INFLUENCE OF SOME MORPHOLOGICAL CHARACTERISTICS ON PERFORMANCE OF SPECIFIC MOVEMENT STRUCTURES AT BOXERS

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Summary
The system consisting of 20 variables, among which the number of 8 variables were of specific movement structures (as criterion variables) and 12 variables with morphological features (as predictor variables), were applied at the sample of 92 boxers being members of Croatian boxing clubs with different weight categories. The relatioship between two different systems of manifest features was determined by calculation of crosscorrelation matrix while the influence of the system of morphological variables (as the system of predictor variable) was calculated by regression analysis. The results based on the analysis of the matrix of crossrelations between criterion system of variables of specific movement structures and predictor system of morphological variables were relatively high and statistically important correlations at most applied variables. They also showed that the predictor system of variables of morphological features has a statistically important influence on all individual criterion variables of specific motor movement structures at the level of .00 (p=.00). So, it can be concluded that morphological structures have a big influence while performing some specific motion structures at boxers.

Key words*: boxers, specific movement structures, morphological features, influence*

Introduction

The process of determination of the influence by some individual segments of the anthropological status on the specific structures in the individual sports makes the basic, and still very live, practical and theoretical problem, which is of a great importance, in the first place, because of the possibility to form as rational procedures for optimal orientation and selection of sportsmen, planning, programming and control of training as possible, together with the efficient supervision of the development referring to the relevant anthropological features of sportsmen during a continuous training process (Malacko & Rađo, 2004). It is well known that a boxer in the sport of boxing solves numerous problem situations in order to realize as bigger effects as possible referring to the demonstration of his sport potentials. It is supposed that even the process of determining the influence of morphological features on the specific motion structures of boxers can be one of important indicators in realizing as better results as possible. Regarding the complexity of the equation for boxing specification, it is difficult to suppose which anthropological features are more or less relevant for the success in that sport. The analysis of the specific movement structures of a boxer can be realized by examination of the two basic parameters of its efficacy - speed and strength. No matter which motion structure (technique) is dealt with, in order to be successful; it has to be realized fast.

The speed of a motion or movement is seen as the ability of body or parts of body to pass a certain route in as shorter duration as possible. In this way, it indirectly depends on the boxer's strength, because it is necessary for initiating the movement of a certain mass and its influence on it on a certain route. The efficacy of a punch is mostly determined by its strength. The strength of a punch depends additionally on the magnitude of strength explosiveness and the speed of fist movement. Due to this mutual dependence between the strength and speed, biomechanical regulations in the boxing technique should be examined, in the first place, through relationship between particular levers and ability to develop a big muscular power in different kinds of conditions. The movement structures in boxing are realized very fast and they have a complex structure and the muscular mass of different topology regions together with the activity in different joints in shoulders, elbow, fist, hip, knee and ankle joint take part in their realization. Different mechanisms at different levels inhibit, synchronically and successively, some particular muscles or muscle groups that realize, more or less successfully, the techniques depending on the basic skill knowledge acquired. The sport of boxing is characterized by diagonal poses and numerous technical elements, tactical performances, movements of a whole body and extremities in different directions with changing intensity and changing tempo.

During a fight, it can be seen that dynamical situations are constantly interchanged by different changes of fighting poses (rotation around the vertical axis), fist techniques realized by punches, blockings-transfer power, defense realized by movements left-right, defense by bends left-right, forwards-backwards, etc. For realization of these techniques, it is required to have a good knowledge on dynamic stereotypes and a good concentration in order to realize the reorganization of the mentioned dynamic stereotypes effectively, in other words, to create new programs of attack, defense and counter-attack activities during a fight. We suppose that even some morphological features of a boxer can have a relevant degree of connection with the success during a fight. So it is assumed that the taller boxers and the boxers with longer arms and legs have a certain advantage in comparance to the shorter ones, that is the ones with shorter extremities and that the boxers with the great amounts of fat tissue are inferior to the ones with the same weight but without having this unnecessary burden; then the boxers having wider fists hit the aim in an easier way producing stronger punches (due to response force and boxing glove punch reduction), and the boxers having a larger measurements are usually more stronger and they endure punches directed to their body easier. It is supposed that it would be a good choice to determine the influence quantity of the specific morphological consistency on the success in the fight of boxing by determining the level of connection in the complete battery of anthropological measures with the success in a fight. Regarding the previously mentioned issue, it can be expected that the arms length, legs, feet, biacromial span, body weight, chest measures, upper arms, forearms and upper legs, fist and feet width, wrist diameter and skin folds on the stomach and back are in a significant connection with the success than some other dimensions (Blažević, 2006).

Aim

The aim of this research is to determine the influence of the predictor system of variables of morphological features on the individual criterion specific movement structures for the reason of a useful selection among sportsmen and planning, program creation and control of the effects produced by the process of training at top level boxers.

Methods

The system consists 20 variables, among which the number of 8 variables were of specific movement structures (as criterion variables) and 12 variables with morphological features (as predictor variables). Those variables were applied at the sample of 92 boxers being members of Croatian boxing clubs with different weight categories. For the purpose of estimation of the specific movement structures, the following variables were applied: 1. skip rope ''SKIP'' 10 seconds (S SKIP), 2. the speed of realizing 100 straights onto a punch bag (SBR100D), 3. speed of realizing combined punches onto punch bag-two straights, two hooks and two uppercuts (SBR100K), 4. both legs jump of 10 seconds and performing the left. right straight punch (SSUNPOD), 6. both leg jumps of 10 seconds and performing left-right uppercut (SSUNPOA), 7. defense from left straight punch and parrying three straight punches-defense from right straight punch by step aside and parrying three straight punches on to the coach's hands (SKONTRA) and 8. a series of 100 combined.punches onto the coach's hands: left straight punch, right uppercut, left-right hook, step aside from the left straight punch and parrying with the right straight punch (SSER100).

The metrical characteristics and standardization of 8 mentioned variables of motion structure were determined in the research realized by Savić (1986) using factor validity in which 89.40% of the common variance was used by the main component. For estimation of the morphological characteristics, the following variables were used: 1. body height (AVISTEL), 2. legs length (ADUŽNOG), 3. arms length (ADUŽRUK), 4. shoulders width (ABIKROM), 5. pelvis width (ABIKRIS), 6. wrist diameter (ADIJRUK), 7. body weight (ATEŽINA), 8. upper leg measurement (AOPNATK), 9. measurement of upper arm in bent tense state (AOPNADF), 10. upper arm skin fold (ANABNAD), 11. back skin fold (ANABLED), and 12. stomach skin folds (ANABTRB).

The morphological features (anthropometrical dimensions) safety was tested and checked by Stojanović, Solarić, Momirović and Vukosavljević (1975). The mentioned dimensions were measured by International Biology Program methodology (IBP). The following statistical central and dispersive parameters were calculated for each of the applied variables: arithmetic mean (M), minimal value (min.), maximal value (max), standard deviation (S) and standard error of arithmetic mean (Se). The variables distributions normality was tested by skewness (Sk) and kurtosis (Ku). The relations between the applied manifest variables for both of the spaces (specific motion structures and morphological variables) were realized by crosscorrelation manifest variables matrix. The calculation of the influence by the system of morphological variables (as the system of predictor variables) on the individual criterion variables of the specific motion structures was realized by regression analysis. The following univariant statistical parameters were applied during the procedure of calculation and analysis of the obtained results: β- an individual influence by each standardized predictor variable on an individual criterion variable by application of the regression coefficient (beta ponder), testing the importance of the influence by each predictor variable on an

individual criterion variable by t-test, and p-statistical importance of the influence by each predictor variable on an individual criterion variable at the level of .05 to .00 (p=.05..00). The multivariant values were calculated using the following parameters: Ro2-squared multiple correlation or the total variance of the system of the predictor variables on the criterion variable, Ro – multiple correlation between the whole system of the predictor variables and criterion variables, F-importance tests using F-relations, and p-of statistical importance of the influence by the whole system of the predictor variables on the criterion variable at the level .05 to .00 (p=.05-.00).

Results

While analyzing the Table 1., where the central statistical and dispersive parameters of variables were presented together with their discrimination by skewness, it is clearly seen that in the scope of the motion structures at boxers, only the variable of skipping rope ''SKIP'' 10 seconds (S SKIP), and the upper arm skin fold (ANABNAD) in the morphology scope, back skin fold (ANABLED) and stomach skin fold (ANABTRB) are abnormally distributed while all other applied variables have a sufficient discrimination (marked with only one *), because the skewness values do not exceed 1.00 of standard deviation.

Table 1. Basic parameters of the specific and morphological dimensions

Varijable	M	min	max	S	Se	Sk	Ku
SSKIP	20.70	13.00	25.00	2.73	.28	-1.11	.43
SBR100D	185.80	139.00	269.00	25.93	2.70	.79*	2.00
SBR100K	249.86	160.00	345.00	37.65	3.92	-.29*	1.39
SSUNPOD	18.96	12.00	24.00	2.43	.25	-.41*	.55
SSUNPOK	17.95	11.00	23.00	2.45	.25	-.46*	.61
SSUNPOA	17.48	11.00	24.00	2.75	.28	.08*	-.06
SKONTRA	21.48	14.00	32.00	4.79	.49	.76*	-.41
SSER100	262.31	180.00	329.00	37.38	3.89	-.81*	-.13
AVISTEL	176.97	159.20	196.60	8.51	.88	.12*	-.47
ADUŽNOG	99.37	89.10	118.20	6.03	.62	.86*	.40
ADUŽRUK	78.05	68.30	91.40	5.70	.59	.35*	-.77
ABIKROM	42.81	36.10	55.10	5.04	.52	.90*	-.39
ABIKRIS	29.11	24.00	39.40	3.55	.37	.79*	.32
ADIJRUK	6.26	4.90	7.80	.72	.07	-.03*	-.81
ATEŽINA	70.22	51.80	108.70	12.94	1.34	.80*	.24
AOPNATK	53.80	43.10	68.00	6.09	.63	-.01*	-.71
AOBNADF	34.18	29.20	43.10	3.09	.32	.61*	-.01
ANABNAD	4.90	3.00	17.00	2.70	.28	2.91	9.15
ANABLED	5.07	3.00	18.00	2.93	.30	2.87	8.76
ANABTRB	6.41	4.00	24.00	3.79	.39	3.18	10.68

Legend: M –arithmetic mean, min –minimal value, max –maximal value, S – standard deviation, Se –standard error of the arithmetic mean, Sk - skewness, Ku – kurtosis

Some relatively high and statistically important correlations of the pairs of variables at all the applied variables of both anthropological space at the level .00 (p=.00) can be found while analyzing the crosscorrelation matrices between criterion system of variables of the specific motion structures and the predictor system of morphological variables (Table 2.).

Table 2. Crosscorrelations between the system of the criterion specific motion structures and the system of the predictor morphological features (Legend:*p (.05) = .19 **p (.01) = .25)

Variable	SS KIP	SBR 100D	SBR 100K	SSUN POD	SSUN POK	SSUN POA	SKON TRA	SSE R100
AVISTEL	-.70*	.84*	.85*	-.85*	-.85*	-.88*	.84*	.92*
ADUŽNOG	-.78*	.87*	.85*	-.85*	-.85*	-.84*	.89*	.84*
ADUŽRUK	-.72*	.82*	.83*	-.85*	-.85*	-.85*	.88*	.89*
ABIKROM	-.84*	.81*	.80*	-.85*	-.85*	-.82*	.90*	.78*
ABIKRIS	-.66*	.82*	.78*	-.85*	-.85*	-.82*	.81*	.81*
ADIJRUK	-.59*	.78*	.79*	-.82*	-.81*	-.85*	.78*	.92*
ATEŽINA	-.78*	.89*	.86*	-.90*	-.90*	-.89*	.90*	.87*
AOPNATK	-.63*	.83*	.83*	-.88*	-.88*	-.90*	.80*	.94*
AOBNADF	-.70*	.84*	.82*	-.86*	-.86*	-.85*	.84*	.85*
ANABNAD	-.69*	.82*	.72*	-.79*	-.79*	-.73*	.69*	.63*
ANABLED	-.71*	.81*	.71*	-.78*	-.79*	-.72*	.70*	.61*
ANABTRB	-.70*	.79*	.69*	-.75*	-.76*	-.69*	.67*	.58*

While determining the influence of the predictor system of variables with morphological features (Table 3) on the individual criterion variables of the specific motion structures, there appeared a conclusion that the predictor system had statistically important connection (a multivariant influence) on all the individual criterion variable at the level .00 (p=.00).

The individual statistically important influence (p) of the morphological features variables on the criterion variable is as follows: SSKIP:ADUŽNOG – legs length (p=.01), ABIKROM – shoulders width (p=.00), ABIKRIS – pelvis width (p=.00), and ATEŽINA – body mass (p=.02), which shows that a better results were achieved by the testees having smaller body weight, narrower shoulders, shorter legs and somewhat wider pelvis. SBR100D: ADUŽRUK – arms length (p= .02), which means that some better results were realized by the testees with shorter arms. SBR100K: AVISTEL – body height (p=.03); SSUNPOD: AOPNATK – upper leg volume (p=.04), which means that the better results were obtained by the testees with the bigger circumference of their upper leg. SSUNPOK: there are no morphological variables but only the whole system of morphological variables; SSUNPOA: AVISTEL – body height (p=.00), and AOPNATK – upper leg volume (p=.03), which means that some better results were obtained by the taller testees with bigger upper leg circumference.

Table 3. Prediction of individual criterion variables
(Legend: Ro2 -multiple correlation squared F - F-test; p - statistical importance)

Variables	SS KIP (p)	SBR 100D (p)	SBR 100K (p)	SSUN POD (p)	SSUN POK (p)	SSUN POA (p)	SKON TRA (p)	SSE R10 (p)
AVISTEL	.33	.06	.03*	.34	.26	.00*	.00*	.00*
ADUŽNOG	.01*	.08	.32	.38	.35	.08	.03*	.00*
ADUŽRUK	.10	.02*	.23	.97	.88	.43	.35	.00*
ABIKROM	.00*	.53	.71	.36	.37	.36	.04*	.00*
ABIKRIS	.00*	.39	.22	.68	.66	.22	.70	.14
ADIJRUK	.08	.35	.58	.86	.83	.29	.21	.01*
ATEŽINA	.02*	.25	.86	.43	.35	.98	.00*	.06
AOPNATK	.16	.95	.55	.04*	.06	.03*	.71	.00*
AOBNADF	.07	.49	.62	.51	.53	.51	.41	.00*
ANABNAD	.08	.86	.72	.96	.98	.66	.28	.68
ANABLED	.41	.74	.47	.32	.27	.33	.59	.08
ANABTRB	.40	.92	.91	.49	.46	.34	.79	.12
R02	.83	.84	.78	.84	.84	.86	.87	.95
R0	.92	.92	.88	.92	.92	.93	.93	.97
F	39.80	36.54	24.12	37.00	37.14	42.77	47.46	148.85
P	.00*	.00*	.00*	.00*	.00*	.00*	.00*	.00*

SKONTRA: AVISTEL – body height (p=.00), ATEŽINA – body weight (p=.00), ADUŽNOG – legs length (p=.03) and ABIKROM – shoulder width (p=.04), which means that some higher values were found at taller testees having bigger weight and longer legs and wider shoulders. SSER100: AVISTEL – body height (p=.00), ATEŽINA – body weight (p=.00), ADUŽNOG – legs length (p=.03), ADUŽRUK – arms length (p=.00), ABIKROM – shoulders width (p=.00), AOPNATK – upper leg circumference (p=.00), AOPNADF – upper arm circumference in the bent and tense status (p=.00) and ADIJRUK – wrist diameter (p=.01), which means that some higher values were found with taller testees having bigger body weight, longer legs and arms, wider shoulders and bigger upper leg and upper arm circumference.

Discussion and conclusion

On the basis of the structural analysis of the motion structures in boxing, the logical conclusion is that motor abilities, that is, speed and explosive strength, are considered to be dominant for the success in a match. Without these much emphasized motor abilities, it would be practically impossible to obtain even some average results. Different aspects of speed (speed of reaction, speed of movement and speed of motion) provide an opportunity to a boxer to react in time on the opponent actions, efficient application of defense techniques, fast performance of individual punches, performing a greater number of punches in the form of series, fast movement in a ring and the efficient usage of counter-attack technique. A high level of explosive strength, especially with arms and shoulder area, as well as the high level of speed, is the basic feature of a quality boxer. A boxer with a distinct explosive strength in arms and shoulder area can direct some very hard and dangerous punches to his opponent and finish a match with only one punch. The legs explosive strength is also very important for a boxer, because it gives an opportunity for a faster movement towards the opponent or backwards. Regarding the fact that a boxer has a strong wish to fight in a ring and to obtain as better sport results in boxing as possible, it is necessary to examine the importance of relations and influence of morphological structures on specific motion structures parallel with determining hierarchical structure of motor abilities. Knowing the fact that the morphological features are undoubtedly relevant in boxing, it is necessary to determine which among them are more and which are less necessary for obtaining higher values in boxer's motion structures. By the process of testing the normality of distribution of each of the applied variables, it was determined that 80% of variables of distributions were normal (symmetrical), which meant that the system of the applied variables suited the testees and the level of quality of the tested boxers. In the applied system of variables of specific movement structures, a mild abnormal distribution was obtained only at variable of rope skip ''SKIP'' of 10 seconds (S SKIP) and its asymmetry reflected in a negative (logically positive) direction. In the system of morphological variables, it can be seen that distributions are abnormal (asymmetric) only at variable of upper-arm skin fold (ANABNAD), back skin fold (ANABLED) and stomach skin fold (ANABTRB) because the values of skeweness go over 1.00 (Sk<1.00). Having in mind that the values in this case are better if they are lower, it means that a greater number of testees had a smaller quantity of a fat tissue, which is considered very positive. Other morphological variables have a sufficient discrimination, which is very important in this research because it is a research about their connection with specific motion structures in the given conditions. On the basis of this empirical research and while applying crosscorrelation analysis, the assumption that motion structures (technical elements) of straight punch, hook and uppercut as well as the structures of movement speed, arms and legs work coordination, explosive and repetitive strength and anaerobic-aerobic capacity (speed strong endurance) are very important in the boxing match was confirmed. Identical importance in a boxing fight is given to morphological characteristics, especially referring to longitudinal and transversal dimension of skeleton and weight and body volume. Determining the influence by the system of predictor morphology variables on the criterion variables of the specific motion structures with boxers by regression analysis, it was concluded that the predictor system in statistically important multivariant relations (Ro2, Ro) had statistically

important connection at level p=.00 with all applied criterion variables, which brought the general conclusion that the applied system of morphological variables gave, in whole, the biggest contributions to the individual specific motion structures. Calculating the individual influence of each standardized predictor variable on each particular criterion variable using the regression coefficient (β) and the process of testing the importance of influence by each predictor variable on each particular criterion variable (p) using t-test, the statistical importance of the influence by each predictor variable on the particular criterion variable at the level from .05 to .00 (p= .05-.00) was determined.

The greatest number of morphological variables (seven) has a significant influence on the criterion variable of the series of 100 combined punches on to the coach's hands: left straight punch, right uppercut, left-right hook, bend right escaping left straight punch and contra punch by right straight punch (S SER 100), and then four variables followed by rope skip ''SKIP'' of 10 seconds (S SKIP) and defense from left straight punch and contra consisting of tree straight punches- defense from straight punch by bend followed by contra to three straight punches on to the coach's hands (SKONTRA).

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UTJECAJ NEKIH MORFOLOŠKIH ZNAČAJKI NA IZVOĐENJE SPECIFIČNIH KRETNIH STRUKTURA KOD BOKSAČA

Sažetak

Na uzorku 92 boksača iz hrvatskih boksačkih klubova i različitih težinskih kategorija, bio je primjenjen sustav od 20 varijabli, od toga 8 varijabli specifičnih kretnih struktura (kao kriterijske varijable) i 12 varijabli morfoloških karakteristika (kao prediktorske varijable). Relacije između dva različita sustava manifestnih varijabli utvrđene su izračunavanjem kroskorelacijske matrice, a utjecaj sustava morfoloških varijabli (kao sustava prediktorskih varijabli) na pojedinačne kriterijske varijable specifičnih kretnih struktura boksača, bio je izračunat pomoću regresijske analize. Na temelju analize matrice kroskorelacija između kriterijskog sustava varijabli specifičnih kretnih struktura i prediktorskog sustava morfoloških varijabli dobivene su relativno visoke i statistički značajne korelacije kod većine primjenjenih varijabli. Rezultati su pokazali da prediktorski sustav varijabli morfoloških karakteristika ima statistički značajan utjecaj na sve pojedinačne kriterijske varijable specifičnih motoričkih kretnih struktura na razini od .00 (p=.00). Može se zaključiti da morfološke karakteristike imaju veoma veliki utjecaj prilikom izvođenja specifičnih kretnih struktura kod boksača.

Ključne riječi: *boksači, specifične kretne strukture, morfološke značajke, utjecaj*

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