CONDITIONS OF SPORTING LEVEL OF FENCERS AT MASTER STAGE OF TRAINING[1]

by

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The paper presents complementary set of statistical methods (factor analysis, taxonomic analysis, one of so called aggregate methods, analysis of information store), leading to separation of a set of variables bringing the greatest stockpile of information on the sporting level of athletes practicing fencing. Especially worth emphasizing is the application and verification of the method (index of competitive development), enabling linear sorting of investigated objects (athletes practicing fencing). Such solution creates conditions of methodologically correct application of strong statistical methods (linear regression function) of great importance in sport prediction.

Key words: Predictive value, information store, aggregate methods, index of competitive development.

Introduction

When making an overview of works connected with issues of research it should be said, that majority of investigations and publications concerning fencing is concentrating on the area of psychomotor issues (different kinds of reaction time), morphostructural predispositions and aspects of special proficiency in fencing. A great part of research is also dedicated to psychological conditions, above all concerning the sphere of personality and temperament characteristics and to psychology of behavior and motivation. A common denominator of this research was gaining information that might be used to construct so-called model of a master, that is a specific optimum of

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characteristics enabling effective selection of candidates to fencing sport and further diagnosing the development of separate abilities.

On the investigation of the components constituting psychomotor abilities in fencing worked Czajkowski [3, 4, 5], Fabian [8], Korfanty [14], Morys [16], Keller, Tyszler [12], Salczenko [26]. Problems of connections of temperament and personality characteristics with effectiveness in fencing fight was reflected in numerous reports and papers of workers as Czajkowski [6, 7], Litkowska-Grzegorczyk [15], Stawowska [27], Rychta [18], Kłodecka-Różalska [13], Bandach [1], Nawrocka [17].

Watching research achievements in fencing during the last 25 years, we must point out the projects of Wężowski [30], Czajkowski [6] and Brol [2]. These workers have made empirical verification of tests widely used in measurable sports. Their work have brought scientific confirmation of notion on decisive influence of directed and special proficiency on the level of results in fencing. Moreover, these papers contain proof of the importance of the specificity of training principle (the choice of contents, directions, kind of exercises, methods and forms according to specific needs of given discipline of sport). In spite of the their importance and logic placement in modern theory of sports, it seems that the newest trends in sport research demand much more effective methods and tools of scientific investigation.

Modern theory of diagnostic investigation should present integral approach to information store obtained in research procedures. Only integrated factors from different areas of science give fully objective picture of complex relations that combine to form sport level in given disciplines of sport. In the last years, diagnostics of motor abilities complex is based on progressively more modern laboratory and computer methods. To explain the connections and cross relations between indexes of different abilities or between their components, the investigators use complex mathematic-statistical and mathematic-logical methods, with high efficiency confirmed in many papers. The breakthrough in this area were works of Ryguła and Sokołowski [24], proving the effectiveness of statistical methods in evaluation of diagnostic usefulness of chosen tests. The innovative value of the concept lies in enriching the diagnostic value of tests with evaluation of their meaning in the process of predicting the future on the basis of biometric model. On the other hand, it is

desirable to determine the information hoard, decisive for the degree of development of separate athletes on the successive stages of sport ontogenesis [23]. The essence of diagnostic investigation is above all the reasonable specification of indexes for analyzed characteristics, and next - choosing from the wide set of these characteristics the ones that bring the greatest store of information on the sport score (level of sport development). The aim is to find for each type of sport (methodologically most correctly) a set of variables with the highest diagnostic and predictive value.

The aim of investigation

One of the aims of this work is verification of usefulness of synthetic measures of development (aggregate methods[4]) for building endogen variable of fencers' preparation to sport combat. Their use will enable methodologically correct estimation of parametric tests, and therefore of optimization algorithms. The quantitative expression of explaining variable in fencing will also enable enormous increase of availability of research as well as solving many complex problems, requiring application of new analytical methods (differential calculus), so far unused in this sport. The main aim of this investigation is optimal choice of explaining variables for mathematical model, which variables provide the greatest amount of information on the sport level of the fencers in the master stage of training.

Research questions

To meet urgent needs of competition sport, this paper attempt to obtain answers for the following research questions:

1. How to specify explaining variables that bring the greatest amount of information on the sport level of the fencers?
2. Which of the investigated tests will be included in optimal combination of explaining variables of regression model?
3. In which degree the tests included in the optimal combination of explaining variables explain the variability of sport level of the investigated fencers?

[4] For more details, see [Rygula, Sokolowski, Wyderka 1993].

Material, methods and research tools

The material for versatile statistical analysis consists of 28 members of Polish National Team, classified in the FIE ranking, called the Olympic group.

Measuring psychomotor abilities

- **Visual-motional coordination** - test made with cross apparatus using an option "impressed program".
- **Simple reaction time** based on computer program authored by I. Ryguła [22].
- **Reaction time with choice** [22].

  In both cases, i.e. simple and complex reaction time, the logging of errors made was treated as an index of concentration and attention focusing.

Psychological investigation

- **Measuring individual differences in the scope of temperament** dimensions with Strelau questionnaire in Wjatkin modification [31]. Four factors were analyzed: agility of nervous processes, intensity of excitation processes, intensity of suppression processes, equilibrium of nervous processes as ratio of excitation index and suppression index.
- **Measuring individual differences in the scope of personality dimensions** according to Personality Inventory of H.J. Eysenck.

  Three indexes were analyzed: neurotizm, extraversion/introversion, lie.

Investigation of special physical aptitude[5]

- **Fencers' endurance -** measuring time on the 16 x 6 m forwards and backwards with steps in fencer's position (the measurement was recorded electronically with resolution of 0.01 s).
- **Precision of movements and spatial orientation -** "pinning" of dropping gloves in 3 tries of 5 series. The result was the number of successful tries (the sum of 3 pinnings in 5 series).
- **Speed of movements, complex from in coordination sense.** The test consisted of combination of 3 fencing actions with measuring of time.

[5] More detailed description of these tests including figures is contained in the paper: Borysiuk Z.: Uwarunkowania poziomu sportowego szermierzy we wstępnym i mistrzowskim etapie szkolenia (Conditions of sporting level of fencers in initial and master stage of training). AWF, Katowice 1999. Doctor's thesis.

- **Agility** (ability of motor adaptation). The test consisted of obstacle run with fencing arms.
- **Ability to make movements with high frequency -** Zuchora test, a form of skipping with clapping hands under the knees in 15 s time.

Anthropometry measurements

They were limited to evaluation of body height and mass. On the basis of these variables Roher slimness index was calculated.

Tools of statistical analysis

Hellwig index of information amount

With consideration of methodologically correct estimation of biometric model[6], in the present investigation has been used algorithm of optimal choice of explaining variables, suggested by Z. Hellwig. This algorithm contains computation of so-called individual capacities of information carriers, defined by the equation:

$$h_j = \frac{r_{oj}^2}{1 + \sum_{i=1}^{k} r_{ij}} \tag{1}$$

and integral capacity:

$$H = \sum_i \left| h_j \right| \tag{2}$$

where:

r_{oj}^2 is correlation coefficient of investigated variables x and dependent variable Y, r_{ij} is correlation coefficient between the remaining independent variables. The combination of independent variables with the highest value of H is the solution of the problem. The value of H is normalized in the <0, 1> range and enables to evaluate the amount of information introduced by chosen variables.

[6] Biometric model is a formal construction showing basic connections between investigated variables [19].

Biometric model as a predictor of effectiveness of criteria of evaluation of sporting level

The application of biometric model enables to determine interactions between investigated variables.

In order to determine the diagnostic value of analyzed variables, this work uses the linear form of regression model, expressed with the equation:

$$\hat{Y} = a_0+a_1x_1+a_2x_2+...+a_nx_n \quad (3)$$

where:

$\hat{Y}$ is endogenous variable computed from the sample, x_1, x_2, x_3 … x_n are explaining variables.

After estimation of the regression model it is necessary to determine the fitting of the model to empirical data by determination of consistency measures. They are:

- determination coefficient described by the equation:

$$R^2 = \frac{\sum_{i=1}^{n}(y_i - \dot{y})^2}{\sum_{i=1}^{n}(y_i - \bar{y})^2} \quad (4)$$

- coefficient of convergence:

$$\varphi^2 = 1 - R^2 \quad (5)$$

- rest variance:

$$S_u^2 = \frac{1}{N-(k+1)}\sum_{i=1}^{n}(y_i - \dot{y}_i)^2 \quad (6)$$

- rest standard deviation:

$$S_u = \left[\frac{1}{N-(k+1)}\sum_{i=1}^{n}(y_i - \dot{y}_i)^2\right]^{\frac{1}{2}} \quad (7)$$

Aggregate index of competitive development

Analysis of the effects of sport combat in fencing presents multiple formal and methodological problems, therefore:

- It is extremely difficult to find criterion enabling to express the achievements of separate athletes on the ratio scale;
- The investigation of the effects of actions of separate athletes with the use of categorized observation techniques formerly used (observations sheet) is very cumbersome and requires a great amount of work.

For these reasons in many scientific disciplines attempts are made of synthetic formulation of endogenous variable [9,21,25]. With this in mind, the present paper presents a model of competitive development, developed on the basis of an algorithm presented by Hellwig [10].

Index of competitive development

Given is a set of athletes $W = \{X1, \ldots, Xk\} \subset R^n$, represented by vectors of their characteristics after normalization. The characteristics are divided to stimulants (S) and destimulants (D). As a standard of the athlete, we will assume a vector $Y = (Y^1, \ldots, Y^n)$, having components equal maximum values of stimulants in a set Ω: $Y^{i,s} = \max\limits_{1\le j\le k} X_j^{i,s}$ and minimum values of destimulants in set Ω: $Y^{i,d} = \min\limits_{1\le j\le k} X_j^{i,d}$. We want that the best athlete in the group (or greater part of them) should differ as little as possible from the standard. Therefore we create numbers:

1° $c_{io} = \left[\sum_{i=1}^{n}(X_i^l - Y^l)^2\right]^{1/2}$ - distance of each vector X_i from standard Y;

2° $\bar{c}_o = \frac{1}{k}\sum_{i=1}^{k} c_{io}$ - mean distance from the standard;

3° $s_o = \left[\sum_{i=1}^{n}(c_{io} - \bar{c}_o)^2\right]^{1/2}$ - standard deviation of these distances;

4° We construct an index of competitive development

$$d_i = 1 - \frac{c_{io}}{\bar{c}_o + 2s_o} \qquad 0 \le d_i \le 1 \tag{8}$$

The closer the index d_i is to 1, the closer to the standard is the i-th athlete.

Factor analysis

Because of the fact, that the investigated characteristics form specific complex of predispositions specified in different measuring scales (order and interval), it is necessary to verify the results of analyses obtained with the use of Hellwig algorithm and multiple regression function. For this purpose multiple factor analysis was used. The main idea in the application of this statistical analysis tool was transformation of greater number of operational indexes into smaller number of conception variables, Another important reason for using factor analysis (in addition to analysis of regression function) was verification of the assumption of the existence of hidden variables (factors), which may have connection with analyzed variables (indexes). It may be one or several hidden variables that may reason for existence in connection with imperfection of measurements effected with the use of applied indexes. In solving this problem was used extraction with the method of principal components as criterion of factor separation, assuming eigenvalue not less then one. Next, the oblique rotation of the factors was made with oblimin method and when no correlation between separated factors greater than 0.25 has been found, the orthogonal rotation with Varimax method was effected.

Results

This work analyses in detail the results of the investigation made on a group of actually best Polish fencers, so-called Olympic cadre. The results of measures of position ($\bar{x}$), variability (V) and scattering (S) in the investigated group show that the analyzed variables have very differential distribution.

The analysis of computed variability (V) indicates that the greatest differences occur in variables x_{10}, x_{21} and x_4. The smallest spread is observed in variables as body height (x_{18}), fencing endurance (x_{12}) and Rohrer index (x_{20}).

On the basis of the analysis of asymmetry index and kurtosis index, it may be said, that the investigated variables have moderately asymmetric distribution, little differing from the normal distribution. This corroborates the thesis on permissibility of using strong statistical tests (correlation and regression calculus).

Table 1. Statistical measures of position and variability of investigated characteristics of fencers (adult, N-28)

Variable name	Mean	Standard deviation	Variability index	Asymmetry index	Flattening index
Strelau - agility of nervous processes [pts]	55.500	11.633	21.0	–0.467	2.206
Eysenck - neurotizm level [pts]	17.000	8.190	48.2	0.865	2.121
Eysenck - extraversion level [pts]	35.000	3.919	11.2	–0.153	2.483
Eysenck - lie level [pts]	7.286	3.544	48.6	0.528	2.079
Strelau - intensity of stimulation processes [pts]	44.071	8.984	20.4	–0.129	2.197
Strelau - intensity of inhibition processes [pts]	40.071	8.289	20.7	0.445	1.662
Simple reaction time [s]	0.183	0.018	9.9	2.243	2.374
Number of errors in simple reaction test [pts]	0.500	0.090	18,1	2.002	2.827
Complex reaction time [s]	0.367	0.033	9.0	0.645	2.252
Number of errors in complex reaction test [pts]	4.000	3.505	87.6	1.807	2.017
Cross apparatus test [pts]	99.929	22.558	22.6	–0.811	2.504
Fencing endurance test [s]	38.579	1.693	4.4	–0.286	2.240
Specialty test - combination of 3 actions [s]	4.201	0.405	9.6	0.484	2.239
"Glove pinning" [pts]	10.964	1.822	16.6	–1.719	2.924
"Obstacle run" [s]	34.720	2.314	6.7	0.791	2.563
Zuchora test - 15 s [s]	47.286	4.325	9.1	0.254	2.236
Strelau - balance of nervous processes [pts]	1.162	0.381	32.8	0.367	2.269
Body height [cm]	178.821	5.445	3.0	0.628	2.276
Body mass [kg]	75.607	5.466	7.2	0.173	2.164
Rohrer index [a.u.]	1.322	0.068	5.2	0.599	2.396
Index of competitive development [a.u.]	0.365	0.182	50.0	–1.190	2.241

Factor analysis

The computations effected on the matrices of correlation coefficients of 21 characteristics (tests) covering separate effects of motor ability, psychomotor

ability and psychological tests indicate the presence of seven factors, explaining 77.5% of total variability.

The obtained results indicate that the analyzed characteristics are complexes of chosen conceptual variables (aptitudes and predispositions).

Table 2. Factor analysis of 20 chosen variables in a group of male fencers (N-28)

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Determination index R^2
Strelau - agility of nervous processes [pts]	0,107	–0,335	0,213	–0,074	–0,027	0,766*	0,234	0,762
Eysenck - neurotizm level [pts]	0,458	–0,135	–0,614	–0,047	0,395	0,054	–0,180	0,891
Eysenck - extraversion level [pts]	–0,216	–0,236	0,784*	–0,124	0,057	–0,081	–0,022	0,804
Eysenck - lie level [pts]	–0,250	–0,007	–0,899	0,070	0,028	0,009	–0,707*	0,640
Strelau - intensity of stimulation processes [pts]	0,370	–0,115	0,779*	0,135	0,125	0,251	0,109	0,947
Strelau - intensity of inhibition processes [pts]	0,178	–0,504	–0,225	0,011	0,180	0,010	0,642	0,942
Simple reaction time [s]	0,175	0,531	–0,107	0,490	–0,132	–0,308	0,024	0,566
Number of errors in simple reaction test [pts]	0,303	0,274	0,259	–0,407	0,380	–0,204	0,191	0,726
Complex reaction time [s]	–0,029	0,099	0,052	0,864*	–0,015	–0,040	0,031	0,780
Number of errors in complex reaction test [pts]	0,057	0,203	–0,039	–0,788*	–0,055	0,207	0,077	0,716
Cross apparatus test [pts]	–0,422	–0,567	–0,290	0,020	–0,193	–0,180	0,246	0,739
Fencing endurance test [s]	0,161	0,02	–0,039	–0,015	0,919*	–0,072	0,114	0,808
Specialty test - combination of 3 actions [s]	–0,202	0,066	0,051	0,104	0,851*	0,282	–0,067	0,794
"Glove pinning" [pts]	–0588	–0397	0,081	0,402	0,102	0,102	0,057	0,872
"Obstacle run" [s]	0,011	0,869*	–0,196	–0,121	0,051	0,022	–0,016	0,762
Zuchora test - 15 s [s]	–0,201	0,141	0,014	0,246	–0,501	0,265	0,466	0,759
Strelau - balance of nervous processes [pts]	0,246	0,302	0,672	0,175	–0,071	0,217	–0,464	0,957
Body height [cm]	–0,898*	–0,066	0,004	0,041	–0,075	–0,187	–0,157	0,998
Body mass [kg]	–0,918*	0,006	–0,025	–0,041	–0,020	0,095	–0,202	0,998
Rohrer index [a.u.]	0,790*	0,258	–0,039	–0,251	0,094	0,003	–0,176	0,991
Eigenvalue	2,973	2,287	2,378	2,168	2,269	1,757	1,670	
Total variability [%]	14,87	11,44	11,89	10,84	11,35	8,79	8,35	

Factor analysis as a research method, has enabled to determine general structure of variability hoard and participation of chosen indexes of analyzed phenomenon.

Optimal choice of explaining variables for regression model

With reference to the research questions presented in the work it should be said that the optimal combination of explaining variables consists of: x_5 - intensity of stimulation processes, x_{11} - result of cross apparatus test and x_{18} - body height. It is worth mentioning that introduction of further variable to the analysis causes reduction of information store - the best combination of four explaining variables H_{max} is 0.85, for five explaining variables it is 0.827.

H_{max} value of the best combination of twenty explaining variables was only 0.518. These results show the importance of using an algorithm of optimal choice of Z. Hellwig explaining variables and the value of this procedure in sport diagnostics.

BEST COMBINATION OF 1n EXPLAINING VARIABLES
No. of explaining variable: 11
Maximum value of Hellwig index of information store = 0.799
Value of indeterminance index $\varphi^2 = 0.201$
BEST COMBINATION OF 2n EXPLAINING VARIABLES
No. of explaining variable: 1, 11
Maximum value of Hellwig index = 0.873 (H_{max} increases)
φ^2 value = 0.094
BEST COMBINATION OF 3n EXPLAINING VARIABLES
No. of explaining variable: 5, 11, 18
Maximum value of Hellwig index = **0.875**
φ^2 value = 0.082
BEST COMBINATION OF 4n EXPLAINING VARIABLES
No. of explaining variable: 5, 10, 11, 18
Maximum value of Hellwig index = 0.850
φ^2 value = 0.082
FINAL, OPTIMAL COMBINATION OF EXPLAINING VARIABLES
Hellwig index of information store = 0.875
Convergence index $\varphi^2 = 0.082$
Number of chosen explaining variables: 5, 11, 18

Structural parameters of regression equation
constant = –1.3141 error: 0.3536
variable no. 5: coeff. = 0.0068 error: 0.0012
variable no. 11: coeff. = 0.0064 error: 0.0005
variable no. 18: coeff. = 0.0041 error: 0.0020
Evaluation of the accuracy of regression function estimation
Parameters of the stochastic structure of regression equation:
Rest variance - 0.0032
Standard deviation of rests - 0.0564
Convergence index - 0.0819
Determination index - 0.9181

Analysis of the structural parameter values of the computed regression equation shows that the greatest influence on the level of sporting development of the investigated fencers had variable x_5 (0.0068), and then x_{11} (0.0064). The value of determination index R^2 contains information that the variables chosen for the equation explain about 92% of variability of the investigated phenomenon. Therefore it may be said that these characteristics have high diagnostic value.

Summary

Decisive role of presented psychomotor abilities (coordinative predispositions) on the result of fencing combat is confirmed by the experts: Keller and Tyszler [12] and Czajkowski [6] in Poland. Summing up the results of our researches it is worthwhile to compare them with the conclusions of the workers mentioned above:

- There is positive connection between reaction time and the results of fencers (the shorter the time, the better results);
- The speed of different kinds of reaction lowers with competitive experience, but is always better then in persons not practicing fencing;
- The fencers of lower class improve their speed by shortening period of execution through improvement of technical skills;
- High class fencers, with perfect technique, improve speed through shortening hidden period of reaction;

- American workers: Keele and Hawkins [11] have indicated that in combat sports and team games - in addition to reaction time, speed of movement, perceptual sensitivity, time sharing ability - the factor decisive for effectiveness and successes is in the first line the flexibility of attention.

The above observations are in good agreement with the results of whole presented investigation procedure in the scope of psychomotor abilities. It seems that the only discrepancies concern the first two observations, because the collected research material does not entitle us to univocally maintain that there is positive connection between reaction time and high sporting level. It is rather thought that the results of reaction speed tests differentiate advanced athletes and beginners, but within the group, e.g. National Team of Poland, have no deciding influence on sporting level.

In accordance with the presumptions of this work - in addition to problems of psychomotor abilities - the greatest attention has been directed to the area of temperament and personality conditions of investigated athletes. In the process of verification of results of investigations and analyses were used Hellwig algorithms described earlier and factor analysis. The collected data confirmed the assumption on the dominating role of extraversion, decidedly dominating among the best athletes, that is Olympic group. Comparison of extraversion level with the principal determinant of temperament, intensity of stimulation process brings univocal similarities on account of sporting level of the subjects. The results of factor analysis of the Olympic group of males confirm the above regularities. This is testified by the third factor in the Olympic group of males "saturated" with an index of extraversion level (0.784) and with intensity of stimulation process (0.780). Integrating these components in one factor informs on their mutual interdependence and meaningful influence on the fencing results. Because in accordance with the concept of Strelau [29], the meaningful role of the index of extraversion level informs on the high reactivity level - a characteristic that usually marks the top class athletes. These results are in agreement with observation of Bandach, who has investigated the cadre of foil fencers, concentrating on the personality dimensions, and found just 25% introverts among them.

Recapping, the conducted investigation has shown - in agreement with observations of numerous workers - a dominance of extravert type among top fencers, characterized with great intensity of stimulation process.

Referring to papers of other workers testing the personality of fencers, among others Stawowska [27], Litkowska [15], the presented conclusions confirm the observation of quoted workers, mostly in the scope of the importance of agility and intensity of nervous processes, strongly correlated with extraversion. The discrepancy seemingly concerns two questions: the level of introversion and neurotizm of top fencers. It seems that results of presented differently places emphases. On the basis of them it could be recognized that among top fencers, the athletes being at the same time introverts characterized by emotional lability, that is high level of neurotizm are extremely rare. The real importance of obtained data is confirmed by everyday training practice and observations of coaches.

Certainly, in the set of explaining variables, the results of tests from the area of special abilities could not be absent. The usefulness of specified specialty variables is confirmed by the publications in this field and experiences of coaches. Here were used the tests already used in fencing diagnostics (combination of three fencing actions, "obstacle run" and "glove pinning") and Zuchora test and test of speed endurance (16 x 6 m in fencing position).

On the basis of the values of separated principal factors (seven-factor solution for the Olympic group), three indices were identified as best predicting the fencing efficiency. They are: test of speed endurance well characterizing its specificity, multiple changes of the direction of movement, steps forwards and backwards with maximum frequency in time below 40 s, bringing the test closer to the conditions of real fight. It should be pointed out that this test has found place in optimal combination of five explaining variables of the regression model (Hellwig index - 0.827). The high accuracy of the "obstacle run" with fencing arms in factor analysis, even with not quite specific character, testifies on the role of psychical processes, specific creative invention and motor adaptation in situations of surprise, typical for fencing combat. The third specialty index reflected in factor analysis of the Olympic group of men is a test described as a combination of three fencing actions. Comparing results of

the presented investigation with reports of other authors, especially with the investigation of Czajkowski [6] nad Brol [2], we find confirmation of the highly predictive importance of two tests, i.e. "obstacle run" and combination of three fencing actions.

The subject of statistically meaningful role of the somatic factors, above all the body height should be stressed. Contrary to standard and now outdated beliefs, the fundamental indices of body build have growing importance in fencing. As early as in the seventies some papers were devoted to this problem. Among them Ziemilska [32] and Wężowski [30] have pointed out the influence of morphologic factors on the achievements in fencing. The workers named above have noticed certain specific dependencies, differences of body height and ratio of armed arm and lower limbs of the fencers practicing sword, sabre and foil. It seems that in modern fencing the important role has the reach - the length of an arm holding the fencing arms.

Conclusions

The comprehensive statistical analysis of the collected research material warrants the formulation of the following conclusions:

1. Hellwig algorithm of the optimal choice of explaining variables of the regression model enables to describe the greatest information store on the sporting level of fencers. It may therefore be universally used in combat sports.
2. On the basis of structural parameters of the computed regression equation it may be said, that the sporting level of the athletes in the Olympic group is above all influenced by the psychical characteristics and body height.
3. The variables considered in the regression equation explain about 92% of variability of the investigated phenomenon.
4. The use of factor analysis has enabled to separate seven factors in the structure of 21 variables in the Olympic group. The greatest value of the common variability (14.8%) had the factor of body build, next the factor of psychical characteristics (11.9%) and special ability (11.4). Together, seven separated factors explained 77.5% of total variability. On this basis it may be said that factor analysis have certain usefulness in the initial stage of

statistical analysis, mainly in the scope of the structure of the set of analyzed variables and hoard of their variability.

5. A method of Wrocław taxonomy, based on the graphs theory, is very effective tool of linear sorting of the set of fencers.

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