).

Morphofunctional indices of athletes participating in three different stages of judo training are connected, in a sense discreetly, with their sports level (ranking position in the group). Both leaders of sports performance (within individual groups and generally) and athletes qualified for low ranking positions can be characterised with very similar profiles of body composition, fitness and physical performance, which is proved by individual profiles of particular athletes (for example, three seniors – Figure 2-6) and generalized correlation results of the distinguished groups of empirical variables with a ranking position of contestants from three different stages of long-term judo training. The greater similarity of the characteristics of leaders (C1) and athletes classified in this group at 3 position in the ranking. The leader (C1) was different from most senior ranked on positions 3 and 10 in terms of special fitness indicators, with the exception of Index IJST (Figure 4). Tenth in the ranking of senior women the most differed from 1 and 3 in the C group in terms of somatic features (Figure 2).

The correlation of age, experience and somatic indices with the ranking position

Only in Group A (comprehensive training stage) with training experience extended by 1 year the ranking position increased by 1.41. The value of the coefficient of determination (R^2) amounted to 0.43, which means that 43% of the total variability in this correlation has been explained by the model. The value of the standard error of estimate 3.28.

In Group B (directed training stage) the ranking position increased by 0.78 with an increase in the level of body water (TBW) by 1, and it increased by 1 with the BMI growth by 1. The value of the coefficient of determination 0.51 and the standard error of estimate 3.52.

In Group C (special training stage) the ranking position increased by 2.38 with an increase in *the age by 1 year. The value of the coefficient of determination was 0.92, which means that* 92% of the total variation of the ranking position variable has been explained by the model. The value of the standard error of estimate 1.29.

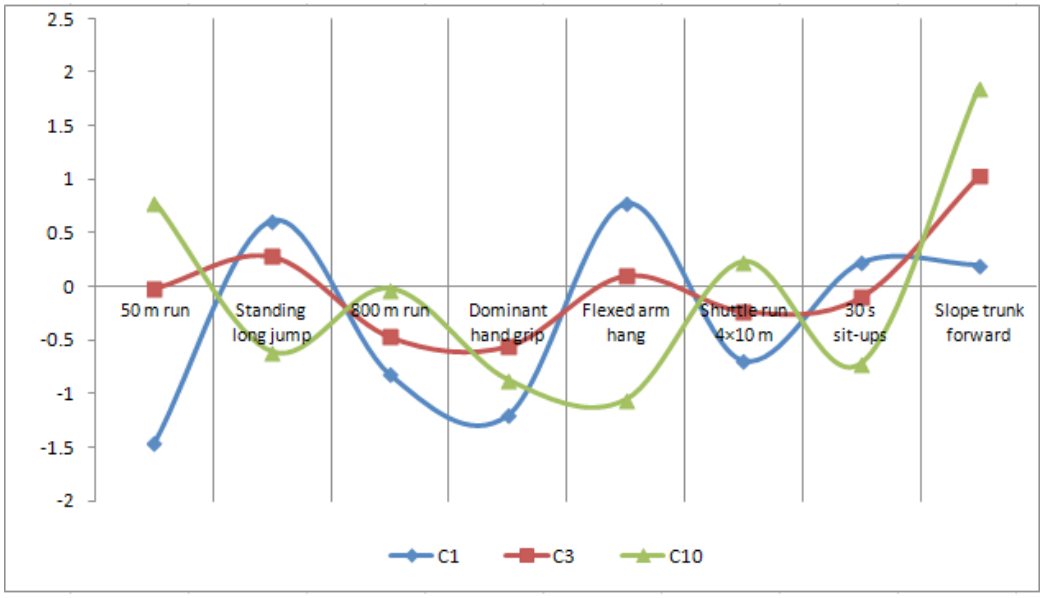

Figure 3. Standardized on the arithmetic mean and standard deviation profiles of judo female seniors (classified at 1-, 3- and 10 positions in the ranking of sports achievements) based on general physical fitness (standardizing incl. absolute values of indicators)

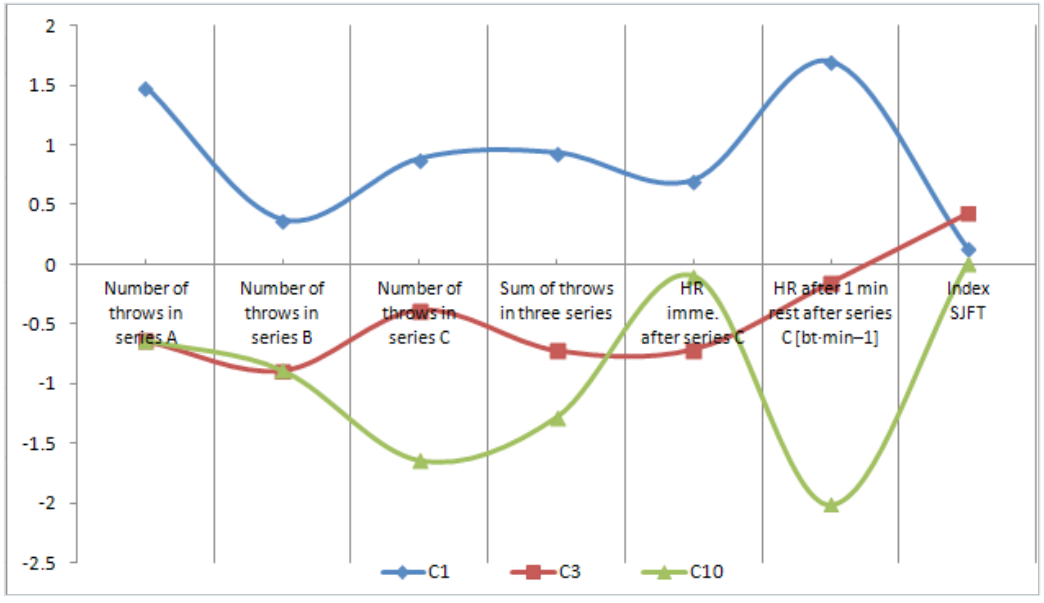

Figure 4. Standardized on the arithmetic mean and standard deviation profiles of judo female seniors (classified at 1-, 3- and 10 positions in the ranking of sports achievements) based on special fitness (standardizing incl. absolute values of indicators)

The correlation of general physical fitness with the ranking position

In a group of 13-15 year athletes (A – comprehensive training stage) from among 8 indicators of general physical fitness only the test *bent arm hang* verged on statistical significance. The ranking position in this group of athletes increased by 0.23 with an increase in the results of this test by 1 second. The value of the coefficient of determination 0.61 and the standard error of estimate 2.83.

In Group B (directed training stage) the ranking position increased by 0.36 with an increase in results of the *hand grip* test by 1 kg and it increased by 0.26 with an increase in results of the *bent arm hang* test by 1 second. The value of the coefficient

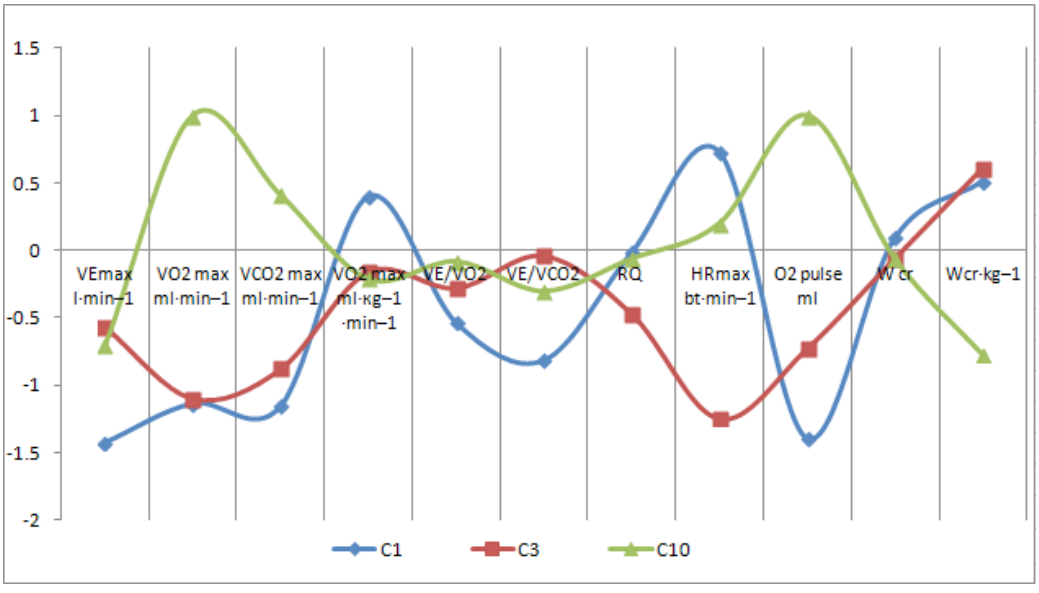

Figure 5. Standardized on the arithmetic mean and standard deviation profiles of judo female seniors (classified at 1-, 3- and 10 positions in the ranking of sports achievements) based on aerobic capacity (standardizing incl. absolute values of indicators)

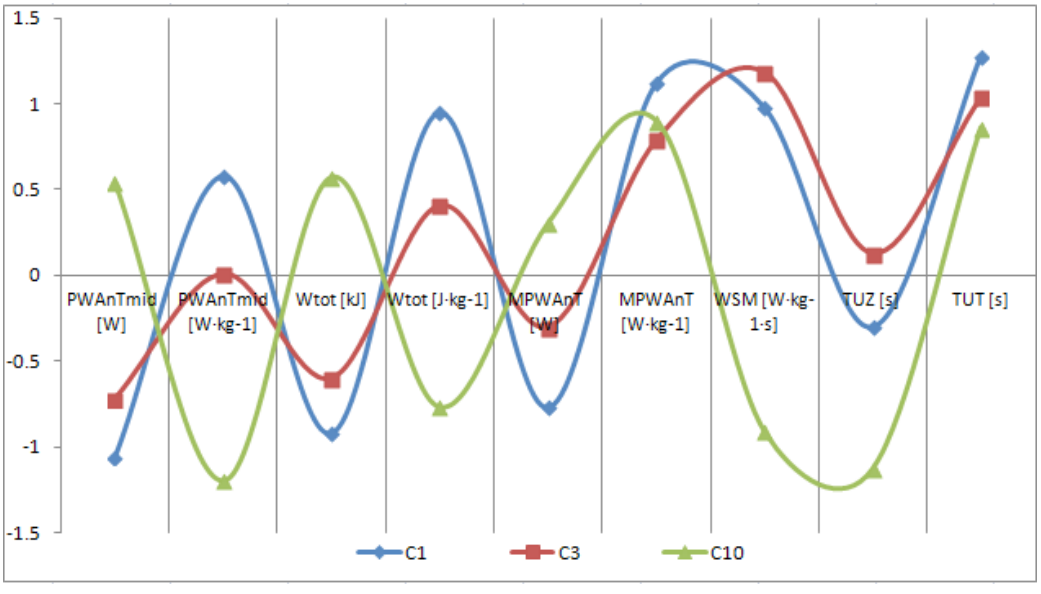

Figure 6. Standardized on the arithmetic mean and standard deviation profiles of judo female seniors (classified at 1-, 3- and 10 positions in the ranking of sports achievements) based on anaerobic capacity (standardizing incl. absolute values of indicators)

of determination 0.72 and the standard error of estimate 2.81.

In Group C (special training stage), similarly to Group A, only the indicator *bent arm hang* revealed a correlation on the verge of statistical significance. The ranking position of seniors increased by 0.22 with an increase in results of the *bent arm hang* test by 1 second. The value of the coefficient of determination 0.61 and the standard error of estimate 2.83.

The correlation of special fitness with the ranking position

In group A the ranking position increased by 2.65 with an increase in the *number of throws in series B*

of the Special *Judo Fitness Test* (SJFT) by 1. It grew by 0.19 with an increase in *the heart beat after one minute since the end of* SJFT by 1. The ranking position among the youngest athletes decreased by 0.39 with an increase in *the heart beat immediately after completion of the* SJFT by 1. The value of the coefficient of determination 0.70 and the standard error of estimate 2.63.

In Group B the regression equation did not reveal any correlations of the distinguished indicators with the ranking position of athletic achievements.

In Group C the ranking position increased by 1.49 with an increase in *total free throws* during SJFT by 1. The value of the coefficient of determination 0.65 and the standard error of estimate 2.07.

The correlation of aerobic capacity with the ranking position

In Group A the ranking position increased by 4.73 with an increase in the *maximum oxygen uptake* ($VO_{2\,max}$) by 1. It increased by 0.86 with an increase in the *ventilation equivalent of oxygen uptake* ($VE \cdot VO_2^{-1}$) by 1, while it decreased by 0.59 with an increase in the *maximum minute ventilation of the lungs* (VE_{max}) by 1. It increased by 0.90 with an increase in the *maximum heart rate* (HR_{max}) by 1. It rose by 8.29 with increasing the aerobic heart rate ($O_2 \cdot HR^{-1}_{max}$) by 1. It decreased by 0.15 with an increase in $VO_{2\,max}$ by 1 and rose by 0.06 with an increase in the *volume of exhaled carbon dioxide at maximum power* ($VCO_{2\,max}$) by 1. In the studied group of athletes the variable *critical power* (W_{cr}) revealed a correlation on the verge of statistical significance. The ranking position increased by 0.66 with W_{cr} growth by 1. The value of the coefficient of determination – 0.99 and the standard error of estimate 0.81.

In Group B the variable *maximum oxygen uptake* (VO_{2max}) was correlated with the ranking position on the verge of statistical significance. The ranking position in this group of athletes increased by 0.13 with $VO_{2\,max}$ growth by 1. The value of the coefficient of determination – 0.76 and the standard error of estimate 2.46.

In Group C, the variable *critical power* (W_{cr}) was located on the verge of statistical significance. The ranking position in this group of athletes increased by 2.58 with W_{cr} growth by 1. The value of the coefficient of determination 0.48 and the standard error of estimate 2.86.

The correlation of anaerobic capacity with the ranking position

In Group A no significant correlations between the tested variables were found.

In Group B the variable *time of maintaining maximum power* in the Wingate test (TUT) was correlated with the ranking position on the verge of statistical significance. The value of the coefficient of determination 0.64 and the standard error of estimate 3.54.

In Group C the ranking position increased by 0.11 with an increase in *total work* by 1. The value of the coefficient of determination 0.57 and the standard error of estimate 0.60.

Discussion

Zbigniew Czajkowski, a very experienced fencing coach and a scholar, stressed that individual factors affecting performance in competitions vary with age and training experience. Other factors, characteristics and properties determine sports success at the initial stage of training, and other at the championship stage. He showed in his research that the more advanced the training stage, the less importance of general fitness as a basis for directed and special performance, and that the correlation coefficient between comprehensive (general) fitness and sports results significantly decreases with athletes' age and experience [30]. Kalina's et al. research [11] proved that the ability to win in very simple close combat is not highly correlated with general fitness. Continuing this concept of research, Sertić et al. [12] verified a hypothesis that performance and final success (victory) in judo vertical posture bouts strongly depends on motor features of the contestants involved. The obtained results indicate that there is a relationship between latent motor variables and both criteria evaluating performance in vertical posture bouts – the number of victories and technical efficacy points.

Our research authenticates these conclusions. Application of multiple regression enabled a more in-depth examination of the correlation between training experience, and above all physical fitness (general and special) and physical capacity (aerobic and anaerobic) with athletes' ranking positions based on sports achievements. These correlations are highly discrete. Sertić et al. [12] called them "latent motor variables". On the one hand, application of cluster analysis in our research enabled identifying athletes with similar morphofunctional characteristics and properties but differing, even extremely, in the ranking position of

athletic achievements. On the other hand, it showed that women with the highest sports successes, regardless of the stage of judo training, are characterized by a certain similarity of morphofunctional properties.

Ryguła [31] showed a high importance of the application of cluster analysis in sports sciences on the example of selection of handball competitors, while Roczniok [32] demonstrated that multidimensional exploration techniques can be effectively used to assist the process of selection for sports swimming. Also Magiera [33], using multiple regression in research on sport climbing competitors, stressed that the most reliable results can be achieved by specifying predictive values of particular trials and tests from different areas of expertise, and then an optimal set of variables with the highest diagnostic and prognostic value. In our study, the results of multiple regression showed that in the tested judo athletes from among 8 indicators of general physical fitness only tests measuring muscle strength (*bent arm hang* and *hand grip*) are significantly correlated with the ranking position. Therefore, the recently published studies on judokas' *hand grip* [34-36] must be regarded as an important direction of research.

Sterkowicz et al. [37] conducted research which was to determine whether the weight category, age and training experience, the degree of advancement, and the level of athletic achievement indeed differentiate judo athletes in terms of specific fitness tests. These studies showed, among others, that the total throws of SJFT (a test applied also in our study) significantly correlates with achievements in competitions.

These indicators have proven to be prognostic also in our research. In a group of athletes with the highest sports level the *total number of throws* performed in SJFT significantly correlated with the ranking position. Also the *number of throws in the series B* and *the heart beat immediately after completion of the test* had a significant relationship with the ranking position, but only in the group of the youngest athletes who implemented the comprehensive training stage (group A). In the third set of variables (aerobic capacity indicators), *maximum oxygen uptake* (in Group A and B) and *critical power* (in Group C) had the greatest correlation with the sports level. An analysis of the relationship between indicators of anaerobic capacity with the sports level showed that only in the youngest group of athletes there were no important correlations of any specific indicator. This result suggests a conclusion that only long-term judo training creates specific adaptive mechanisms manifested by a relationship of anaerobic capacity with sports achievements (a throw and counterattack requires a dynamic engagement of motoneurons involved during these operations, similarly to a few seconds' restraining of the opponent's moves when fighting the horizontal posture, or *ne waza – pining techniques, strangle techniques, the joint techniques*).

We believe that the most important generalization of discussion of our results against the background of the previously published research results of other authors can be narrowed down to three statements:

it is the most important to determine early a judo adept's talent for this sport, because the coach has no influence on talent, but he can either develop it (if he is qualified) or ruin the chances to achieve results at the level of the highest international competition (Olympic sport and World Championships) if he makes mistakes regarding long-term planning of training, the content of training sessions, and burdening the body with physical effort;

it is possible that a person with outstanding aptitude for judo will be simultaneously characterised by unique morphofunctional and mental properties, which authorizes a prediction that he/she would well tolerate specific efforts, be less prone to injuries and more resilient to failure and a destructive impact of successes on the psyche in the long run;

a person with a talent for judo fight but much more inferior to peers in terms of morphofunctional and mental properties should be provided with individualised training as soon as possible for the sake of his/her motor safety and effort safety.

Conclusions

The results confirm a thesis that it is impossible to accurately predict the future sports performance even on the basis of a number of systematically monitored morphofunctional traits of judo athletes at each stage of training. The applied method allows, however, determining factors which at particular stages of judo training are most strongly associated with efficiency during the most important judo tournaments.

References

1. Raczek J. Okresy krytyczne w treningu sportowym dzieci i młodzieży. Sport Wyczynowy 1988; 12 (288): 9-1 [in Polish]
2. Płatonow W. N. Obszczaja tieorija podgotowki sportsmienow w olimpijskom sportie. Kijów 1997; Olimpijskaja Literatura [in Russian]
3. Ryguła I. Proces badawczy w sporcie. AWF, Katowice 2003 [in Polish]
4. Płatonow WN, Sozański H. Optymalizacja struktury treningu sportowego. RCMszKFiS, Warszawa 1991 [in Polish]
5. Raczek J. Podstawy szkolenia sportowego dzieci i młodzieży. RCMszKFiS, Warszawa 1991 [in Polish]
6. Tumanian GS. Sportiwnaja borba, otbor i planirowanie. WiS Moskwa 1984 [in Russian]
7. Jagiełło W. Wieloletni trening judoków. COS. Warszawa 2000 [in Polish]
8. Jagiełło W, Kalina RM, Tkaczuk W. Age peculiarities of speed and endurance development in young judo athletes. Biol Sport 2001; 18(4): 281-295
9. Jagiełło W, Kalina RM, Tkaczuk W. Development of strength abilities in children and youths. Biol Sport 2004; 21(4): 351-368
10. Jagiełło W, Kalina R. Properties of Motor Development in Young Judokas. J Hum Kinet 2007; 17:113-120
11. Kalina RM, Chodała A, Dadeło S et al. Empirical basis for predicting success in combat sports and self-defence. Kinesiology 2005; 37(1): 1-13
12. Sertić, H, Sterkowicz, S, Vuleta D. Influence of latent motor abilities on performance in judo Kinesiology 2009; 41(1): 76-87
13. Jagiełło W, Kalina RM, Korobielnikow G. Morphological diversification of female judo athletes. Arch Budo 2007; 3: 27-34
14. Franchini E, Huertas JR, Sterkowicz S et al. Anthropometrical profile of elite Spanish judoka: comparative analysis among ages Arch Budo 2011; 7(4): 239-245
15. Jagiełło W. Differentiation of the body build in judo competitors of the men's Polish national team. Arch Budo 2013; 9(2):117-125
16. Callister R, Callister RJ, Staron RS et al. Physiological characteristics of elite judo athletes. Int J Sports Med. 1991; 12: 196–203
17. Laskowski R. Obciążenia treningowe a wydolność fizyczna kobiet trenujących judo. Gdańsk 2007; AWFiS [in Polish]
18. Franchini E, Bertuzzi RCM, Takito MY et al. Effects of recovery type after a judo match on blood lactate and performance in specific and non-specific judotasks. Eur J Appl Physiol 2009; 4: 377–383
19. Pałka T, Lech G, Tyka A et al. Differences in the level of anaerobic and aerobic components of physical capacity in judoists at different age. Arch Budo 2013; 3: 195-203
20. Adam M. A profile of Paweł Nastula's individual technical-tactical preparation. Arch Budo Sci Martial Art Extreme Sports 2013; 9: 69-75
21. Adam M, Smaruj M. The indices of technical-tactical preparation of the World's Judo Champions in Tokyo 2010 as an assessment criterion for individual training Arch Budo Sci Martial Art Extreme Sport 2013; 9 33-39
22. Sikorski W. Nauka praktyce judo. Polski Związek Judo. Warszawa 2010 [in Polish]
23. Sterkowicz S, Sacripanti A, Sterkowicz-Przybycień K. Techniques frequently used during London Olympic judo tournaments: A biomechanical approach. Arch Budo 2013; 1: 51–58
24. Pilicz S, Przewęda R, Dobosz J et al. Physical Fitness Score Tables of Polish Youth. Criteria for Measuring Aerobic Capacity by the Cooper Test. Studia i Monografie AWF. Warszawa 2002
25. Sterkowicz S. Test specjalnej sprawności ruchowej w judo. Anrtopomotoryka 1995; 12-13: 29-44–[in Polish]
26. Suchanowski A. Efficiency and restitution. Research Yearbook 1993; 1: 97-105
27. Zdanowicz R, Wojcieszak I, Wojczuk J. Cykloergometryczny test wydolności anaerobowej. [In:] Wydolnościowe testy specjalne – wdrożenia. Instytut Sportu, Warszawa 1985: 9-25 [in Polish]
28. Bar-Or O. The Wingate anaerobic test: An update on methodology, reliability, and validity. Sports Med 1987; 4: 381-384
29. Stanisz A. Przystępny kurs statystyki z zastosowaniem STATISTICA PL na przykładach medycyny. StatSoft, Kraków; 2007 [in Polish]
30. Czajkowski Z. Wpływ wybranych czynników na wyniki osiągane przez szermierzy. In: Sterkowicz S (ed). Czynności zawodowe trenera i problemy badawcze w sportach walki. Zeszyty Naukowe AWF Kraków; 2001; 83: 254-274 [in Polish]
31. Ryguła I, editors. Elementy teorii, metodyki, diagnostyki i optymalizacji treningu sportowego. AWF Katowice; 2002 [in Polish]
32. Roczniok A. Zastosowanie analizy skupień w procesie naboru do pływania sportowego. Zeszyty Metodyczno-Naukowe AWF; Katowice; 2006; 21: 167-175 [in Polish]
33. Magiera A. Zastosowanie modelu wielorakiej regresji i funkcji klasyfikacyjnych we wspinaczce sportowej. Zeszyty Naukowo-Metodyczne AWF Katowice; 2008; 25: 7-22 [in Polish]
34. Franchini E, Miarka B, Luciano et al. Endurance in judogi grip strength tests: comparison between elite and non-elite judo players. Arch Budo 2011; 7(1): 1-4
35. Sánchez AG, Domínguez AS, Turpin JAP et al. Importance of hand-grip strength as an indicator for predicting the results of competitions of young judokas. Arch Budo 2011; 7(3): 167-170
36. Bonitch-Góngora JG, Almeida F, Padial P et al. Maximal isometric handgrip strength and endurance differences between elite and non-elite young judo athletes Arch Budo 2013; 4: 239-248
37. Sterkowicz S, Blecharz J, Lech G. Zróżnicowanie zawodników judo wysokiego poziomu sportowego w aspekcie wskaźników doświadczenia, rozwoju fizycznego, sprawności psychomotorycznej oraz działalności startowej. In: Sterkowicz S, editors. Czynności zawodowe trenera i problemy badawcze w sportach walki. Zeszyty Naukowe AWF Kraków; 2001; 83:124-135 [in Polish]
38. Kudo K. Judo in action. Grappling techniques. Japan Publications Trading Company. Tokyo, San Francisco; 1974
39. Kalina RM, Barczyński BJ. EKO-AGRO-FITNESS© original author continuous program of health-oriented and ecological education in the family, among friends or individually implemented – the premises and assumptions. Arch Budo 2010; 6(4): 179-184

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