Powerlifting at Junior Level
Selection Paradigm

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Abstract: The variability of the sport result obtained in powerlifting (PL) causes a few profound problems within coaching practice. One of them is the issue that concerns assigning individuals to particular training group of fitness level. Simply, this process is called selection. Since PL does not have any scientific-based selection algorithm we reckon, it is necessary to project it, with the idea to rationale the procedure. Thus the aims of the study were to construct discriminant and classification functions. A group of thirty-two powerlifters was selected for the investigation (22,397 yr ± 0,826). The average sport result was 331,449 ± 41,959 Wilks Points. Observation method and diagnostic survey were used to collect the data. During the course of the multidimensional statistical analysis, Hellwig's algorithm, multiple regression, and discriminant analysis were utilised. The distances between stratified subdivisions of athletes were maintained in 99%. The classification matrix of young powerlifting contestants indicates that all the athletes were grouped adequately. Finally, for junior age category in PL, classification functions assign individuals to specified subgroups statistically better than a priori rule.

1 INTRODUCTION

One of the most important aspects in professional sport is the selection process. Due to methodological progress in sports science, it is important to use multidimensional techniques of data exploration alongside the issue of talent identification and thus selection. This kind of statistical analysis has been presented by Ryguła (2003) and Maszczyk (2008).

In powerlifting (PL) the essential components of sport mastery in all PL events (squat, bench press, deadlift) were revealed broadly (Mayhew et al., 1993); (Keogh et al., 2005); (Winwood, 2011). The extension of cited research is the dilemma of powerlifters selection.

The literature points out discriminant analysis (DA) as a one of the most suitable analytical methods in solving the problems concerning talent identification and the selection process in sport.

The applicability of AD was exposed earlier on the basis of many disciplines (Ryguła, 2003; Magiera and Ryguła, 2007; Saavedra et al., 2010). It is very true that it holds a privileged position in identifying some key features of sports performance, especially when its distribution is diversified among athletes. Moreover, DA is suitable for prediction group membership of a given individual (sports selection) as well as to examine the structure of sport result across a few homogenous divisions – classes (Ryguła, 2003); (Magiera and Ryguła, 2007).

2 METHODOLOGY

2.1 Methods, Aims and Hypotheses

In the paper, observation method and diagnostic survey were used. Several measurements and assessments techniques of competitors' personality characteristics were implemented to gather the data.

The aims of the research were to construct discriminant and classification functions for homogenous groups. The goals implicate following questions: (1) Which of the predictors will form the optimum set of discriminate variables that distinguish young powerlifters? (2) What will the value of cumulative proportion of discriminate functions be? (3) Will classification functions identify powerlifters statistically better in comparison with chance accuracy algorithm? These questions concern two hypotheses:

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H1: $\Lambda \neq 0$;
H2: Press's Q > $\chi^2_{(\alpha;\ df-1)}$

2.2 Participants

Thirty-two powerlifters participated in the research. All subjects answered the powerlifting history questionnaire and signed a consent form before participation. The main precondition for involvement in the study were: at least 4 years' training experience in powerlifting drill, a positive medical examination as well as a adequate level of general and specific physical fitness.

The essential number of individuals was established by the procedure proposed by Greń (1976). The study was approved by the Bioethical Committee for Scientific Research at the Regional Medical Chamber (reference number KB - 102/11).

2.3 Investigation Procedure

The study protocol consisted of seven test and seven retest days divided into two areas: general and specific. During the first day (meeting), anthropometric measurements were made. In the course of the two consecutive days a general fitness test (EUROFIT) and tests measuring the maximum power of the upper limbs and the whole body were examined. On the fourth day the efficiency of the cardiovascular system, the reaction time measurements and a psychological test (NEO-FFI) were executed. All of the aforementioned procedures were included in the general part of the diagnosis and between each meeting an interval of 24 hours was set. A retest was carried out immediately after a two day break after the last test in the general examination. Subsequently, with an interval of 48 hours, the second session of tests (powerlifting specific) was carried out. The sport result was assessed firstly. Next, after three days, specific speed was tested, and after a further two days, specific endurance was assessed. As in the case of the general part of the examination, after collecting the data from the second block of tests (powerlifting specific), with a 48 hour break, a retest was performed.

Measurements were taken during the transition phase of the annual training schedule, in the afternoon (3 PM), except for anthropometric measurements, which were performed in the morning, before breakfast. Each test was accompanied by a standard warm-up, along with a movement explanation and its demonstration.

2.4 Measurements and Variables

Independent variables were obtained by measuring different athletes' characteristics in the areas outlined below. Their detailed descriptions have been documented in doctoral thesis of Płóciennik (2012). All subjects undertook a comprehensive set of test, which include assessment in the following domains:

Anthropometric Dimensions. In order to obtain the structural status data of the powerlifters, research was performed by the same person using the tools recommended by the International Society for the Advancement of Kinanthropometry (ISAK) and by applying the assumptions of sport anthropometry (Drozdowski, 1998). Particularly, the height was measured with a portable stadiometer (Model 214, Seca Corp., Hanover, MD, USA) and weight was measured with Tanita scales (model BC-418, Tanita Corp, Tokyo, Japan). During skinfold thickness examination, a Harpenden caliper (Gima, Milan, Italy) was used. In measuring muscle circumferences we utilised a fibreglass tape. Other features of the body structure, such as skeletal dimensions – bone breadths, width or lengths were determined with a small anthropometer.

The obtained results, according to formulas proposed in the literature (Drozdowski, 1998); (Mahyew et al., 1993); (Shephard, 1991); (Watson et al., 1980), were used to determine the components of body mass (adipose and muscle tissue) in total as well as in percentage values. Also basic anthropometric indices and silhouette proportions were computed. Namely, trunk length to stature ratio, upper to lower limb length ratio, Quetelet II index, chest depth to chest width ratio, acromio-iliac index.

Maturity Offset. The formula described by Mirwald et al., (2002) was adapted;

Anaerobic and Aerobic Capacity. The maximum oxygen uptake (aerobic capacity) was defined by McArdle`s equation (McArdle et al., 1972). The maximum anaerobic work (MAW), as an expression of anaerobic–non–lactate capacity, was diagnosed according to guidelines published by Drabik (2007);

The Measurement of Overall Physical Fitness. The EUROFIT test battery was applied with a standard concept (Council of Europe, 1988);

The Muscle Power Indices. The testing procedures ware described by Council of Europe (1988); Salonia et al., (2004); Mayhew et al., (2005);

The Measurement of Specific Physical Fitness. The number of correct performed movements made within 15 seconds in each of the three PL events was the basis for the assessment of the *specific speed*. Rules for performing the trials were based on the regulations of the International Powerlifting Federation (IPF) and assumptions of anaerobic capacity test (ACT 5/15) (Bolach and Jacewicz, 2008). Fundamentally, ACT 5/15 test meets the main conditions for assessing the speed skills in PL.

According to the IPF, athletes had three rounds in each event at their disposal. Rest between attempts was as much as three minutes long. With respect to the results of the powerlifting events, the load was adjusted to 50% repetition maximum (RM). It equalled the initial intensity of the ACT 5/15 test. The time was measured with an accuracy of 1/100 second with a standard electronic timer.

Specific endurance was determined by counting subsequent repetitions in each of the PL events until exhaustion (Forbes, et al., 2007). Athletes carried out tests with a load of 70% RM (Forbes et al., 2007). After warming up, the subjects performed one attempt for each trial. Whole procedure was accomplished according to the principles of the IPF;

The Measurement of Movement Technique. The frequency of movements represented the indicator of movement technique I (IMT_I). Data from the fifth and fifteenth (last) second of specific speed tests were subjected to evaluation:

$$\text{Indicator of technique I} = \frac{\begin{array}{c}\text{average frequency of movements in 5 seconds}\\ \text{(from all events)} + \\ \text{average frequency in 15 seconds (from all events)}\end{array}}{2}$$

The technique of movement is connected with an athlete's somatic and energetic potential. Thus, keeping in mind PL requirements, a suitable construction of the indicator of movement technique II (IMT_{II}) was designed:

$$\text{Indicator of technique II} = \frac{\text{muscle mass [kg]}}{\text{upper body power} + \text{lower body power}}$$

The Measurement of Personality. NEO-FFI Personality Inventory was used in the Polish version (Zawadzki et al., 1998), based on the original inventory by Costa and McCrae (1992). Neuroticism, extraversion, openness to experience, agreeableness and conscientiousness were measured. The raw data was used in the analysis;

The Measurement of Reaction Time. Reaction time was obtained with means of computer tests (Klocek et al., 2002);

The Measurement of Hemodynamic Parameters. Stroke volume and cardiac output (SV, Q) were calculated according to Starr`s concept (as cited in Woźniak et al., 1986, p. 126).

Ultimately, the measurements of 45 characteristics were made so that in the further part of our study they served as 44 independent variables and one dependent variable Y (table 1).

2.5 Statistical Analysis

All data were primarily studied through descriptive statistics. Pearson's product moment was computed to screen the linearity across the matrix of independent variables (**X**) and to assess the relationship between each predictor variable (x_i) and Y – the sport result. Strictly, for defining errors in performed test, we used the LoA technique (Altman and Bland, 1983). In order to select the optimum combination of model parameters, Hellwig's algorithm was adapted. Its description is given by two formulas:

$$h_i = \left| r_i^2 \right| / 1 + \sum_{i \neq j} \left| r_{ij} \right| \quad (1)$$

$$H = \sum_{j=1}^{m} h_j, \quad (2)$$

where h_i – is the individual capacity of information for the i-th explanatory variable (x_i), r_{0i} is the correlation coefficient of the i-th explanatory variable with the dependent variable (Y); r_{ij} is the linear correlation coefficient between i-th and j-th explanatory variable; H is the overall capacity of information of carriers (independent variables) for a given combination. Since this analytical method does not take into consideration statistical significance of variables, we ran multiple regression analysis and therefore checked P-values. Finally, to construct selection model in PL at junior age category, we applied multiple discriminant analysis – DA (Ryguła, 2003). Briefly, one of the main goals of DA is to derive mathematical functions for strata membership of new cases. There are as many equations as subgroups under investigation. Therefore, we computed three linear classification formulas for group of weak (W), medium (M) and elite (E) sport results (Equations: 3, 4, 5).

Statistical analyses were made on a standard PC using the STATISTICA software (Release 10.0).

3 RESULTS

Data exploration was initiated from descriptive analysis. We postulate to present all variables, which were taken in the investigation (table 1).

Table 1: Descriptive characteristics of parameters tested in 21-23-year old powerlifters.

No. x_i/ Y	Units	M	SD	CV	As	Cu-3
Y- Sport result	Wilks Points	331.449	12.659	41.959	0.127	-0.588
1. Age	years	22.397	3.688	0.826	0.000	-0.968
2. Body mass	kg	83.488	12,720	10.620	0.579	0.701
3. Axillary chest circumference at maximum inhalation	cm	110.331	5.506	6.075	0.296	-0.696
4. Arm circumference	cm	36.428	7.752	2.824	-0.183	-0.799
5. Tight circumference	cm	61.941	6.433	3.985	-0.058	0.158
6. Trunk length to stature ratio	Point	30.985	4.852	1.503	0.097	-0.116
7. Upper to lower limb length ratio	Points	86.259	4.139	3.570	0.916	0.780
8. Quetelet II index	Points	26.341	8.556	2.254	0.742	0.955
9. Stroke volume	ml	65.254	9.886	6.451	0.457	0.024
10. Total body balance	n	3.156	84.445	2.665	1.097	0.627
11. Lower body power	m	2.520	4.641	0.117	0.006	-0.278
12. Upper body power	m	7.996	7.420	0.593	-0.142	-0.723
13. Total body power	m	15.434	6.218	0.960	0.723	0.779
14. Upper limb speed	s	7.803	6.572	0.513	0.249	-0.815
15. Hand grip force	kg	60.094	14.466	8.693	0.533	-0.361
16. Upper arms isometric endurance	s	38.856	35.038	13.614	0.668	0.229
17. Simple reaction time	s	0.270	7.985	0.022	-0.150	-0.274
18. Choice reaction time	s	0.444	8.777	0.039	0.244	-1.185
19. Specific speed	n	47.188	7.901	3.728	0.034	0.649
20. Indicator of technique I	Hz	1.142	8.454	0.097	-0.393	-0.379
21. Indicator of technique II	a.u.	4.946	10.995	0.544	0.002	0.120
22. Maturity offset	years	3.612	27.732	1.002	0.220	0.108
23. Quantity of fat tissue	kg	14.869	15.619	2.322	-0.195	-0.697
24. Height	cm	178.175	6.848	46.890	0.549	1.113
25. Percentage of fat tissue	%	12.255	1.490	2.219	0.226	-0.770
26. Cardiac output	l	4.594	0.341	0.116	1.377	3.649
27. VO_2max	ml/kg/min	46.243	2.089	4.362	0.789	1.100
28. Chest depth to chest width ratio	Points	71.913	5.913	34.968	0.044	-1.148
29. Acromio-iliac index	Points	67.003	4.599	21.152	1.225	2.619
30. Body surface	m^2	2.035	0.162	0.026	0.401	0.577
31. Total body water	l	49.385	4.444	19.751	0.488	0.656
32. Flexibility	cm	13.563	7.691	59.157	0.213	-0.692
33. Total endurance	n	71.219	13.937	194.241	1.150	1.947
34. Abdominal endurance	n	29.438	2.602	6.770	-0.082	0.673
35. Agility	s	19.567	2.067	4.271	0.919	1.008
36. Maksimal anaerobic power	kJ	2.109	0.327	0.107	0.684	0.523
37. Specific endurance	n	50.750	4.363	19.032	-0.118	-0.207
38. Neuroticism	Points	15.313	6.508	42.351	0.374	-0.527
39. Exstraversion	Points	29.781	6.057	36.693	0.232	-0.425
40. Openness to experience	Points	24.969	5.642	31.838	0.499	0.658
41. Agreeableness	Points	27.563	6.101	37.222	-0.772	0.098
42. Conscientiousness	Points	33.156	5.419	29.362	-0.109	-0.171
43. Quantity of muscle tissue	kg	52.107	7.329	53.719	0.145	-0.202
44. Percentage of muscle mass	%	62.344	2.728	7.440	0.433	0.220

*Presented data are expressed as mean (M), standard deviation (SD), coefficient of variation (CV), asymmetry index (A_s), kurtosis (Cu-3).
**Note: results for variables x_{11}-x_{13} were obtained in general fitness tests (see information in paragraph 2.4). Thus, original units were shown.

The reason for this is that main statistics, like mean and standard deviation are very informative about the data distribution. In turn, appropriate range of values for kurtosis and skewness enable to perform multidimensional data exploration (table 1). At this moment it is also necessary to report the errors in accomplished measurements. They were ranged from 93.75% to 100% limit of agreement (LoA).

The further (advanced) statistical analysis we began from choosing the optimum combination of variables (H_{max}) – equations: 1, 2. It included following dimensions: age (x_1), axillary chest circumference at maximum inhalation (x_3), trunk length to stature ratio (x_6), upper to lower limb length ratio (x_7), Quetelet II index (x_8), total body balance (x_{10}), lower body power (x_{11}), indicator of technique I (x_{20}).

At this stage of study relevant issue is to test H0: $b_i= 0$ and H0: $\sum_{i=1}^{p} b_i + b_0= 0$. The t and F statistics ware essential in falsification procedure (table 2). From the data, it appeared all of the predictors are statistically significant as well as the whole model. Calculations indicate that R^2 is very high and S_e rather low. Straight, it means that constructed function adequately describes sport result in PL for junior age and is good enough to incorporate it into coaching practice.

Nevertheless, the range of Y variable was high and equalled 166.079. This situation shows that the researched group of sportsmen did not represent a homogenous structure. Such an occurrence facilitates the performance of a discriminant analysis. In the very beginning of the computational process in DA, powerlifters were stratified into independent groups (subdivisions). This was done through establishing sport result categories. Consequently, we have grouped athletes into three classes: n_w - weak = 12 individuals, with sport result range: 250-299 Wilks Points; n_m - medium = 10 individuals, with sport result range 300-349 Wilks Points; n_e - elite = 10 individuals, with sport result lower limit >350 Wilks Points. Since three athletes outperformed 400 Wilks Points, the last interval is open.

Bearing in mind that DA has many restrictions (Bates, 2005), discriminant functions were computed from stepwise algorithm – the backward variant. Due to the analysis, from the verified set of variables (H_{max}), discriminant model comprised of five predicators (age (x_1), axillary chest circumference at maximum inhalation (x_3), upper to lower limb length ratio (x_7), lower body power (x_{11}), indicator of technique I (x_{20})). The total discriminant power of these variables (Wilks Lambda Λ) reached the value of 0.068. Based on this result, we can say that parameters in the model should be considered as highly adequate for developing a discriminant functions. Now, respecting theoretical assumptions, the verification of H0 is of particular interest – variables do not discriminate powerlifters. To test this, discriminant functions – u_1 and u_2, had to be constructed. The value of empirical Chi-square statistics was large enough to accept H1 only in the case of u_1. Thus, ultimately u_2 was not analysed.

In the model, the variables with the highest discriminatory power, in order of importance, were as follows: axillary chest circumference at maximum inhalation (x_3), upper to lower limb length ratio (x_7).

According to computation, the lowest weight in the function u_1 had x_1 (0.34822), and following the guidelines (Bates, 2005) it has been removed from further analysis. This move resulted in obtaining adequate high significance for all predictors in discrimination model; $\Lambda= 0.089$ ($F_{(8,\ 52)}= 15.192$; $p<0.0000$).

Due to the findings that are placed in table 3, cumulative proportion totalled 0.99. Therefore, after reducing number of dimensions to u_1 hyperspace, distances between subclasses were maintained in 99%. Besides determining the optimum hyperspace (discriminant functions) that separates athletes divisions, DA is also helpful in classification function computation. By means of DA it is possible to construct classification functions for each of the established subgroups. They should be recognized as the fundamental instruments of diagnosis process in the selection procedure (model) of young powerlifters.

Table 2: The coefficient weights of sport result predictors for junior age category powerlifters.

R= 0.977; R^2= 0.954; F(8,23)= 59.888 p<0.00000; S_e= 10.426						
n=32	b*	Stand. error b*	B	Stand. error b	t(23)	P
Intercept			-583.816	82.17859	-7.10424	0.000000
x_1	0.119476	0.051814	6.069	2.63179	2.30587	0.030476
x_3	0.235655	0.090051	1.628	0.62197	2.61689	0.015415
x_6	0.176696	0.081615	4.932	2.27785	2.16500	0.041008
x_7	0.154085	0.063421	1.811	0.74543	2.42956	0.023335
x_8	0.149064	0.068286	2.775	1.27132	2.18294	0.039504
x_{10}	-0.128212	0.061340	-2.018	0.96566	-2.09019	0.047849
x_{11}	0.129987	0.058501	46.631	20.98667	2.22196	0.036405
x_{20}	0.214541	0.068699	93.248	29.85937	3.12290	0.004781

* Names and order of variables are the same as in table 1.

**Note: the parameter R reflects the multidimensional zero-order correlation coefficient. Consequently, R^2 indicates the amount of explained variation by the regression equation. Abbreviation S_e stands for standard error of estimation; F is a common test, which in the analysis of multiple regression is utilised for measuring the significance of all parameters in the model. Finally, statistics b* and B are standardized and unstandardized coefficient weights respectively.

Table 3: The weights of the first discriminant function after x_1 exclusion.

x_3	x_7	x_{11}	x_{20}	Cumul. prop.
-0.717340	-0.802297	-0.548476	-0.500043	0.990285

* Names and order of variables are the same as in table 1.

In our research, *a priori* probability was set in accordance to group sizes. In terms of raw data, classification functions have the following structure:

$$W= -2716.19+13.19x_3+28.26x_7 +542.63x_{11}+361.58x_{20} \tag{3}$$

$$M= -2935.00+13.68x_3+29.23x_7 +561.34x_{11}+395.93x_{20} \tag{4}$$

$$E= -3262.18+14.55x_3+30.72x_7 +586.22x_{11}+424.38x_{20} \tag{5}$$

By performing classification matrix investigation (table 4), misclassified observations have been identified. Equations 3, 4, 5 predicted correctly 100% cases; Press's Q = 64> $\chi^2_{(\alpha;\ df\text{-}1)}$= 44.99.

Table 4: Classification matrix.

n= 32	Assignment correctness percentage	A priori prob. p=.31250	A priori prob. p=.37500	A priori prob. p=.31250
W	100,000	10	0	0
M	100,000	0	12	0
E	100,000	0	0	10
T	100,000	10	12	10

*Abbreviations: W- weak sport results group; M- medium sport results group; E- elite sport results group; T- total classification accuracy derived by the equations.

In order to test robustness of the group membership prediction, the formulas were also verified along the validation sample. Four contestants composed of the validation dataset. Their data are reported in brackets: n_{33} [105.8 81.949 2.43 1.022], n_{34} [107.2 85.095 2.38 1.00], n_{35} [106.3 81.989 2.55 1.144], n_{36} [114.5 84.989 2.51 1.133]. Multiplying the individual's score by the classification coefficient for each variable in the equations (3, 4, 5), we obtained the same accuracy of prediction as in the case of training group.

4 DISCUSSION

The study was established by performing a multidimensional analysis. The findings showed that an optimum combination of independent variables in powerlifting in the junior age category includes only eight predictors out of forty-four. These are: age, axillary chest circumference at maximum inhalation, trunk length to stature ratio, upper to lower limb length ratio, Quetelet II index, total body balance, lower body power, indicator of technique I. To obtain their diagnostic value, multiple regression coefficients were computed. In the light of factography, on the basis of weight factors, each of the dimensions in the H_{max} set strongly influence sport result. Subsequent analysis (table 2) proved that the stochastic parameters of biometric model for sport result in powerlifting satisfy the requirements of coaching practice. It fulfils coincidence criterion (Hellwig, 1969): sign $r_{(xiY)}$ = sign a_i (sign of regression coefficient). The determination index equalled 0.954 points, S_e was low and amounted to about 10.5 Wilks Points.

From coaching practice viewpoint above means that the biometric model can be used as a basis for effective prediction of dependent variable – Y, e.g. if axillary chest circumference at maximum inhalation is increased by 1-cm then the value of Y variable (sport result in PL) will increase by 1.628 Wilks Points, assuming that the other variables from the regression model remain unchanged (table 2).

As it was presented in many research, stepping forward from multiple regression analysis to discriminant analysis, the structure of sport result can be studied profoundly (Magiera and Ryguła, 2007); (Ryguła, 2003).

Our study demonstrated that the best set of variables, which discriminate powerlifters consists of four predictors: axillary chest circumference at maximum inhalation, upper to lower limb length ratio, lower body power, indicator of technique I. All of them are important in distinguishing young powerlifters. According to the evidence, 99% of the phenomenon we investigated has been explained; Wilks Lambda was only 0.09 points and satisfied the significance criterion at P≤ 0.05. Thus in the spotlight of the statistical theory, H1 holds true.

In the area of strength sports disciplines, there is lack of applicative research demonstrating discriminant analysis. It should be pointed out that in this domain, only Fry et al., (2006) have presented comprehensive model of selection that was based on DA. In their study the global Wilks Lambda equalled 0.664, and percentage of correct classifications was fairly high – 88.55%.

If specific physiological demands are taken into consideration, other papers regarding scientific approach to selection problem in sport were run for disciples much different than powerlifting. Namely, handball (Ignacik, 2008); (Ryguła, 2003), sport climbing (Magiera and Ryguła, 2007), javelin (Maszczyk, 2008), swimming (Saavedra et al., 2010). Aforementioned experiments, when comparing results, have one main thing in common – appropriately high value of classification correctness. It was always greater than the calculation based on chance accuracy algorithm.

In the presented research, the total number of correctly identified athletes has a value of 100%. Basic statistics in the assessment procedure of powerlifters classification effectiveness was Press's Q test. Its empirical result was much higher than the table value of Chi-square. Therefore at the 95% confidence, the inequality described with H2 has been proven positively. Hence, according to the analysis and statistical theory the model of selection we projected reached significantly better results in athletes' assignment than chance accuracy procedure. Consequently, it may be said that on the basis of the study, the classification paradigm can be usefully applied to support the process of recruiting athletes in PL.

Normally, discriminate analysis in the science of sport is run on training and testing set. In this manuscript research was extended to validation sample. After assigning output to variables in equations: 3, 4, 5, the total accuracy of prediction equalled also 100%. Subsequently, it suggests that constructed model is plausible and satisfies the requirements of effective selection in powerlifting for junior age category.

Summing up, paradigm we developed is adequate tool for young coaches for optimization of the selection procedure. We claim it is worth of further investigation.

5 CONCLUSIONS

(1) The most important determinants for the powerlifters discrimination model are axillary chest circumference at maximum inhalation, upper to lower limb length ratio, lower body power, indicator of movement technique I; (2) According to the value of cumulative proportion, the first discriminant function maintain the distances between subdivisions of powerlifters in 99%; (3) As per Q Press's test, classification functions are identifying powerlifters statistically better from *a priori* procedure.

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