No. 2, Vol. XV /2014

G Y M N A S I U M

Scientific Journal of Education, Sports, and Health

MULTIVARIATE REGRESSION ANALYSIS IN MAHALANOBIS OF ATHLETES AND INIFIED PARTNERS

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Keywords: *reliability, latent, dimension, matrix, vectors, variance*.

Abstract

Multivariate regression analysis of criterion variables from Z_c in the space of Mahalanobis variables from M can be defined as a solution to the problem $M\beta = Z_c + E \mid \operatorname{trag}(E^tE) =$ minimum. As $M^tM = I$, the solution which is easily obtained by differentiating the function $\operatorname{trag}(E^tE)$ is: $\beta = M^tZ_c = R_{rr}^{-1/2}R_{rc}$, and the matrix of partial regression coefficients is, in fact, a matrix of ordinary product-moment coefficients of correlation between the regressors transformed to a Mahalanobis form and criterion variables. Of course, that is why the asymptotic variance of coefficients β_{jp} from matrix β is simply $\sigma_{jp}^2 = (1 - \beta_{jp}^2)^2n^{-1}$, and the tests of hypotheses H_{0jp}: $\beta_{jp}^* = 0$ are easily $f_{jp} = \beta_{jp}^2((n - 2)(1 - \beta_{jp}^2)^{-1})$, because under H_{0jp}: $\beta_{jp}^* = 0$, variables f_{jp} have the Fisher-Snedecor F-distribution with 1 and n - 2 degrees of freedom. Regression functions are now defined by the operation $\Psi = M\beta$ with the covariance matrix $G = \Psi^t\Psi = \beta^t\beta = R_{cr}R_{rr}^{-1}R_{rc}$ and the diagonal elements of the matrix $\rho^2 = (\rho_p^2) = \operatorname{diag} G$ are usual coefficients of determination; and since $Z_c^t\Psi = R_{cr}R_{rr}^{-1}R_{rc} = G$, elements ρ_p of matrix ρ are normal multiple correlation coefficients, so the tests of hypotheses H_{0p}: $\rho_p^* = 0$ are defined by the functions $f_p = (\rho_p^2(1 - \rho_p^2)^{-1})((n - m - 1)m^{-1})$ because under H_{0p}: $\rho_p^* = 0$, functions f_p have the Fisher – Snedecor F-distribution with m and n - m - 1 degrees of freedom.

1. Introduction

The United Nations experts` estimates indicate that today there are about 800 million people in the world to whom the term „people with disabilities“ can be applied. That amounts almost 10% of the world population (WHO, 2000) and represents a major health, social, economic and political problem that tends to increase.

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Based on UNESCO provisions (1990, 1995, 1997), great attention is paid to early treatment of children, and according to their new classification, a new system of primary education continues after the preschool treatment, so that professional orientation could start in primary school to continue and grow into vocational rehabilitation in high school. New ideas and suggestions contributing to further solution of all the issues of diagnosis, rehabilitation and protection of disabled persons are of vital importance for their further treatment.

In 2000 the World Congress in Beijing pointed out that application of new methods, techniques and technologies during education, vocational training and employment of disabled persons, facilitates career choice and success at work (Andrijević, 2000; Arsić, & Stanković, 2014). Much faster and more modern application of new aids for school, work and overall life make it easier for handicapped people to achieve success in all fields. Ongoing monitoring and inclusion of the system of disabled people in the mental health movement, which is spreading, aim at preventing growing forms of mental stress and diseases by informing the public about the abilities and opportunities of these people, discovering new ways and forms of assistance. Among disabled people, there are certainly a great number of those with mild mental disabilities. The society is increasingly making efforts to improve the lives of people with such personality profile and their involvement in sports is surely very useful for them.

2. Material and methods

To carry out the research correctly and obtain results stable enough in terms of sampling error, it was necessary to take a sufficient number of respondents in the sample. The sample size for this type of research was conditioned by the objectives and tasks of the research, the population size and degree of variability of the applied system of parameters.

Based on the chosen statistical-mathematical model and program, objectives and hypotheses, we opted to include 40 respondents in the sample, a total of 80 in each subsample (40 Special Olympics athletes and 40 partners). The size of such a sample should meet the following criteria:

The effective of the sample should be such as to permit as many degrees of freedom as to make it possible for any coefficient in the pattern matrix or any correlation coefficient equal to or larger than .30 to be considered different from zero with an inference error less than .01, to use adequate statistical methods successfully, according to the latest beliefs, the number of subjects in the sample should be five times larger than the number of the variables applied.

In addition, respondents were to meet the specific requirements: respondents were male, the age of respondents was defined on the basis of chronological age, so the research covered respondents aged 15 to 18 years plus- minus 0.5 years, respondents were required to be members of a society that brings together Special Olympics athletes, respondents were required to attend training classes regularly what was determined on the basis of records kept by the coaches. In defining the population from which the sample was drawn, except the above, no other

restrictions or stratification variables were applied. The measurement was carried out in organizations and schools that bring together children with special needs.

For the assessment of conative characteristics, the measurement instrument CON6 was selected by which the following conative regulators were evaluated (Popović et al., 1995a; Popović et al., 1995b; Popović et al., 1996; Momirović, et al., 1999; Boli, et al., 2012):

Activity regulator (EPSILON)
Organ function regulator (CHI)
Defense reaction regulator (ALPHA)
Attack reaction regulator (SIGMA),
System for coordination of regulatory functions (DELTA) and
System for integration of regulatory functions (ETA).

For the evaluation of success in a football game, the following elements were measured by this program:

1. Football Techniques (STEH)
2. Offensive tactics (SNAP)
3. Creativity (SSTC)
4. Defensive tactics (SODB)
5. Playing behavior (SPON)
6. Responsibility (SODG)
7. Engagement (SANG)
8. General assessment of success in the game (SOUS)

As regression analysis in the Mahalanobis space has very convenient comparative characteristics relative to the standard canonical model of multivariate regression analysis, an algorithm that generates the largest amount of usable information about the parameters of the model will be described here. The algorithm is implemented by a program written in the Matrix language and the performance of the program is shown in some previous studies.

Multivariate regression analysis of criterion variables from Z_c in the space of Mahalanobis variables from M can be defined as a solution to the problem

$$M\beta = Z_c + E \mid \text{trag}(E^tE) = \text{minimum}.$$

As $M^tM = I$, the solution easily obtained by differentiating the function $\text{trag}(E^tE)$ is

$$\beta = M^tZ_c = R_{rr}^{-1/2}R_{rc},$$

so the matrix of partial regression coefficients is, in fact, a matrix of ordinary product- moment coefficients of correlation between the regressors transformed in a Mahalanobis form and criterion variables. Of course, that is why the asymptotic variance of coefficients β_{jp} from matrix β is simply

$$\sigma_{jp}^2 = (1 - \beta_{jp}^2)^2 n^{-1},$$

and the tests of hypotheses $H_{0jp}: \beta_{jp}^* = 0$ are easily

$$f_{jp} = \beta_{jp}^2((n - 2)(1 - \beta_{jp}^2)^{-1}),$$

because under $H_{0jp}: \beta_{jp}^* = 0$, variables f_{jp} have the Fisher-Snedecor F-distribution with 1 and n – 2 degrees of freedom.

The regression functions are now defined by the operation

$$\Psi = M\beta$$

with the covariance matrix

$$G = \Psi^t\Psi = \beta^t\beta = R_{cr}R_{rr}^{-1}R_{rc},$$

so the diagonal elements of the matrix

$$\rho^2 = (\rho_p^2) = \text{diag } G$$

are normal coefficients of determination, and since

$$Z_c{}^t\Psi = R_{cr}R_{rr}^{-1}R_{rc} = G,$$

elements ρ_p of matrix ρ are ordinary multiple correlation coefficients, and the tests of hypotheses H_{0p}: $\rho_p^* = 0$ are defined by the functions

$$f_p = (\rho_p^2(1 - \rho_p^2)^{-1})((n - m - 1)m^{-1}),$$

because under H_{0p}: $\rho_p^* = 0$, functions f_p have the Fisher-Snedecor F-distribution with m and $n - m - 1$ degrees of freedom.

As the matrix of residual variables is

$$E = Z_c - M\beta,$$

then

$$W = E^tE = R_{cc} - G$$

is a matrix of their covariances. Their correlations defined by the matrix

$$C = \rho^{-1}G\,\rho^{-1}$$

are sometimes helpful for identification of regression functions as well as correlations of residual variables defined by the matrix

$$\Phi = \Sigma^{-1}W\Sigma^{-1}$$

where $\Sigma^2 = \text{diag } W$ is a matrix of variances of residual variables.

The structure of regression factors in the Mahalanobis space is simply

$$S = M^tM\beta\rho^{-1} = \beta\rho^{-1},$$

so elements s_{jp} of matrix S are ordinary product-moment correlation coefficients. Therefore, the asymptotic variance of coefficients s_{jp} from matrix S is

$$\xi_{jp}^2 = (1 - s_{jp}^2)^2n^{-1}$$

and the tests of hypotheses H_{0jp}: $s_{jp}^* = 0$ are defined by the functions

$$f_{jp} = s_{jp}^2((n - 2)(1 - s_{jp}^2)^{-1}),$$

because under H_{0jp}: $s_{jp}^* = 0$, variables f_{jp} have the Fisher-Snedecor F-distribution with 1 and $n - 2$ degrees of freedom.

As β is, in fact, a correlation matrix, in the matrix

$$V^2 = \beta\bullet\beta = (v_{jp}^2),$$

where $\bullet$ is an operator of Hadamard multiplication, there will be components of the variances of the regressor and criterion variables under this model of regression analysis. If we now denote the sum vector of row g with e_g and the sum vector of row m with e_m, the elements of the vector

$$j^2 = V^2e_g$$

will be fractions of the variance of each regressor which was involved in the prediction of a set of criterion variables. Of course, in the vector $(e_m{}^tV^2)^t = \text{vec } \rho^2$ there will be coefficients of determination, and the elements in the columns of

matrix V^2 are parts of the variance of each criterion variable that can be attributed to certain regressor variables.

All the data in this research were analyzed at the Multidisciplinary Research Center, Faculty of Sport and Physical Education, University of Pristina by the system of data processing programs DRSOFT developed by Popović, (1980, 1992, 1993) and Momirović, & Popović, (2003).

3. Results and Discussions

Modern sports development is increasingly based on scientific research and the cybernetic approach in modeling sports training process. Such an approach requires discovering regularities and relationships between different areas of psychosomatic status responsible for or involved in the execution of various motor tasks in sports.

Modern football has a large complexity and variability of motor actions that are aimed at achieving the highest possible tempo, dynamics and attractiveness, the optimal personality development of players and finally success in sports competitions.

Football coaches in this country, do not yet use sufficiently scientific research and principles in planning and programming sports training process making it impossible to achieve better athletic performance.

Success in football is possible only if an integral method is used to define the phenomena which are of primary importance for structuring basic movements in a football game, regularities of target transformations and basic generators of kinesiological activities.

Statistically significant multiple correlation coefficient .33 was obtained by regression analysis of performance effectiveness in a football game as a criterion and predictor system of conative characteristics, indicating that the total valid variance of 11% with its significance Sig = .00 was explained. Only one statistically significant direct and partial correlation with the predictor variable was obtained, together with the system for integration of regulatory functions. Based on this sample, it can be said that success in a football game is possible to be explained only by the effectiveness of the system for integration of regulatory functions.

It is reflected in the hypo - or hyperfunction of inhibitory mechanisms in certain situations followed by inhibition of some physiological processes and enhanced egotonicity. This factor of the first row belongs to asthenic (anxiety) syndrome characterized by decreased excitation of the higher centers for regulation and control. It is obvious that it reduces adaptation in sports because it deactivates those structures of the nervous system which are responsible for that. This regulator is in a two-way relationship with the defense reaction regulation that modulates tonic arousal.

Table 1. *Regression analysis of criteria and conative characteristics*

	R	Partial R	Beta	t	Sig.
EPSILON	,03	,03	,041	,45	,65
XI	-,06	-,06	-,114	-,79	,42
ALPHA	-,05	-,05	-,103	-,69	,48
SIGMA	,01	,01	,013	,14	,88
DELTA	,12	,13	,176	1,61	,10
ETA	-,13	-,14	-,238	-1,79	,05
R	R %	df1	df2	F	Sig
,33	,11	6	70	3,27	00

4. Conclusions

The research was conducted in order to determine influence of conative characteristics on the criterion variables in Special Olympics athletes and partners in football.

For this purpose, 80 athletes and partners engaged in football were tested. For the assessment of conative characteristics, the measurement instrument CON6 was selected by which the following conative regulators were evaluated: activity regulator, organ function regulator, defense reaction regulator, attack reaction regulator, system for coordination of regulatory functions, system for integration of regulatory functions, and system for excitation and inhibition.

To assess success in a football game, the following variables were used: evaluation of the effectiveness of the techniques, evaluation of the performance effectiveness in the offensive phase, evaluation of the performance effectiveness in the defensive phase, evaluation of individual creativity during the game, team responsibility evaluation, engagement evaluation, behavior evaluation, general evaluation of success in the game.

The algorithms and programs implemented within this thesis have been fully presented and the results of the programs have been analyzed.

Statistically significant multiple correlation coefficient .33 was obtained by regression analysis of performance effectiveness in a football game as a criterion and predictor system of conative characteristics, indicating that the total valid variance of 11% with its significance Sig = .00 was explained. Only one statistically significant direct and partial correlation with the predictor variable was obtained, together with the system for integration of regulatory functions. Based on this sample, it can be said that success in a football game is possible to be explained only by the effectiveness of the system for integration of regulatory functions.

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