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Non Linear Relationships between Anthropometric and Motor-Endurance Variables

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ABSTRACT

Nonlinear regressions are rare in anthropology. In this paper we have tried to identify the significance and the character of the linear and non-linear relations between some anthropometric measures and the motor-endurance status. All subjects (300 moderately physically active males, mean aged 24±3.4 years) were measured for body weight, body height, body mass index, push-ups, sit ups, standing high jump, 50 meters swimming, and 1500 meters running. Linear (general model: $y=a+bx$) and nonlinear regression (general model: $y=a+bx+cx^2$) was calculated simultaneously. According to the presented results the non linear-square relation between variables can be expected: a) if there is evident cause why two absolutely different sub-groups of subjects should reach equal results in the criterion, b) if a non-linear-square basis for the established relationship can be found. In conclusion, simple linear and non linear regression procedures are to be used for the identification of linear and nonlinear predictors in nonlinear multiple regressions.

Key words: *fitness status, nutritional status, kinesiology, methodology*

Introduction

Defining the correlations between and within different anthropological dimensions is a problem often investigated. Relations between motor and endurance status – on the one hand, and some other anthropological dimensions – on the other, are frequently described[1–5]. However, all the mentioned studies calculated the linear correlation models (univariate or multivariate). But, in the last few years a growing interest in the non-linear models usage has been noticed[6–9]. In kinesiology, a deficiency of the non-linear methodological procedures is obvious. Nevertheless, the authors of this study share the opinion that the non-linear models can be »a step forward«. In some cases, with certain significance, the nature of non-linear relationships between the variables can be observed and explained. For example, Ambrozić[9] clearly and logically explains the established correlation model between body height-stature, as a criterion, and calf circumference, as a predictor, in the calculated square-function-model, in 7–9 year old children. The relation between stature and calf circumference is described following the logic of the circle surface calculation (πr^2). Consequently, stature and body weight are highly correlated. »Calf surface« conquers body weight. Further, the »calf-surface« (in the morphological testing non-directly determined by calf-circumference measurement) can be approximately defined as a circle surface-magnifying as the square-function of the radius, which finally determines the square-non-linear relation between the calf circumference and stature. Sekulic et al.[8] used a non linear model and explained the relationship between certain anthropological dimensions (predictors) and psycho-physiological exercise responses (criteria). The authors defined that two absolutely different groups (extremely rhythm-coordinated and non-coordinated) have an extreme low level of physiological response during an aerobic dance training session. They concluded that for these two groups (well coordinated and non coordinated) aerobic dance sessions are either too complicated (for the non coordinated), or on the other hand – too simple (for the well-coordinated). This abstrusity, as well as simplicity, determines an energetically undemanding workout for both characteristic groups.

The assumption is that a sort of the non-linear correlation exists within some of the motor dimensions and as was supposed, between the motor and morphological dimensions.

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As aforesaid, the use of the nonlinear correlation models in kinesiology, as well as in anthropology, is very rare. Probably, the main problem is in the complexity of the calculation and the interpretation of the non-linear regressions. The second problem is obvious from the previous studies that calculated a sort of the non-linear (mostly square function) regressions. Authors[9] regularly calculated and interpreted the significance of the main non-linear-regression parameters (coefficients of the correlation and coefficients of the determination) only, but avoided interpreting (probably did not calculate – but surely did not present in the papers) the numerical value and the significance of the characteristic non-linear-regression-element (»*c*« element in the equation: $y=a+bx+cx^2$). All these said facts probably initiated serious mathematical-statistical, but also interpretative errors. In short, any non-linear regression correlation coefficient would be significant if the linear one is significant too, but it does not necessarily define the non-linear »logic« of the relationship. If the non-linearity is aimed at, the key-parameter that should be observed is the non linear-equation-element. If the non-linear-equation-element is not significant, it practically »linearizes« the non linear equation. In those particular cases, the interpretation of the non-linear regression is – mathematically incorrect.

This study was aimed at investigating the significance and the character of the linear and non-linear ratios between some anthropometric measures and the motor-endurance status of the subjects. The idea was to establish the quantity and describe the nature of the anthropometric measures' nonlinear influence on the manifestation of the motor-endurance status variables, using single and multiple predictors. According to previous studies[8,9] we expected that the non-linear model of the simple and the multiple regression would define the true logic of the correlation between the variables.

As far as we know, such a paper dealing directly with the non-linear multiple relations between the morphological status (predictors) and motor-endurance variables (criteria) has not been published in recent literature.

Materials and Methods

Subjects: 300 recreationally physically active males (18–27 years, mean age 24 ± 3.1 years), all in good health, served as the sample of subjects. All of them were physically active and none of them reported recent injuries. The subjects received a complete explanation of the purpose and the procedures of the study and gave their written consent.

Variables: The sample of variables consisted of two sets: three anthropometric variables (body weight, body height, and body mass index), and four motor-endurance variables (push ups, sit ups, standing high jump, 50 meters freestyle swimming, and 1500 meters run). Each subject performed the anthropometric and motor-endurance testing within the same week. It must be stressed that the subjects were familiar with all motor-endurance tests, and they had sufficient experience in swimming 50 m.

Anthropometric variables: Body weight (BW) and body height (BH) were measured with standard techniques to the nearest 0.1 kg and 0.5 cm, respectively. Body mass index (BMI) was calculated as follows:

$$BMI=BW(kg)/[BH(m)]^2.$$

Motor-endurance variables: Push-ups. The subject starts from a rigid erect position with the arms extended, and lowers the body until chest touch-down, and then pushes upward until full extension of the arms is reached. The maximal number of correctly performed push-ups became the score (PUSH-UP). *Sit-ups*. The subject starts in the supine position with the knees extended, fixated from the lower hip, holding his hands behind the neck. From this position, the subject performs a 90-degrees sit up (SIT-UP). Maximal number of correctly performed sit-ups became the score. *Standing high jump*. The subject performs maximal vertical jump-and-reach from the standing erect position using arm swing (HIGH-JUMP). The result is expressed as the difference between maximal reach-height and maximal vertical jump-height. *50 meters freestyle swimming*. Altogether 4–6 subjects were tested the standard FINA procedure (FS50M). *1500 meters run*. Standard IAAF procedure was used to measure 1500 meters run (1500M).

Data processing methods: We calculated descriptive statistics for all the variables. Linear and non-linear correlations were calculated between the anthropometric variables and motor-endurance variables. The general non-linear square function equation (second order polynomial model) used was: $y=a+bx+cx^2$, where »*y*« presents the criterion (one of the analyzed motor-endurance variables), and »*x*« presents the predictor (one of the anthropometric measures). All coefficients were considered significant at a level of 0.95 ($p < 0.05$). Statsoft's Statistica version 6.0 was used for all the statistical procedures.

Results

Table 1 shows the results of the subjects in all the measured anthropometric and motor-endurance variables. Kolmogorov-Smirnov's test showed no significant differences between the observed and theoretical normal distributions of results.

In Table 2 the results of the linear and non linear regression calculated between the anthropometric characteristics (predictors), and motor-endurance variables (criteria) are presented. From 30 regressions in total (15 linear and 15 non linear), 8 linear and 11 non linear calculations reached a satisfactory level of significance ($p < 0.05$). First, we must point out the relatively low percentage of the common variance explained (up to 10%). Therefore, we can suggest that some other predictors e.g. muscle mass, cardiorespiratoy fitness, muscle strength, coordination, etc. should be studied in the future, because of the possible higher significance in the explanation of the criteria.

TABLE 1
DESCRIPTIVE STATISTICS

	X	Minimum	Maximum	SD
BH (cm)	182.06	166.50	203.00	6.57
BW (kg)	76.10	56.00	105.00	8.93
BMI (kg/m^2)	22.94	17.73	28.80	2.27
PUSH-UP (repetitions)	27.47	7.00	59.00	8.72
SIT-UP (repetitions)	35.74	12.00	61.00	10.12
HIGH-JUMP (cm)	46.35	23.00	61.00	5.76
FS50M (s)	35.94	27.00	54.40	4.21
1500M (s)	427.70	330.00	687.00	48.20

BH – body height, BW – body weight, BMI – body mass index, PUSH-UP – maximal number of the push-ups, SIT-UP – maximal number of the sit-ups, HIGH-JUMP – standing high-jump, FS50M – freestyle swimming 50 meters, 1500M – 1500 meters running

TABLE 2
LINEAR AND NON LINEAR REGRESSION INDICATORS (COEFFICIENT OF THE CORRELATION – R, COEFFICIENT OF THE DETERMINATION – R^2, INTERCEPTION COEFFICIENT – A, LINEAR COEFFICIENT – B, CURVATURE COEFFICIENT – C)

CRITERIA	PREDICTOR	MODEL	R	R^2	a	b	c
PUSH-UP	BH	LINEAR	0.18*	0.03*	72.05*	–0.18*	
		NON LINEAR	0.18*	0.03*	–6,72	0.47	–0.65
	BW	LINEAR	0.16*	0.03*	39.48*	–0.16*	
		NON LINEAR	0.26*	0.06*	–54.42	2.29*	–2.50*
	BMI	LINEAR	0.06	0.00	32.35*	–0.06	
		NON LINEAR	0.26*	0.07*	–11.02*	3.15*	–3.20*
SIT-UP	BH	LINEAR	0.07	0.01	–54.42	–0.07	
		NON LINEAR	0.07	0.01	39.48	0.29	–0.35
	BW	LINEAR	0.06	0.00	40.79*	–0.06	
		NON LINEAR	0.12	0.01	–15.95	1.24	–1.30
	BMI	LINEAR	0.02	0.00	37.90	–0.02	
		NON LINEAR	0.17*	0.03*	–15.95*	2.17*	–2.20*
HIGH-JUMP	BH	LINEAR	0.16*	0.02*	21.54*	0.16*	
		NON LINEAR	0.16*	0.02*	–7.99	–0.53	–0.37
	BW	LINEAR	0.07	0.01	49.85*	–0.07	
		NON LINEAR	0.19*	0.04*	–3.00	2.06*	–2.10*
	BMI	LINEAR	0.19*	0.04*	57.64	–0.19*	
		NON LINEAR	0.24*	0.06*	–6.76	1.53*	–1.70*
1500M	BH	LINEAR	0.04	0.00	367.90*	0.05	
		NON LINEAR	0.05	0.00	788.25*	–0.58	0.63
	BW	LINEAR	0.16*	0.03*	363.53*	0.16*	
		NON LINEAR	0.23*	0.05*	784.76*	–1.90*	2.04*
	BMI	LINEAR	0.16*	0.02*	351.74*	0.16*	
		NON LINEAR	0.29*	0.08*	1116.0*	–2.90*	3.10*
FS50M	BH	LINEAR	0.04	0.00	30.75*	0.03	
		NON LINEAR	0.06	0.00	160.71	–1.40	0.00
	BW	LINEAR	0.19*	0.04*	28.07*	0.10*	
		NON LINEAR	0.26*	0.07*	74.59*	–1.11*	0.00*
	BMI	LINEAR	0.21*	0.05*	26.33*	0.42*	
		NON LINEAR	0.29*	0.09*	85.23*	–4.64*	0.11*

*$p < 0.05$, BH – body height, BW – body weight, BMI – body mass index, PUSH-UP – maximal number of the push-ups, SIT-UP – maximal number of the sit-ups, HIGH-JUMP – standing high-jump, FS50M – freestyle swimming 50 meters, 1500M – 1500 meters running

In Figures 1–4, a few of the characteristic linear and non linear relations are presented.

Discussion

Compared to BH and BW, BMI is the most significant predictor of the motor-endurance criteria (three significant linear and all five significant non linear predictions). For a complete explanation of the relationships, the graphic presentations (Figures 1–4) are very useful. Figure 1 presents the relation calculated by the linear and nonlinear regression models for the variables BMI and PUSH-UP. The linear correlation coefficient is negligible (i.e. not significant, $p>0.05$), but the non linear model determines the common variance at a significant level ($p<0.05$). The reason for the relatively large difference in the numeric parameters of the correlation equations (0.06 *vs.* 0.26) can be found only by analyzing

a) b)

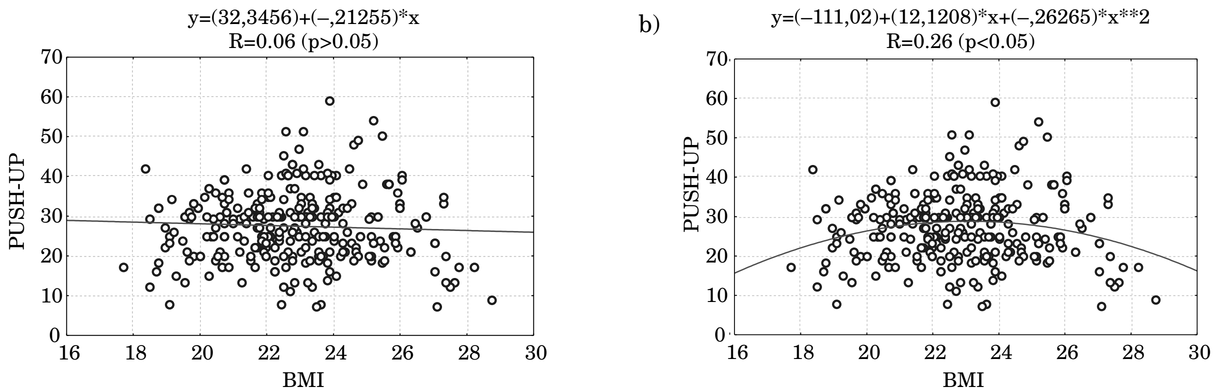

Fig. 1. Linear and non linear correlation model for the variables: BMI – body mass index and PUSH-UP, (a) Linear relation BMI, PUSH-UP, (b) Non linear relation BMI, PUSH-UP.

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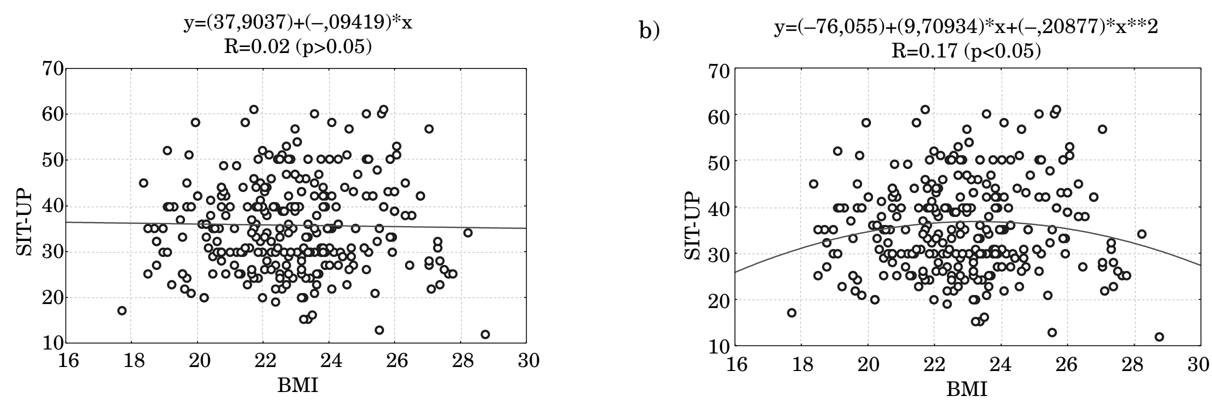

Fig. 2. Linear and non linear correlation model for the variables: BMI – body mass index and SIT-UP, (a) Linear relation BMI, SIT-UP, (b) Non linear relation BMI, SIT-UP.

a) b)

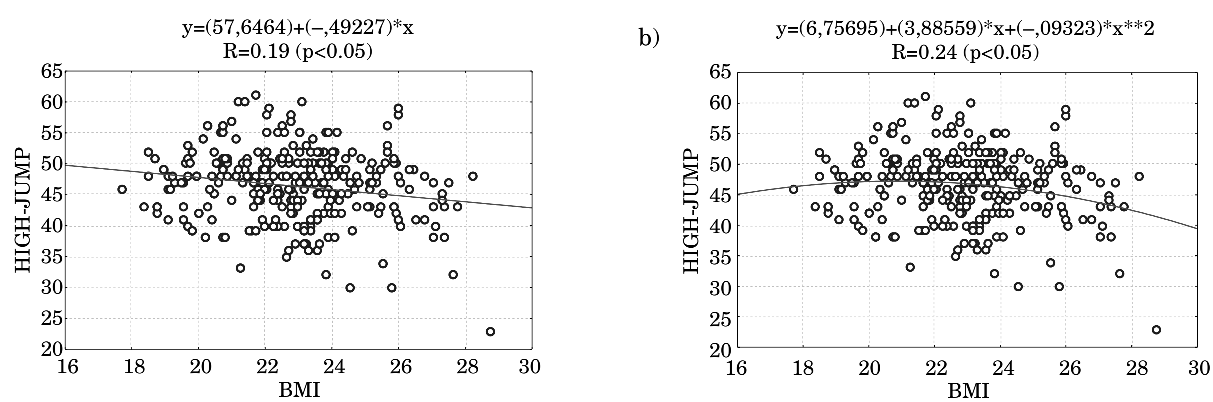

Fig. 3. Linear and non linear correlation model for the variables: BMI – body mass index and HIGH-JUMP, (a) Linear relation BMI, HIGH-JUMP, (b) Non linear relation BMI,HIGH-JUMP.

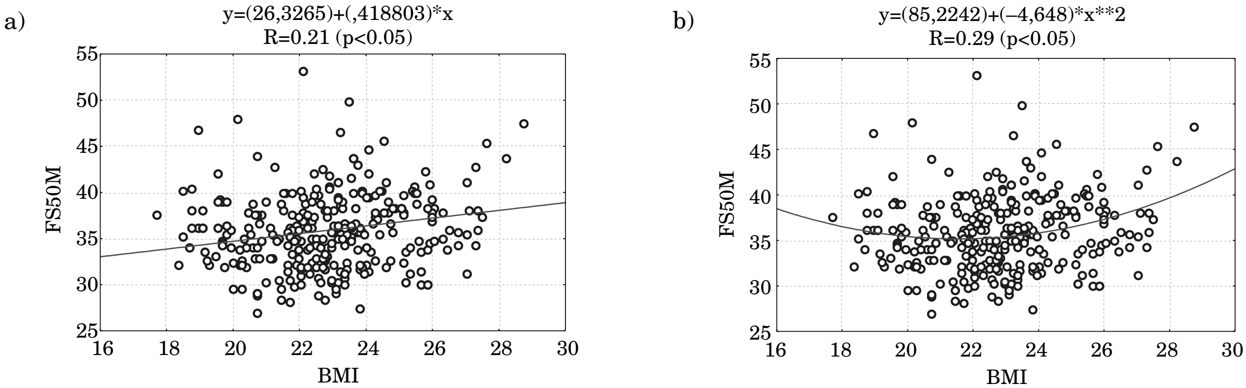

Fig. 4. Linear and non linear correlation model for the variables: BMI – body mass index and FS50M (50 meters freestyle swimming, standard FINA procedure), (a) Linear relation BMI, FS50M, (b) Non linear relation BMI, FS50M.

the graphic presentation. The scatter plot (Figure 1) is set as a »geometric parable«. This phenomenon can be explained knowing the motor-manifestation of the PUSH-UP test. During the test the subject has to push his own body from the floor, using his arm and torso strength (triceps brachii and m. pectoralis major et minor, mostly), and to perform as many repetitions as possible. Since human muscle strength increases at a lower rate than body weight[10], the larger the subject's body weight is – the harder the test is, explaining the significant negative correlation between BW and PUSH-UP. A similar finding using an allometric model, rather than linear, has been recently published[11]. The relatively expressed BW is characteristic for the subjects placed on the right side of the scatter plot. But, the BMI in its equation also includes the factor of the BH. The expressed BH is characteristic for the subjects placed on the left side of the scatter plot. According to the non linear regression curve (Figure 1b) it is obvious that very tall subjects (left side of the scatter plot) perform the PUSH-UP test poorly, very much like the overweight subjects (right side of the scatter plot). The reason can be found in the already explained characteristics of the PUSH-UP test. As stated, the subject has to conquer his own body weight, by his arm-extension movement. Definitely, the arm's length is a burdening factor, because it defines the length of the characteristic push-up movement, and naturally – the quantity of the work (longer arms – greater work). Finally if we know that the arm length is positively correlated with the BH[12–14], the negative influence of the BH on the PUSH-UP manifestation is clear. Since the linear correlation would be significant only if the constant direction of the regression-line is established, it is not surprising that our study as well as previous ones[15–17] did not establish any significant linear relation between the BMI and different motor-endurance manifestations mostly. More precisely, some authors actually defined the significant negative linear relations between the BMI and motor-endurance status variables, but only for the overweight and/or obese subjects[16,18,19], meaning that they actually found the relationship which is characteristic for the right side of the presented scatter plot, only (Figure 1b).

A very similar logic of the relationship can be followed in the interpretation of the linear and non-linear regression between the BMI (predictor) and SIT-UP (criterion), presented in Figure 2. But, we have to point out that the expressed BW (higher BMI – right side of the scatter plot) and the expressed BH (lower BMI – left side of the scatter plot) has not as great an influence on the manifestation of the SIT-UP ($R=0.17$, $p<0.05$), as it has on the manifestation of the PUSH-UP ($R=0.26$, $p<0.05$). Namely, during the SIT-UP test a subject performs the movement only in the upper torso, fixed on the floor from the lower hips. Therefore, the subject has to support a smaller part of the whole body during the performance of the SIT-UP, than during performance of the PUSH-UP.

Somewhat different is the relationship between the BMI (predictor) and the HIGH-JUMP (criterion). When one observes the graphic presentation of the linear regression equation (Figure 3a) the negative direction of the regression line is obvious and significant ($R = 0.19$, $p < 0.05$). It mainly emphasizes out the fact that the expressed BW (right side of the scatter plot) has a negative influence on the HIGH-JUMP manifestation. But, there is no negative influence of the expressed BH (left side of the scatter plot) as in the previously discussed tests (PUSH-UP and SIT-UP). In this particular case, nonlinear regression (Figure 3b) defines the true logic of the relation between the observed variables (BMI and HIGH-JUMP), again. In the left part of the scatter plot, the regression curve is oriented »neutrally« (parallel with the abscise). On the right side of the scatter plot, the curve is oriented negatively (towards the lower right quadrant of the coordinate system). Since the abscise presents the BMI results, further explanation can be given. The low BMI probably has no influence on the HIGH-JUMP performance. On the other hand, above average BMI (right side of the scatter plot) slightly negatively influences the manifestation of explosive strength (power), measured by the HIGH-JUMP test. It means that for the subjects, that are below average in BW (and therefore below average in BMI), the correlation between BMI and HIGH-JUMP can not be identified, but for the above-average subjects (above average in BMI and BW), a negative correlation between BMI and HIGH-JUMP is evident.

Another possible reason for the observed non-linearity can be found in the problem of overweight. There is no doubt that overweight defines the burdening factor in the HIGH-JUMP performance. It can be supported by the fact that the non linear regression between BW and HIGH-JUMP is significant. At the same time, the linear regression coefficient is negligible (i.e. not significant). The result in the HIGH-JUMP test is positively correlated with squared velocity. It can be identified using the physical equation of the velocity:

$$v = \sqrt{2gh}, \text{ which defines } h = \frac{v^2}{2gh}$$

v – velocity, g – gravity constant (9.81 m/s^2), h – height of jump

Furthermore, a higher velocity is harder to achieve, if the object is greater in mass (in this case – BW), because it defines the expressed need for the production of force:

$$v = \frac{F \times t}{m}$$

v – velocity, t – time, m – mass of the object (in this study – BW)

Therefore, it is clear that overweight, and the expressed BMI, generate a lower result in the HIGH--JUMP on the nonlinear basis.

The non-linear correlation coefficient between BMI and 1500M exceeds all previously discussed relationships (R=0.29, p<0.05). Mainly it points out the more pronounced non-linear influence of the BMI (as a predictor) on the endurance (1500M – criterion), than on the strength and power criteria (PUSH-UP, SIT-UP and HIGH-JUMP). We are of the opinion that the logic of the non linear correlation, which is characteristic for the right side of the scatter plot, can be defined following the previously stated and explained negative influence of body mass on the velocity, and square-function relationship between v and h. In this particular case h can be interpreted as a »single step distance«. Moreover, the expressed need for the production of force, defines the higher characteristic work-intensity during a single step, leading to more pronounced lactate accumulation[20], and so on – a poor result on the endurance variable, in our study – 1500M. Taking into consideration the presented non linear correlation, the study of Vanderburgh and Mahar[21] is interesting. Authors indicated that conventional expression of the 2-mile run times (as an indicator of aerobic fitness – endurance) for men tends to penalize men who are heavier. Here the presented and discussed results support Vanderburgh and Mahar's conclusions.

In Figure 4 the linear and non linear relations between BMI and FS50M are presented. In this particular case, a certain percentage of the common variance and the non linear relationship can be explained using the equation of drag force:

$$F = \frac{c \times \rho \times v_{rel}^2 \times A}{2}, \text{ which defines } v_{rel} = \sqrt{\frac{2F}{c \times \rho \times A}}$$

c – constant dependent of the object's outline form (shape), ρ – density (in this case – water density), A – transversal surface, F – drag force, v_{rel} – relative velocity

We may observe the A as *maximal transversal body surface*, approximately defined as a circle surface-magnifying as the square-function of the radius ($r^2\pi$). Naturally, in this case A is highly dependent of the BW, but even more dependent on the BMI. Why is this so? The subject may have a higher BW that is the result of a larger BH, but it does not increase the transversal surface of the body during swimming (A). Also, this is probably the reason for the absence of any significant correlation between BH and FS50, and a less common variance explained using the BW predictor then the BMI predictor. Therefore, it is clear that the A magnifying as the square function of the BMI, because the higher the BMI is – the larger the transversal surface of the body is. All this leads to a decrease of velocity (v_{rel} in the equation), and finally – a poor result in the FS50, on the non linear basis.

The question which arises is, should we use the simple linear and non linear regression results – select the linear and non linear predictors, and calculate the non linear multiple regression? The linear model of the multiple regression analysis is very popular[1,22–25], but as far as the authors of this study know, apart from technical sciences[26,27], papers dealing with the non linear multiple regression calculation are very rare. Generally it is well known that multiple regression ensures a qualitatively better prediction of the criterion, than simple regression (the calculation of the regression equation a using single predictor)[24]. Therefore, based on the results presented in Table 2, we chose two predictors (BH and BW) and tried to calculate the multiple regression for the criterion HIGH-JUMP. We used two regression models; linear:

$$z=a+bx+cy$$

and non linear

$$z=a+bx+cy+dy^2$$

z – criterion (HIGH-JUMP), x – first, linear predictor (BH), y – second, nonlinear predictor (BW), a, b, c, d – characteristic elements of the equation

Needless to say, we avoided the BMI as a multiple regression predictor, because of the high linear relationship between BMI and the other two anthropometric variables (BH and BW). The results are presented in Table 3.

As presented in Table 3, linear and nonlinear multiple regressions are significant (p<0.05). Accordingly, because of the numerically higher coefficient of the determination and the significant non-linear element (d), the

TABLE 3
MULTIPLE LINEAR ($Z=A+BX+CY$) AND NON LINEAR ($Z=A+BX+CY+DY^2$) REGRESSION INDICATORS (COEFFICIENT OF THE CORRELATION – R, COEFFICIENT OF THE DETERMINATION – R^2, INTERCEPTION COEFFICIENT – A, LINEAR COEFFICIENTS – B AND C, CURVATURE COEFFICIENT – D)

CRITERION	PREDICTORS	MODEL	R	R^2	ELEMENT	
HIGH-JUMP	BH (x)				a	13.43
	BW (y)	$z=a+bx+cy$	0.24*	0.06*	b	0.24*
					c	–0.14*
HIGH-JUMP	BH (x)				a	18.30
	BW (y)	$z=a+bx+cy+dy^2$	0.31*	0.10*	b	0.06*
	BW^2 (y^2)				c	0.45*
					d	0.00*

*p < 0.05, BH – body height, BW – body weight, HIGH-JUMP – standing high-jump

relationship between the predictors and criterion should be interpreted using the non-linear model, however it would not be possible separated from the graphic presentation of the calculated regression (Figure 5).

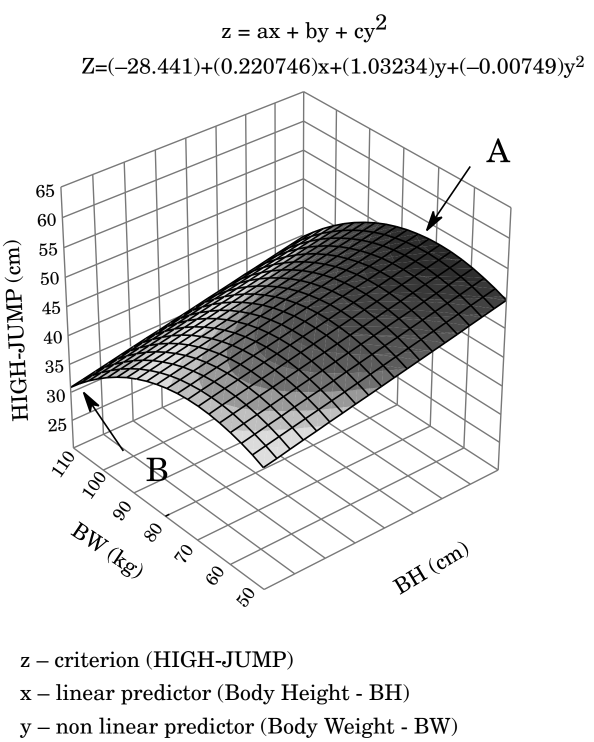

Fig. 5. Graphical presentation of the non linear multiple regression (A – best performers' positioning, B – worst performers' positioning).

It is evident that the relationship between predictors (BH and BW) and criterion (HIGH JUMP) is too complicated to explain using the calculated parameters and equation elements, only (Table 3). But, from a graphical presentation of the criterion prediction, the following explanation can be given. BH influences criterion (HIGH-JUMP) linearly, and BW non linearly. In short, the best results with the criterion can be expected for the subjects that are average in BW, but above average in BH (approximate position of the »best-performers« is marked with A on the graph). The main reasons for such a statement – these subjects can use their expressed BH (arm swings, relatively long extremities ensures a higher angular velocity, etc.), but only if the BW is average (average BW guarantees solid muscle mass which is the generator of force). In contrast, the »poor-performers« are characterized by low BH and high BW (point B on the graph). These subjects probably have a relatively large quantity of fat tissue – ballast mass[12,14], which is definitely a burdening factor in performing the HIGH-JUMP. The stated complex interaction between the morphological predictors and motor criterion is probably the reason why some authors have recently suggested the usage of different normalization procedures, which should ensure pondering of the influence of the BW on different motor-manifestations[10,11].

Conclusion

In conclusion, according to what is presented here and the discussed results, the non-linear – square relation between variables can be expected and explained in two cases:

1. If there is evident cause (for example – a biomechanical and/or a physiological cause) why two absolutely different sub-groups of subjects should reach equal results in the criterion (like the non linear relationship between BMI and PUSH-UP; where highly expressed BH and highly expressed BW negatively influence the PUSH-UP performance). Our opinion is that (for those cases) the non-linear regression curve is set as a geometric parable, and the linear regression between same variables is not significant.
2. If an established non-linear relationship can be explained following some evident non-linear-square basis (like in the non linear relationship between FS50M and BMI). The observation is that in these cases the non linear regression curve is not set as a geometric parable, but parallel with the abscise in one half (the first or second half) and then slightly changes direction (pointing out the upper or lower quadrant of the coordinate system). The authors are of the opinion that these cases are characterized by a significant linear regression calculation, but the non-linear calculation explains a greater proportion of the common variance than the linear one does.

In this paper we have tried to identify and explain the possible non-linear predictions of the motor-endurance status variables, using the most common anthropometric predictors (body weight, body height and BMI). The results of the study encourage the usage of non-linear regressions in kinesiology, because it has been proven that nonlinear regressions, in some cases, define the real nature of the ratios between the variables. Also, parallel usage of the linear and non-linear regressions allow one to choose qualitative non linear and linear predictors that can be used in the non linear multiple regression predictions.

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NELINEARNE POVEZANOSTI ANTROPOMETRIJSKIH I MOTORIČKO-FUNKCIONALNIH VARIJABLI

SAŽETAK

Nelinearne regresijske procedure rijetko se primjenjuju u antropologiji. U ovom članku pokušali smo utvrditi značajnost i karakter linearnih i nelinearnih povezanosti između nekih antropometrijskih mjera i motoričko-funkcionalnih varijabli. Ispitanici (300 umjereno fizički aktivnih muškaraca, prosječne dobi 24±3.4 godine) izmjereni su na varijablama prediktora (tjelesna težina, tjelesna visina, indeks tjelesne mase), i kriterija (sklekovi, podizanje trupa iz ležanja, skok u dalj iz mjesta, plivanje na 50 metara i trčanje na 1500 metara). Linearne (model: $y=a+bx$) i nelinearne regresije (model: $y=a+bx+cx^2$) izračunavane su paralelno. Dobiveni rezultati ukazuju na to da se nelinearne-kvadratne zavisnosti među varijablama mogu očekivati: a) ukoliko postoji jasan razlog zašto bi dvije potpuno različite podskupine ispitanika trebale postizati podjednake rezultate na kriterijskoj varijabli; b) ukoliko postoji nelinearna-kvadratna osnova za utvrđenu međuzavisnost varijabli. Konačno, linearne i nelinearne regresijske procedure s jednim prediktorom mogu se efikasno upotrijebiti za utvrđivanje linearnih i nelinearnih prediktora kod nelinearnih višestrukih regresija.