INTERRELATIONSHIP BETWEEN ANTHROPOMETRIC, MOTOR, AND SPECIFIC TECHNIQUE VARIABLES AND WRESTLING BOUT

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Abstract

The research on the relationship between anthropometric, motor and specific technique variables, and wrestling combat showed significant positive correlation. The research was carried out on a group of students studying at the Faculty of Physical Education. It was established that the level of acquisition of certain skills to a large extent contributes to victory and, vice versa, that their poor acquisition is responsible for defeat. Moreover, better results were achieved by subjects who exercised higher coordination, explosive strength and flexibility.

Keywords: anthropometry, motor abilities, wrestling, regression analysis

Zusammenfassung

ZUSAMMENHANG VON ANTHROPOMETRIS-CHEN, MOTORISCHEN UND SPECIFISCHEN VARIABLEN DER TECHNIK UND DEM ERFOLG BEI EINEM RINGKAMPF

Die auf dem Muster der Studenten der Fakultät für Körperkultur durchgeführte Forschung des Zusammenhangs von anthropometrischen, motorischen und specifischen Variablen der Technik mit dem Ringkampf erbrachte eine positive und bedeutende Korrelation. Es wurde festgestellt, daß das Niveau der Beherrschung von einigen Techniken entweder dem Sieg oder der Niederlage beitrug. Die Probanden, deren Koordinationsfähigkeiten, Explosivkraft und Flexibilität größer waren als die der anderen, waren beim Ringkampf mehr erfolgreich.

Schlüsselwörter: Anthropometrie, motorische Fähigkeiten, Ringen, Regressionsanalyse

1. Introduction

In recent years there are numerous scientific studies dealing with the relationship of different sub-spaces of psychosomatic dimensions and the results in different kinesiological disciplines. On the basis of the obtained results the researchers have attempted to determine their specification equation. The issue of specification equation in wrestling is far from being solved, although in the last few years an increased interest of researchers is evident. In comparison with the number of studies on the impact of wrestling on the development of different anthropological dimensions and their interrelationship in wrestlers, studies dealing with the relationship of the performance in wrestling and some anthropometric, motor and psychological dimensions are rather scarce.

Furthermore, there are no generally accepted criteria for the evaluation of performance in wrestling. Most of the authors investigated the relationship of different anthropological dimensions and the performance in some wrestling techniques from a standing stance in a group of students at the Faculty of Physical Education (Aračić, 1979; Kovačić, 1979; Soršak, 1985; Marić, 1982, 1983, 1984, 1985; Pavlović, 1982; Stojković, 1984 and others). A smaller number of studies dealing with the same topic was carried out on the sample of younger children, older children and adolescents (Marić, 1984, 1985, 1985, 1987, 1989; Siser, 1984 and others).

Some authors like Horvat et al. (1981) investigated the

relationship of different anthropological, motor, psychological and functional tests, and the specific wrestling tests, in order to establish the battery of measurement instruments for the selection, follow-up and control of training in wrestlers. However, the basic and the most relevant criterion in wrestling is definitely the achieved performance in actual bout. To the knowledge of the authors of this paper, studies related to the relationship between some motor variables and the performance in actual wrestling bout are not numerous. They are mostly studies carried out by students studying at the Faculty of Physical Education, on the similar sample and by administering fewer motor variables for the prediction of combat criteria. Šarić (1979) employed three variables of flexibility, Vukić (1979) three variables of explosive strength, and Vilenica (1981) three coordination variables as the predictor system. Each of the authors explained only 1.5-2% of combat variance.

Cvetković (1984) carried out similar investigation on the sample of 98 students at the Faculty of Physical Education employing the predictor system of eight motor variables: 3 for coordination, 1 for balance, 1 for the speed of move frequency, 1 for flexibility, 1 for the explosive strength, and 1 for the repetitive strength of arms and shoulders. The criterion variable was obtained by pondering the number of victories and by giving additional points to the competition finalists. It seems that the criteria were not well defined, which impacted the regression analysis results. The selected predictor system failed in explaining the criterion variable of the combat. Kuleš, Marić et al. (1984) carried out an interesting investigation on the sample of 78 young wrestlers aged 13-14. In the former case classical regression analysis was employed, and in the latter the quasi-regression analysis. Predictor system of six variables for assessing the speed of movement frequency (20, 50, and 60 m sprints), pushups performed in 10 seconds, and a number of wrestler's bridges performed from the lying position in 10 seconds. The wrestler's efficiency was assessed by using three specific wrestling variables:

- fighting spirit: three coaches, schoolchildren's leaders who knew the subjects well assessed the fighting spirit on the 1 to 7 point scale;
- speed of going into the bridge in 10 seconds;
- number of victories in one's own weight category (maximum of 7 victories in each weight category).

By the predictor system 58% of combat variances, 51% of fighting spirit variances, and 49% of bridge variances were explained. The battery of measurement instruments used in this investigation lend themselves very well as the selection standards for courses (schools) in wrestling.

The objective of the research was to establish relations of the manifest anthropometric, motor and specific wrestling technique variables, and actual wrestling combat.

2. Methods

2.1 Sample of subjects

The investigation was carried out on the sample of 228 students studying at the Faculty of Physical Education, University of Zagreb. The subjects were 19 through 25 years of age, so it might be assumed that the subjects were relatively stable as regards their motor, morphological and other psychosomatic dimensions.

The sample may be considered discriminatory since students on entering the Faculty of Physical Education must meet certain requirements, such as medical check-up and measurements of some motor, anthropometric, cognitive and conative parameters.

All the subjects have taken a course in wrestling prior to undergoing measurement procedure.

The sample of 228 subjects allowed such a number of degrees of freedom that each correlation coefficient being .13 or more could be considered significant at the level of reliability of .95, and each correlation coefficient being .17 or more, at the level of reliability of .99.

2.2 Measurement instruments

2.2.1 Predictor variables

2.2.1.1 Procedures for measuring anthropometric characteristics

The anthropometric variables used in this research were selected from the group of 23 anthropometric variables¹. The 15 selected variables cover the space of four hypothetically latent dimensions: longitudinal skeleton dimension, transversal skeleton dimension, circular body dimensionality and sub-cutaneous fat tissue.

To assess longitudinal skeleton dimension the height of the body (VISTIJ), and the length of legs (DUŽNOG) and arms (DUŽRUK) were measured; to assess transversal skeleton dimension bicrystal ratio (BIKRIS), wrist diameter (DIJRUZ), and the knee diameter (DIJKOL) were measured; to assess sub-cutaneous fat in folds of the lower leg (NABPOT), the armpit (NABPAZ), the back (NABLED), and the upper arm (NABNAD) were measured; to assess circular body dimensionality (TEZTIJ) the circumference of the upper arm (OPSNAD), the circumference of the forearm (OP-SPOD), the circumference of the upper leg (OPSNAT), and the circumference of the lower leg (OPSPOT) were measured.

The measurements have been carried out in consonance with the procedures suggested by the International Biological Programme. The detailed description of the procedure employed can be found in Momirović et al. $(1969)^2$.

2.2.1.2 Procedures for the assessment of motor abilities

In order to assess motor abilities of the subjects 14 measurement instruments, which partly cover the space of latent dimensions of energy regulation and regulation of movement which are said to be responsible to a large extent for the performance in wrestling, have been employed for the purpose of this research.

The test results have been coded for the sake of processing. The first symbol indicates the motor space, the next two hypothetical latent primary factor, and the last three symbols indicate a special characteristic of each measurement instrument. The following measurement instruments have been used: the test polygon backwards for the reorganization of the movement stereotype (MRE-POL); side steps for agility (MAGKUS); the test of pulling through and jumping (MBKPOP) to gain speed of performing complex motor tasks; the hand tapping test (MBFTA2) for the frequency speed; the test of standing transversely with both legs on the balance bench (MBAP20) for balance with open eyes; the test of forward bend straddle (MFLPRP), outward turn (MFLISK) and forward bend standing on bench (MFLPRK) for flexibility; long jump from the standing position (MFEDSM), throwing the medicine ball from

¹ The choice, reliability determination and latent stuctures of anthropometric variables have been elaborated in Croatia by: Momirović, 1969, 1971; Kurelić, Momirović, Stojanović, Šturm, Radojević, & Viskić-Štalec, 1975; Solarić, Stojanović, Vukosavljević & Momirović, 1975; Stojanović, Hošek, Momirović & Vukosavljević, 1975.

² Momirović et al: Factor Structure of Anthropometric variables (1969).

the lying position (MFEBML), and 20 m sprint from the elongated start (MFFV20) for explosive strength; the tests of chin-ups on the horizontal bar by undergrip and trunk lifting on bench (MRCDTK) for the repetitive strength, and finally the test of load hold in a half squat for the static strength (MSLIZP).

2.2.1.3 Procedures for the assessment of wrestling characteristics

To assess wrestling characteristics the following variables have been used for the purpose of this research:

(1) five holds from a standing position in a way that each hold illustrates one of the group techniques from a standing position:

- > 1. pushing down by passing under the arm;
- > 2. pulling down over the shoulder;
- > 3. hip-turn by head and arms hold;
- > 4. trunk and single arm hold;
- > 5. arm and body hold pushing to the floor.

1. Pushing down by passing under the arm

The wrestlers are in a right high on guard standing position. The wrestler grasps by his left arm the opponent's ankle and by his right arm the upper part of the opponent's arm. From the same stance he drags the opponent's arm strongly forward with the objective to get him off balance and have him move forward with his left leg (ann drag was accompanied by the body weight since at the same time he takes with a pull cover of his trunk by a hip-turn towards the opponent). Then the wrestler turns right, puts his left leg behind the opponent's right one thus transferring his weight, releases the opponent's ankle and by his left hand executes the front waist hold. He continues to drag the opponent's right arm downwards and rightwards, and by his left arm he pulls his trunk, swings to the right and with a circular motion he drives his opponent to the mat.

2. Pulling down over the shoulder

The wrestler is in the right combat stance, he grasps and nails down the opponent's right arm below his left upper arm. By turning on the toes of the right leg and by holding the opponent's right upper arm by his right arm (he clinches the opponent's arm on his right shoulder), he comes under the opponent by throwing his weight to the left leg. His legs are half bent, the trunk bent slightly forward, and his back turned to the opponent's chest (rotation of 180⁰). The phase of entering this hold is followed by the stage of hip grappling by extending legs and the hooked arm drag with the forward trunk bend. If forward bend, arm drag, and hip grappling are executed properly and explosively, the flight stage follows during which the opponent's body makes a parabola and drops into a bridge. The wrestler's left hand goes behind his opponent's head, while his right hand takes hold of the opponent's right hand.

3. Hip-turn by head and arm hold

The wrestlers are in the right medium guard combat stance. A wrestler grips with his left arm the opponent's

right arm above the elbow, and his lower arm fixes below his own left upper arm. His right arm is usually on the opponent's neck to the left. He pushes himself below the opponent's navel by turning on his right foot toes for about 190-200°, and his back to the opponent. The legs are slightly bent in knees, and the trunk is almost upright. At the same time he turns his head to the left, and moves his left leg behind the right one parallel at the foot distance. His right hip is turned slightly outside the right hip of the opponent, by making use of the inertia move, and the head and arms pull downwards. By extending legs he hip-turns the opponent under the gravity center, continuing head and arms pulling. By bending forward and to the left he enforces the opponent's drop of arms and head. Joint forces acting parallel but in different directions cause the parabola flight of the opponent's body whose point of support is on the attacker's back. The opponent falls forwards. In the end the attacker sits on his right hip holding the opponent's head and arms.

4. Front waist trunk and single arm hold

From the right combat stance the attacker executes the hold of the opponent's right arm and front waist trunk, he lowers the gravity centre while in half-squat brings his left leg to the outside of the opponent's right one. The distance between legs is the same as between shoulders, the chest and hips are below the opponent's, the head is at the side of the hooked arm. The attacker takes a tight hold of the opponent and by dropping backwards by extending legs, and by hips and abdomen turns the opponent upwards and backwards. By executing head and trunk turn and dropping into bridge, he revolves to the left, chest turned to the mat and the opponent, he holds the opponent in a dangerous position.

5. Arm and body hold pushing to the floor

The most favourable moment for the execution of this hold is when wrestlers are in a double hold of arms and trunk and standing stance of different names (the attacker in the right and the opponent in the left standing stance). The attacker pulls the opponent by left arm-drag and in this way causes the opponent's defensive reaction, the forces of which are directed in opposite direction. Taking advantage of the situation, the attacker suddenly changes the direction of forces, pushes his right leg backwards and thrusts himself forward. At the same time he puts weight onto the opponent's left arm and trunk (he clenches his left leg). By the thrust of his left shoulder against the opponent's chest he overturns him on his back. The thrust of the shoulder must be accompanied by pulling the hooked parts of the opponent's body forwards, downwards and to the right. The attacker completes his hold by grasping the arms and the trunk from the side turned to the opponent, trying to sweep him to the mat.

Eight competent judges assessed the performance of holds selected as representative for each group of techniques from a standing stance. Each judge evaluated all five holds performed by each subject by grades ranging from 1 to 5. Each subject performed each grip three times in succession, and the judges evaluated each performance. They evaluated the following grip structures:

> 1. right basic combat position and hold I point

٢	2.	the stage of initiation of a hold	1 point
>	3.	working stage	1 point
)	4.	completion stage	1 point
)	5.	general impression (coordinated	

performance of all stages without interruption) 1 point

If one of the structures was not performed correctly it gained no points, so the final score varied from 0 to 5.

The final evaluation of wrestling characteristics for each subject in each of five techniques was presented by standard deviations of the first main components of the intercorrelation matrix of variables defined by the judges' grades.

2.2.2 Criterion variable

Subjects were classified into 7 weight categories, but not according to the weight categories established by the World Amateur Wrestling Federation (FILA). The reason is that students studying at the Faculty of Physical Education are much more homogenous regarding their anthropological characteristics than the general population of wrestlers, and consequently the range between minimum and maximum weight in students is much smaller than in wrestlers in general. The students with minimum weight weighted 60 kg (the lowest weight category in wrestling is 48 kg), and students with maximum weight weighted 90 kg (the highest weight category in wrestling is over 100 kg). The range between bottom and top limit of each weight category was 5 kilos. The categories were as follows: up to 60 kilograms, 60 to 65 kilograms, 65 to 70 kilograms, 75 to 80 kilograms, 80 to 85 kilograms and 85 to 90 kilograms.

Each wrestler had five to six bouts in his own category. Each bout lasted 3 minutes within 120 minutes necessary for all the subjects to participate in five or six bouts. Each group consisted of 28 to 30 participants.

The number of victories and defeats in one's category was recorded for each participant, and in such a way that it was possible to know whom the participant defeated and who he was defeated by.

2.3 The Data Processing

To find the answer to the relation of the predictor system and the performance in an actual wrestling bout, a rather atypical approach was applied. That is, in cooperation with an associate Mr. J. Štalec, statistical technology allowing a much more precise insight into the contribution of each single variable, as well as of the whole predictor system, to the explanation both of the victory and defeat in actual bout between two opponents, was applied. The fact was particularly important since the applied competition system according to the weight categories necessarily reduced the variability among the subjects regarding the morphological, and motor variables. Consequently, it was assumed that the generally applied regression analysis would in this particular case be inapplicable.

Thus, in this paper the <u>bouts</u> and not the <u>subjects</u> are treated as entities. Since the subjects executed 648 bouts altogether, where there necessarily were 648 victories and 648 defeats, the total number of entities was 1296. All the entities were a part of the gross result matrix, in the way that victories were ranked first and defeats followed. To every victory and every defeat the following were added:

- All the features that were measured as predictors in a subject who won or lost the bout, in other words the results of his anthropometric, and motor tests and wrestling characteristics (TSUB1.....TSUB5)
- wrestling characteristics of the opponent which were coded by the symbols TPARI.....TPAR5.

In such a way the rows of the gross results matrix were formed while the indicators of morphological, motor and wrestling status formed the columns of the matrix. The number of the latter equalled the number of bouts. Along with these data which follow successively since they refer to the same subject, wrestling characteristics for some bouts were taken into account since they always refer to another opponent.

On the basis of gross results the intercorrelation matrix of all the predictors was established, and then the regression analysis of the binary type was applied with each victory being marked as 2, and each defeat as 1.

The objective of the analysis was to establish whether, and to what extent, it is possible, on the ground of the predictor system, to predict either victory or defeat, in other words to establish whether the characteristics of winners or losers are discriminatory for the prediction of the outcome of future bouts.

3. Results and Discussion

By means of the regression analysis the relationship between manifest anthropological, motor and wrestling technique variables, used as predictor systems, and the performance variables of subjects in an actual wrestling bout, was established. The predictor system allows the prediction of 16% of the criteria variance at the level of significance of p=0.01, which is undoubtedly an evidence of the high complexity of the wrestling combat. Out of a total of 39 predictor system variables, 11 had significant partial regression coefficients. Only one anthropometric variable had a significant partial regression coefficient. However, its contribution to the variance determination is negligible. Motor variables contributing most to the criteria variance were: pulling through and jumping (skipping), as a part of the latent dimension of the expediency of performing complex motor tasks and throwing the medicine ball from the lying position as a measure of explosive strength.

Four wrestling technique variables play an important role in predicting the performance in an actual bout. Yet, all the variables related to the wrestling technique showed high significance and, in comparison with the others, relatively high orthogonal projections on the regression factor. Hence, the level of acquisition of the elementary wrestling techniques to a large degree defines the obtained regression factor, the fact that leads to the logical conclusion that it contributes to the largest

	R	Q(R)	PARTIR	BETA	Р	SIGMA-B	Q(BETA)	F(BETA
TEZTJE	02	,15	04	.11	27	.09	.00	06
OPSNAD	08	.39	04	-,07	.59	_05	.18	20
OPSPOD	11	.00	01	02	.25	.05	.67	28
OPSNAT	01	.00	.04	.06	09	.05	.19	03
OPSPOT	08	.62	04	06	.49	.04	₊ 15	19
VISTJE	.04	.01	.02	.04	16	.06	.46	.09
DUZNOG	.05	.19	.00	.01	.03	.06	.92	.14
DUZRUK	.01	.05	01	02	02	.05	.76	.03
NABNAD	.04	.69	.00	.03	.02	.04	.92	.09
NABPAZ	.03	.18	01	-,02	05	.05	.74	.07
NABLED	.02	.00	.02	06	.07	.05	.49	.06
NABPOT	02	.39	02	03	.05	.04	.50	05
DIBIK	03	.48	04	.01	,15	.04	.13	06
DIRUK	09	.37	02	.01	,23	.04	.53	22
DIKOL	04	.00	.00	03	03	.04	.86	10
MREPOL	.08	.14	.01	.14	.08	.03	,77	.20
MAGKUS	.02	.00	03	04	06	.03	.34	.05
MBKPOP	,18	.47	.11	.09	2.54	.04	.00	.44
MBAP20	08	.00	04	.04	.34	.03	.18	21
MBFTAP	.07	.00	.09	00	.66	.03	.00	.18
MFLPRR	06	.01	.03	.02	26	.04	.00	15
MFSDSM	05	.03	00	04	.02	.03	.91	12
MRAVIS	10	.08	.01	06	18	.04	.61	24
MFLISK	.01	.00	03	11	02	.03	.01	02
MFLDPK	11	.82	04	03	.66	.04	.12	28
MFEBML	12	.00	08	.06	1.34	.04	.00	29
MRE20V	00	.00	02	00	.01	.03	.38	01
MSLIZP	09	.86	06	.02	.49	.03	.05	22
MRCDTK	04	.00	00	04	.02	.03	.89	09
TSUB-1	16	.00	.02	06	34	.04	.59	41
TSUB-2	18	.00	07	11	1.92	.04	.02	46
TSUB-3	18	.00	02	03	.46	.04	.56	46
TSUB-4	20	.00	06	09	1.81	.04	.04	49
TSUB-5	15	.00	01	01	.12	.04	.84	38
TPAR-1	.16	.00	.03	.03	.54	.04	.37	.41
TPAR-2	.18	.00	.04	.06	1.12	.04	.12	.46
TPAR-3	.18	.00	.03	.05	.90	.04	.03	.46
TPAR-4	20.	.00	.07	.09	1.82	.04	.04	.49
TPAR-5	.15	.00	.02	.03	.40	.04	.46	.38
)					1	
DELTA	RO	000000000000000000000000000000000000000	SIGMA-D	F	DF1	DF1 DF2		Q
,15947	.15947 .39934		.91680	611036	39	12	1256	

Table 1 The Relation of the Manifest Motor, Anthropometric and Wrestling Technique Variables, and of the Performance of Subjects inActual Bout

extent to the explanation of that part of the criterion variable which can be clarified by this predictor system. However, as it is evident from Table 1, the acquired techniques TSUB2 and TSUB4 (the techniques of shoulder and hip throw by head and arm hold) significantly

contributed to the performance in winners, whereas poorly mastered techniques TPAR3 and TPAR4 (hipturn by head and arm hold and throw by twisting the front waist) in losers contributed to their defeat. That is, poor execution of hip-turn puts the opponent behind the attacker's back, which brings him 1 point, and also the possibility of the counter-attack on the mat. Poorly mastered technique of turning by twisting enables the opponent to gain victory relatively easy by pinning the attacker down (having him on the back for at least 1 second), but mastering the execution of appropriate and stable wrestling bridge is a long process.

Such response of the predictor system variables has been caused by the neutralization of the variability of motor and morphological characteristics, owing to the fact that bouts were carried out according to the criteria of weight categories. Though the differences related to the acquisition of wrestling techniques statistically significantly support prediction, their impact is relatively small, the fact that might imply that the variability of performance must be with the anthropological characteristics which were not taken into account.

Apart from technical superiority better performance (victory on points or pinning) was achieved by subjects with better coordination and greater explosive strength, better flexibility which is closely related to the manifestation of explosive strength and economic energy consumption during the whole competition, in the course of which each participant participated in 5 to 6 bouts. Since there was no question of the automated habits acquired during the short training time, particularly not in very complex circumstances of situation combat, it might be rightly assumed that the more efficient mastering of wrestling techniques would have contributed to the combat efficiency.

The basic reasons for significant but poor wrestling techniques applied in actual bout are as follows:

- a) the high complexity of techniques and tactics of contact sports like wrestling (wrestling by classical, free, judo and sambo style) covering more than one thousand technique elements. The elementary course in wrestling at the Faculty of Physical Education covers 10 holds (and counter-holds) from a standing stance, and 12 holds (and counter-holds) from the classical referee's stance, 8 holds from a standing stance and 5 from the referee's (and counter-holds) free style;
- b) limited time allotted to the discipline of wrestling which is dictated by the overall curriculum, and some other regulations regarding the curriculum. Out of the total of 60 hours allotted to this discipline, 12 account for theory and 48 for practical training and theory. Provided that students, before taking their test, practiced on the average another 50 hours (holds are tested from the basic bout position and the most favourable static position), the whole period would still undoubtedly be insufficient for the

acquisition of the basic knowledge in wrestling, in comparison with the two-year wrestling training programme of minimum 320 hours, an average of 480 hours, and optimum of 640 hours (2, 3 or 4 time training a week, each lasting 90 minutes);

- c) no knowledge whatsoever (apart from the athletes engaged in these disciplines) of contact sports in general;
- *d*) impossibility of training techniques situationally owing to the limited time.

On the basis of everything stated above it might be assumed that the high performance depends on training and mastering techniques in the situation context and the quantity of time allotted to this discipline. However, these are the topics to be addressed in further studies.

4. Conclusion

The fundamental objective of the study was to establish the degree of impact of some anthropometric, motor and specific wrestling variables on the performance of the beginners in wrestling in actual wrestling bout by classical style.

The investigation was carried out on the sample of 228 students studying at the Faculty of Physical Education, University of Zagreb. The battery of 14 motor and 15 anthropometric measurement instruments were applied. Furthermore, each student was evaluated for the performance of each of 5 selected holds, and consequently their success in actual wrestling bout was established. The relationship of the performance criteria, defined by the number of victories, and anthropometric, motor and specific wrestling variables was determined by the regression analysis.

It is possible to predict about 16% variance performance in actual wrestling bout by using predictor system of manifest measures of anthropometry, motorics, and hold performance evaluation. The level of elementary wrestling techniques acquisition defines to a large extent the obtained regression factor. Furthermore, students who were more coordinated and who had more explosive strength and flexibility achieved better results.

All the data point to the inevitability of further studies dealing with beginners in wrestling, then children in general, and prospective wrestlers in order to promote teaching of wrestling in schools aimed at orientation, selection, programming and control of the training process.

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