

CANONICAL RELATIONS OF MORPHOLOGICAL DIMENSIONS AND MOTOR ABILITIES OF TOP WRESTLERS

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(Original scientific paper)

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Abstract

In a sample of 103 wrestlers, aged from 19 to 24 years, was applied the system a total of 29 variables, of which 12 morphological variables and 17 motor abilities variables, in order to determine the correlation results of canonical correlation analysis showed that the relations between the canonical factor from the system variables of variables motor abilities, which was interpreted as the integral canonical general factor of motor ability wrestlers and canonical factor of the system variables of the morphological characteristics, interpreted as an integral canonical factor of growth and body development, shows that the statistically significant level ($p=.000$), which means that the wrestlers of this quality level and these morphological characteristics are achieving very good results in motor abilities, which thoroughly confirms the hypothesis of a positive connection between these two fields. Based on the results acquired in the research in this way, it could be concluded that is necessary to have on motor ability wrestlers and optimal morphological development being developed at the integral interactive basis for performance of particular variables from the system motor abilities. These pieces of information can be important factors in transformation programming processes in wrestling.

Keywords: *testing, wrestling clubs, training, cross correlations, canonical analysis,*

INTRODUCTION

Wrestling is one of the group sports of polystructural acyclic movements with very complex elements which are performed in different stages of the fight, and the success of both the performance of the given technique, and in the competitive struggle depends on many factors and dimensions. (Cvetković, Č., Sertić, H., Marić, J., Pekas, D., Baić 2004). As the individual situation in the fight never repeated twice in the same way wrestlers are forced to reorganize motion stereotypes learned in a short period, depending on whether there are in the stage of attack or defense. A large number of technical elements and variants in which can performed, countless variations that are performed with the aim of implementing tactics, wrestling ranks in sports where apart the motor and functional skills are very important cognitive and co native traits too (Jozic 2002). The program of training in wrestling adds so much

attention in the development of anthropological characteristics in accordance with their equation specifications (power, speed, coordination, balance and flexibility). Although this is probably the most important skills for success in wrestling, it is hard to calculate their independent effect on the success. In fact, some these skills are different at wrestlers who belong to different weight and age categories. "In this study, the association established a group variable anthropometric characteristics and motor abilities of the wrestlers aged 19-24 years. It was found that the wrestlers applied between anthropometric characteristics and motor abilities; there is a statistically significant correlation of four pairs of canonical factors.

The problem of this study is to determine the canonical correlation between the system of morphological characteristics (12 variables) and battery of tests motor abilities (17 variables), of wrestlers in the 7 wrestling clubs in Kosovo, in order to

determine their mutual relations. That is, as specific objective of this study is to determine how to adjust the training to the wrestler's opportunities, in order to achieve a more efficient success and overall progress of wrestler's. From the already placed object and problem of this research can be also in the set and one hypothesis that could be moved in the direction expecting positive canonical connections two areas.

METHODS

The sample of respondents in this study was 103 wrestlers from the seven active sport wrestling clubs of Kosovo, aged 19-24. In the period of taking measurements the subjects were healthy regularly trained and were without significant morphological, motor and physiological aberrations. The measurements in this study were conducted before the happening of the state the regular trainings in December 2010. To get real data the study was conducted in the halls in which the sportsmen train and during regular training. Results were analyzed by the package Statistic 6.0.

For the assessment of wrestler's morphological characteristics was applied the following system variables:

- Variables for assessment of longitudinal dimensions

Body height (BOHE),
Leg length (LELE),
Arm length (ARLE)

- Variables for assessment transversal dimensions:

Width of the pelvic (WIPE),
Width of the wrist (WIWR),
Width of the knee (WIKN)

- Variables for assessment of body mass:

Body mass (BOMA),
Chest circumference (CHECI),
Upper arm circumference (UACI),

- Variables for assessment of subcutaneous adipose tissue:

Spine skin fold (SPSK),
Abdominal skin fold (ABSK),
Forearm skin fold (FOSK),

For the assessment of wrestler's motor abilities was applied the following battery of tests:

- Variables for assessing of explosive power:
Standing a long jump (SLJU),
Hurling a medical ball from supine position (HMBS),

- Hurling a medical ball from twisted (HMBT),
- Variables for assessment of coordination:
Turn in the air (TUAI),
Drumming by feet and hands (MBFH),
Figure eight with bending (EIBE),
Turn on the floor (TUFL),
- Variable for assessing of the speed movement frequency:
Hand tapping (HATA),
Foot tapping (FOTA)
- Variables for assessment of flexibility:
Deep forward bend (DFBE),
Flexibility with a stick (FLST),
- Variables for assessment of repetitive strength:
Lifting the trunk in shelter (LTSHE)
Pushups (PUUP),
Chinning (FOLI),
Raising the trunk from sitting (RATS)
- Variables for assessment of balance:
Standing along one leg with open eyes (SO1L)
Transverse standing on two legs with open eyes (SO2L)

With the aim of establishing relations between the two different batteries of multidimensional morphological variables and manifest motor abilities variables, of the wrestlers was applied the canonical correlation analysis. The aim of these statistical methods is the formation of linear combinations in the set of independent variables, but in the way that inside these linear combinations there exists maximum correlation. Assuming that these two applied batteries of variables are linearly connected, first was performed interpretation of the cross-correlation matrix, then by Bartlett's test was tested the statistical significance of canonical correlation coefficients.

RESULTS AND DISCUSSION

In table 1, were shown the results of morphological variables, where it is clearly evident that in the applied distributive variables are generally symmetrical, because their value does not exceed values greater than 1.00, except for variables: Width of the wrist (WIWR 2.42), Chest circumference (CHECI -1.07), Spine skin fold (SPSK 1.26) and Abdominal skin fold (ABSK 1.24) from a total number of 12 morphological variables, 10 of them have a positive asymmetry, while 2 have a negative asymmetry.

In table 2, were shown the results of basic descriptive motor abilities parameters, where it is clear-

Table 1. Descriptive parameters (morphological characteristics)

	Variables	Minimum	Maximum	Mean	SD	Skewness	Kurtosis
1	BOHE	1.60	1.96	1.7460	8.0131	.543	-.196
2	LELE	68.00	114.00	97.0388	7.0744	-.332	1.966
3	ARLE	64.50	84.50	72.5631	3.8955	.620	.952
4	WIPE	24.00	42.00	30.6155	3.3538	.945	1.047
5	WIWR	5.00	9.50	5.9447	.6390	2.422	10.113
6	WIKN	8.60	14.00	10.8961	1.0178	.339	.573
7	BOMA	46.00	106.00	72.8641	13.1269	.559	.194
8	CHECI	33.00	120.00	94.9223	13.2511	-1.072	4.213
9	UACI	23.00	37.00	27.1825	2.4452	.953	1.289
10	SPSK	.50	6.00	2.0350	1.0591	1.255	1.909
11	ABSK	.60	5.50	1.8650	.9227	1.242	2.037
12	FOSK	.40	4.20	1.5476	.7407	.897	.811

Table 2. Descriptive parameters (basic motor abilities).

	Variables	Minimum	Maximum	Mean	SD	Skewness	Kurtosis
1	SLJU	1.80	2.72	2.2867	.1326	-.513	2.282
2	HMBS	3.00	9.80	6.1843	1.3503	.139	-.525
3	HMBT	2.70	9.80	5.7308	1.4248	.403	-.064
4	TUAI	3.31	7.00	5.1641	.8521	.145	-.231
5	MBRN	5.00	17.00	10.3951	2.5248	.150	-.045
6	MBFH	15.00	26.30	19.3690	1.3307	1.142	8.344
7	TUFL	.00	22.00	10.8971	2.4489	1.498	11.725
8	HATA	28.00	60.00	35.3689	6.2088	1.622	3.270
9	FOTA	20.00	41.00	30.3981	4.2342	.596	.083
10	DFBE	1.00	23.00	9.7427	5.1306	.794	.146
11	FLST	58.00	117.00	90.4272	12.4378	-.346	-.348
12	LTSHE	5.00	60.00	25.6990	14.4241	.864	-.455
13	PUUP	10.00	75.00	26.1748	11.4330	1.047	1.871
14	FOLI	1.00	22.00	10.9320	5.1014	.409	-.747
15	RATS	15.00	35.00	22.9223	5.4371	.409	-.967
16	SO1L	4.00	120.00	44.6602	29.0390	1.329	1.413
17	SO2L	4.00	90.00	33.3010	21.1659	.969	.524

ly evident that in the applied distributive variables are generally symmetrical, because their value does not exceed values greater than 1.00, except for motor variables: Eight figure by bending (EIBE 1.14), turn on the floor (TUFL 1.49), hand tapping (HATA 1.62), pushups (PUUP 1.04), and standing along on one leg (SO1L 1.32), from a total number of 17 motor variables, 15 of them have a positive asymmetry, while 2 have a negative asymmetry,

From the analysis of the cross correlation matrix between the structure of morphological dimensions and the structure of motor skills variables of the wrestler (table 3), can be observed that the highest coefficients and statistically significant correlations with the tests: hurling a medical ball from twisted (HMBT .69) and hurling a medical ball from supine position (HMBS .68) and the lowest coefficients and statistically significant correla-

tions with the morphological dimensions have the standing along one leg with open eyes (SO1L.19). and lifting the trunk in shelter (LTSHE.19). In this study, as well the other obtained a high correlation of morphological dimensions and motor skills, cross correlations coefficients between the dimensions of the morphological dimensions and motor abilities in the variables applied in the measured values are ranged in the values from .19 to .69.

In determining the relations between morphological dimensions and the structure of motor skills variables of a wrestler (table 4), using Bartlett's measure chi-square test (χ^2), was found that at the wrestler there was a statistically significant correlation of the three pairs of canonical factors. In the first pair at the level of ($p=.000$) the canonical correlation is ($R_c = .91$), and explains 83% of the vari-

Table 3. Cross correlations morphological characteristics and motor abilities of the wrestler

	Variables	BOHE	LELE	ARLE	WIPE	WIWR	WIKN	BOMA	CHECI	UACI	SPSK	ABSK	FOSK
1	SLJU	.34	.29	.26	-.01	.06	.13	.24	.34	.21	-.08	-.06	.01
2	HMBS	.67	.63	.52	.05	.24	.36	.56	.50	.47	.10	.19	.30
3	HMBT	.69	.63	.56	.09	.29	.48	.58	.53	.50	.13	.20	.29
4	TUAI	-.11	-.36	-.11	.46	.06	.11	.08	.03	.11	.41	.28	.09
5	MBRN	.12	.32	.10	-.27	-.03	.04	-.01	.09	.03	-.31	-.25	-.10
6	MBFH	-.06	-.26	-.07	.32	.10	.07	.12	.03	.14	.29	.30	.10
7	TUFL	.02	-.11	.02	.32	.17	.04	.08	.04	.06	.24	.10	-.01
8	HATA	.02	.17	.11	-.20	.17	-.01	-.19	-.12	-.08	-.37	-.37	-.31
9	FOTA	.04	.15	.08	-.17	.02	-.04	-.15	-.01	-.03	-.40	-.40	-.31
10	DFBE	.16	.15	.13	-.11	.09	.02	-.10	-.08	-.06	-.40	-.37	-.35
11	FLST	.36	.34	.25	.03	.04	.17	.48	.39	.26	.32	.46	.54
12	LTSHE	-.10	-.13	-.07	.17	.19	.06	-.27	-.16	-.01	-.27	-.35	-.53
13	PUUP	-.13	-.30	-.15	.25	.07	-.04	-.30	-.20	-.01	-.33	-.46	-.58
14	FOLI	-.00	-.05	-.03	.18	.20	-.02	-.09	.02	.08	-.11	-.24	-.33
15	RATS	-.05	-.13	-.05	.28	.24	.01	-.23	-.12	.08	-.27	-.36	-.52
16	SOIL	.00	.19	.08	-.29	.01	-.09	-.16	-.13	-.09	-.36	-.31	-.19
17	SO2L	.06	.25	.01	-.30	-.02	-.03	-.06	-.06	-.03	-.26	-.20	-.10

Significance = $p (.05) = .19$; $p (.01) = .24$.

Table 4. Significance of canonical correlation

	Canonical R Cr	R-sqr Cr-sqr	Canonical Chi-sqr.	df	p	Lambda prime $\tilde{\epsilon}$
0	.910	.828	492.41	204	.000	.003
1	.809	.654	339.32	176	.000	.020
2	.775	.600	247.01	150	.000	.058
3	.629	.396	167.27	126	.008	.146
4	.555	.308	123.41	104	.095	.242
5	.543	.295	91.33	84	.274	.350
6	.495	.245	60.91	66	.654	.497
7	.376	.142	36.45	50	.924	.658
8	.347	.121	23.17	36	.952	.766
9	.274	.075	11.97	24	.980	.871
10	.208	.043	5.17	14	.983	.942
11	.123	.015	1.32	6	.970	.985

R_c = coefficients of canonical correlations, R_c^2 = coefficient of determination,
 Hi-square test χ^2 , d = degrees of freedom, p = statistical significance, $\tilde{\epsilon}$ = lambda).

ance of these sets of variables, in the second pair at the level of ($p=.000$) the canonical correlation is ($R_c=.81$), and explains 65% of the variance of these sets of variables, and the third pair at level of ($p=.000$) the canonical correlation is ($R_c=.78$), and 60% explains of the variance of these sets of variables, in relation to other pairs of canonical factors that are not statistically significant and do not contain a significant amount of common variance.

Based on the calculated matrix structure of canonical factor in space morphological variables (table 5), it is clear that the structure of the first canonical factors are applied to all the morpho-

logical variables, so that so that it can be interpreted as an integral canonical factor of growth and body development. As for the second and third canonical factors the wrestler's of morphological variables there is not statistically significant correlation and due to the poor information variables' value, those cannot be defined or interpreted.

Analyzing the calculated matrix of canonical structure factors in the variables' space of the wrestler's motor skills (table 6), it is clear that the structure of the first canonical factor is composed of all motor variables, is interpreted as a general canonical motility factor, especially motor vari-

Table 5. Structure of canonical factor in the morphological variable.

			Fc 1	Fc 2	Fc 3
1	Body height	BOHE	.835	-.424	.020
2	Leg length	LELE	.646	-.627	-.283
3	Arm length	ARLE	.712	-.535	.023
4	Width of the pelvic	WIPE	.583	.418	.507
5	Width of the wrist	WIWR	.565	-.135	.465
6	Width of the knee	WIKN	.796	-.066	.290
7	Body mass	BOMA	.948	-.010	-.112
8	Chest circumference	CHECI	.813	-.084	-.013
9	Upper arm circumference	UACI	.866	.104	.185
10	Spine skin fold	SPSK	.737	.617	-.104
11	Abdominal skin fold	ABSK	.789	.493	-.250
12	Forearm skin fold	FOSK	.745	.253	-.549

Table 6. Structure of canonical factor in the motor variables

			Fc 1	Fc 2	Fc 3
1	Standing a long jump	SLJU	.634	-.195	.406
2	Hurling a medical ball from supine position	HMBS	.599	-.470	.578
3	Hurling a medical ball from twisted	HMBT	.614	-.414	.567
4	Turn in the air	TUAI	-.780	.419	.251
5	Drumming by feet and hands	DFEH	.807	-.353	-.193
6	Figure eight with bending	FEWB	.519	-.353	.242
7	Turn on the floor	TUFL	.486	-.253	.356
8	Hand tapping	HATA	.846	-.007	-.211
9	Foot tapping	FOTA	.830	-.033	-.129
10	Deep forward bend	DFBE	.417	.658	.024
11	Flexibility with a stick	FLST	-.536	-.626	.251
12	Lifting the trunk in shelter	LTSHE	.688	.530	.021
13	Push ups	PUUP	.713	.440	.109
14	Chinning	FOLI	.757	.330	.209
15	Raising the trunk from sitting	RATS	.670	.512	.182
16	Standing along one leg with open eyes	SOIL	.719	-.142	-.255
17	Transverse standing on two legs with open eyes	SO2L	.639	-.121	-.114

ables for assessing of the speed movement frequency: hand tapping (HATA .85), and foot tapping (FOTA .83), motor variables for assessment of coordination: Drumming by feet and hands (DFEH .81), Turn in the air (TUAI -.78), Figure eight with bending (FEWB .52), motor variables for assessment of balance: Standing along one leg with open eyes (SOIL .72), transverse standing on two legs with open eyes (SO2L .64), motor variables for assessing of the repetitive strength: Chinning(FOLI .76), Pushups (PUUP .71), Lifting the trunk in shelter (LTSHE .69), Raising the trunk from sitting (RATS .67), variables for assessment

of the explosive power, Hurling a medical ball from twisted (HMBT .61), Hurling a medical ball from supine position (HMBS .60), standing long jump (SLJU .63), except variable Deep forward bend (DFBE .69) and variables Flexibility with a stick (FLST -.63) that make up the structure of the second canonical factor mobility variables interpreted as a canonical motility factor is the flexibility, that the canonical correlation factor longitudinally and adipose tissue, defined variables: length of the legs (LELE -.65), arm length (ARLE .71), body height (BOHE. .85), Spine skin fold (SPSK .74), and abdominal skin fold (ABSK .79). From

this we can conclude that higher entities with a lower amount of fat in the body achieve better results in the flexibility test. As for the the third canonical factors the wrestler's of motor variables there is not a statistically significant correlation and due to the poor information variables' value, those cannot be defined or interpreted (table 6).

CONCLUSION

Relations between morphological variables and motor abilities variables were determined using Hotelling's canonical correlation analysis, the significance of canonical correlation coefficients was tested by the Bartlett's χ^2 test at the level of significance ($p=.00$). The canonical analysis indicated on a high correlation between morphological variables and motor tests that can be seen through three significant pairs of canonical factors.

The first pair of canonical factors extracted 91% of the variance and explained 83% variance thousand sets of variables. The second pair of canonical factors extracted 81% of the variance and explained 65% variance thousand sets of variables. Third pair of canonical factors extracted 78% of the variance and explained 60% variance thousand sets of variables. The second canonical factor of morphological variables in space cannot be interpreted due to poor correlation coefficients measured values while the first canonical factor of morphological variables in space to the fullest extent the variables body mass (BOMA .95), chest circumference (CHECI.81), circumference of forearm (UACI.87), a factor of body height (BOHE .84), arm length (ARLE.71), leg length (LELE .65), (longitudinal factor), upper arm skin fold (UACI .87), abdominal skin fold (ABSK.79), a factor of subcutaneous adipose tissue. High values obtained canonical correlations between two sets of variables are realistic given the choice of the variables themselves, the way of realization of the training process with a high level of motivation wrestlers.

Canonical general motor factor and factor of growth and body development (longitudinally, transversally, body mass and adipose tissue) show that they are bipolar, which means that smaller amounts of subcutaneous adipose tissue and smaller scale measures, better will predict the results in motor variables with optimal representation of muscle mass at the expense of subcutaneous adipose tissue, as seen through the correlation of body

mass (BOWE .95) and a body height (BOHE .84). The results of this study will enable optimal and purposeful use of motor tests to monitor the effects of the training and for better planning and programming of wrestlers training.

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КАНОНИЧКИ ОДНОС НА МОРФОЛОШКИТЕ ДИМЕНЗИИ И МОТОРНИТЕ СПОСОБНОСТИ НА ВРВНИТЕ БОРАЧИ

УДК: 796.81.071.012
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Апстракт

На примерок од 103 борачи, на возраст од 19 до 24 години, беше применет систем од 29 варијабли, од кои 12 беа антропометриски и 17 моторни варијабли за проценување на моторните способности. Целта беше да се утврдат нивните меѓусебни релации. Резултатите на каноничката корелациона анализа, покажаа дека релациите меѓу каноничкиот фактор од системот варијабли на моторните способности, индигриран како генерален моторен фактор и каноничкиот фактор од системот на антропометриските варијабли, индигриран како фактор на расно и развој на телото, покажаа статистичка значајност на ниво .00. Тоа конкретно значи дека тренираниите борачи би постигнувале мошне добри резултати во моторните способности, со што е потврдена хипотезата за позитивната поврзаност на антропометриските димензии и моторните способности. Врз основа на добиените резултати од истражувањето може да се заклучи дека за изведувањето на одделните варијабли од системот на моторните способности, неопходна е оптимална моторна способност и оптимален морфолошки развој на борачите. Овие информации можат да представуваат значајни чинители за програмирање на трансформационите процеси во борењето.

Клучни зборови: *тестирање, боречки клубови, тренинг, корелации, каноничка анализа*