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Original scientific paper

Non-Linear Approach in Kinesiology Should Be Preferred to the Linear – A Case of Basketball

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A B S T R A C T

In kinesiology, medicine, biology and psychology, in which research focus is on dynamical self-organized systems, complex connections exist between variables. Non-linear nature of complex systems has been discussed and explained by the example of non-linear anthropometric predictors of performance in basketball. Previous studies interpreted relations between anthropometric features and measures of effectiveness in basketball by (a) using linear correlation models, and by (b) including all basketball athletes in the same sample of participants regardless of their playing position. In this paper the significance and character of linear and non-linear relations between simple anthropometric predictors (AP) and performance criteria consisting of situation-related measures of effectiveness (SE) in basketball were determined and evaluated. The sample of participants consisted of top-level junior basketball players divided in three groups according to their playing time (8 minutes and more per game) and playing position: guards (N=42), forwards (N=26) and centers (N=40). Linear (general model) and non-linear (general model) regression models were calculated simultaneously and separately for each group. The conclusion is viable: non-linear regressions are frequently superior to linear correlations when interpreting actual association logic among research variables.

Key words: *anthropometric predictors, performance indicators, elite junior men, non-linear multiple regression, sports science*

Introduction

The association of variables within different anthropological dimensions is a problem that has been often investigated[1–5]. In most circumstances linear univariate and multivariate correlation models have been calculated, whereas non-linear regression models have rarely been used in anthropological science.

For any system in function, whether it is a shift of an entire team up and down the court during a game or simple periodic movements such as tapping, it is assumed to have components or mechanisms responsible for that process. If we assume that components interact additively, meaning that system behavior is a sum of its parts, we are talking about linear systems. Linear paradigm, characterized by utter certainty and predictability, has been replaced by non-linear one in natural sciences. Scientists like Einstein, Bohr, Heisenberg, and Dirac played a decisive role in that shift of paradigm[6].

Multiplicative interactions between various components of the system are considered to be the bases of non-linear systems as opposite to additive approach of the linear systems. We may say that non-linearity is more general than linearity and can better describe behavior of complex systems that have large number of internal elements. However, when there is too few information to determine relationships between the components, the linear relationships should be regarded a better starting point[6].

Lebed and Bar-Eli state that dynamical systems »player–team« can be considered as self-organized and self-regulated complex systems[7]. According to these authors, both the players and team are capable to self-organize behavioral patterns as a response to situational stimulus, either extrinsic or intrinsic, with no influence of external factors. As a consequence, the authors imply that interconnections between elements in complex systems are non-linear in their nature, whereas interconnections with environment can be both linear and non-linear. Non-linearity of complex systems is expressed in their effects that are unpredictable to a great extent due to the existence of

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many direct and indirect feedback loops[8]. So, apart from non-linearity, important quality of complex systems is their dynamic nature[9,10].

Probably there is no model measuring effectiveness within team sports games that can represent reality in whole. Furthermore, it is known that is not possible to explicitly design theories and models in kinesiology with no fault since they are tested on a limited assembly of instances. This is particularly true for theories and models that apply interactive approach. Namely, experts are aware of the fact that theories and models are constantly modified under the influence of feedback generated in the process of scientific-exploratory work. The linear model, which up to now prevailed in the explanations of performance factors in sports, does not explain the interaction between inner and outer factors of competition effectiveness. Unlike the linear, the non-linear model provides a more appropriate insight and understanding of multiple influences of inner and outer factors of effectiveness in sports, especially because the modern approach to research of game sports understands a match/game as a dynamical interaction process between two opponents[11].

Lane and Corrie state the purpose of modern science is to provide understanding of non-linear relations characterizing complex systems[12]. No doubt human beings and their behavior appertain to the group of complex systems. During the last few years some advantages of non-linear regression calculations and interpretations have clearly been demonstrated[13–17]. In one of the studies, Sekulić and associates used a non-linear model and explained the relationship between anthropological predictors and psychophysiological exercise responses[12]. In another study Sekulić, Zenić, & Grčić Zubčević, the authors identified the significance and character of the linear and non-linear relations between the simple anthropometric predictors and swimming performance on a sample of young swimmers[14]. Linear and non-linear regressions were calculated simultaneously. Both studies emphasized some of the main advantages in the non-linear regression model calculation, which allowed a higher level interpretation of relationships. The last study enabled a precise anthropometric modelling in swimming using simple and easily obtainable variables.

There is no doubt that in most sport events morphological characteristics and body-constitution indices are important factors of performance and sports achievements[14,18–21]. For instance, Parr et al. claim that the greatest proportion between body mass and body height is in centers (0.53 kg/cm), then in forwards (0.5 kg/cm) and guards (0.46 kg/cm)[21]. In certain sport games, different playing positions evidently require different structure of situation-related measure of effectiveness as well as different and very specific morphological characteristics of players[17]. Basketball is one of the sports that demand morphological optimization for a certain position in the game[22]. Therefore, the optimal body constitution criterion should be satisfied prior to assigning a certain athlete to a certain position in a particular sport game[23]. Trninić, Dizdar and Jaklinović claim that the anthropometric status of basketball players makes a distinction between playing positions, by which it directly sets tasks in the game evident in the official situation-related measure of effectiveness indicators (performance indicators)[24]. In short, body height is an obvious morphological advantage since it allows a player to act closer to the shooting target of the game – basket[25–27]. Additionally, the body height (BH) variable is an important factor which has an influence on recruiting players for a position and a role in the game appropriate for them[28,21]. This phenomenon imposes a demand in anthropology-related research in basketball: relations have to be established separately for each main playing position. As far as the authors of this paper know, there are no recent studies published where the influence of body height (BH) on situation-related measures of effectiveness (SE) is proven separately for guards, forwards and centers. The main reason for that is most likely a limited number of participants whose SE should be observed during the same competition[1,29–31]. Therefore, that research obstacle should be avoided appropriately if reliable conclusions are to be drawn.

Consequently, in the current study we tried to make a step forward in defining true logic of the relationships between morphological characteristics and overall measure of effectiveness in basketball by calculating non-linear relationships between different anthropometric-morphological variables and performance indicators (situation effectiveness; SE) of basketball players playing three basic positions in basketball game.

Based on the authors' experience and conclusions from previous studies[13,14,17], the aim of this study was to calculate and interpret linear and non-linear anthropometric predictors (AP) of characteristic situation-related measures of effectiveness (SE) of international elite junior basketball athletes playing primarily one of the three main positions in basketball game (centers, forwards, and guards). We hypothesized the following: (a) influence of anthropometric predictors (AP) on characteristic situation-related measure of effectiveness (SE) will be different for guards, forwards and centers, and (b) certain significant non-linear relations between the anthropometric predictors and situation-related measures of effectiveness, which would explain the true nature of anthropometric influence on basketball performance, will be identified and interpreted accordingly.

Methods

Participants

The sample of participants included 132 participants – top-class junior basketball players of Europe for the season 2000/2001. They were members of eleven national teams that participated in the 19th European Junior Basketball Championships (EJBC). Their mean age was 17.7 years. Only 108 players that played at least eight minutes (and more) per game on average were selected for the study investigation. The sample of players was divided according to playing positions into three standard groups: guards (N=42), forwards (N=26), and centers (N=40).

Variables

The sample of variables consisted of two sets: predictor variables – three anthropometric predictors (AP), and criterion variables – ten standard situation-related measures of effectiveness (SE).

Anthropometric variables: Body mass (BM) and body height (BH) were measured with the standard techniques to the nearest 0.1 kg and 0.5 cm, respectively. Body mass index (BMI) was calculated according to the equation: $BMI=BM\ (kg) / [BH\ (m)]^2$.

Situation-related measures of effectiveness (SE). Relative measure of effectiveness in one point, two points and three points shooting was calculated as the percentage between the made and the executed shots (1P, 2P, and 3P). All the other variables, including defensive rebounds (DR), offensive rebounds (OR), assists (A), turnovers (TO), steals (ST), personal fouls (PF) and blocks (B), were calculated as the proportion between the player's overall situation-related measure of effectiveness in each of the SE variable divided by the time each athlete played during the EJBC. It allowed us to compare different overall situation-related measures of effectiveness which were, naturally, influenced by the total time played. Using such an approach, each of the analyzed variables was practically normalized by time (achievement per minute x 40). Data were collected during the EJBC using the official game statistics of the tournament.

Data processing methods

Descriptive statistical variables (means and standard deviations) were calculated for all the observed variables. For the purpose of defining the AP→SE relations, the general linear ($y=a+bx$) and non-linear square function $y=a+bx+cx^2$ equations were used, where »y« stood for a particular criterion (one of the analyzed SE variables), and »x« represented a particular variable (one of the AP). All coefficients were considered significant at the level of 0.95 ($p<0.05$). Statsoft's Statistica®, ver. 6.0, was used for all the statistical procedures.

Results

In Table 1 descriptive statistics of the variables obtained in the study are presented. Arithmetic means and standard deviations, separately for each group, were calculated. All the variables were considered normally distributed according to the Kolmogorov-Smirnov test.

Although the discussion of the data obtained herein was not within the objectives of the study, descriptive values are presented since all the participants were European elite junior basketball athletes. Values of the last seven variables were calculated in a way that the absolute frequency of each element was divided by minutes each player spent playing on the court, and then the obtained values were multiplied by the time of a basketball match (40 minutes). The given procedure enabled us to compare the situation-related measures of effectiveness of all the players regardless of the time spent in the match.

TABLE 1
DESCRIPTIVE STATISTICS (MEAN, STANDARD DEVIATION – SD)

	Guards		Forwards		Centres	
	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD
BH (cm)	188.03	4.91	196.84	4.31	202.34	5.22
BMI (kg/m^2)	23.01	1.30	22.59	1.74	23.84	2.19
BM (kg)	81.38	5.66	87.41	5.89	97.50	8.35
1P (%)	64.24	27.78	63.72	25.72	58.45	23.41
2P (%)	47.16	21.71	46.62	17.06	45.88	18.94
3P (%)	28.12	19.86	30.28	26.11	15.06	28.74
DR (per min*40)	2.45	1.60	3.10	1.84	4.08	2.13
OR (per min*40)	0.86	1.18	1.84	1.18	2.67	1.44
A (per min*40)	2.31	1.27	1.14	0.85	0.79	0.69
TO (per min*40)	2.64	1.48	2.28	0.94	1.56	1.11
ST (per min*40)	3.00	1.64	3.42	1.92	2.76	1.42
PF (per min*40)	3.56	2.00	4.05	1.62	6.19	5.19
B (per min*40)	0.09	0.18	0.62	0.73	0.88	0.99

BH – body height; BMI – body mass index; BM – body mass; 1P – free throw ratio; 2P – two points ratio; 3P – three points ratio; DR – defensive rebounds; OR – offensive rebounds; A – assists; TO – turnovers; ST – steals; PF – personal fouls; B – blocks; per min*40 – for each minute of the time played

Table 2 displays linear correlation coefficients between AP and SE criteria. Accordingly, in the same table, only the significant non-linear correlation coefficients are presented. As expected, all linear relations were significant when calculated using the non-linear square correlation as well. However, altogether eight linear and eight non-linear correlation coefficients were established.

BMI→ (offensive rebounds)OR and BM→OR relations shows significant linear correlations (0.30 and 0.37, respectively). BMI is an index calculated as the ratio between body mass (BM) and BH. Therefore, lower values of BMI are established in lighter participants (and/or taller ones). Since guards are the most homogenous in BM when compared to the other basketball players across positions[17,23], the variance of BH practically defines the BMI diversity in the sample of guards.

In the sample of forwards and even more in centers, BM is an important factor in performance of defensive rebounds (DR) (0.34 and 0.41, respectively) and the interpretation would be very much like the previously discussed one in guards and the significant linear BM→OR correlation.

In further discussion only those non-linear relations where the non-linear »c« element of the equation is significant will be discussed. Those relations are presented in Figures 1–4.

Figure 1 displays a non-linear relation between body height (BH) and 3P criterion for the sample of guards (R=0.44). Non-linear relation explains the BH→3P relation even better than the linear one (0.44 to 0.36, respectively). Precisely, the regression curve is parallel to the abscissa in the first half of the diagram. Near BH of 188 cm, the curve slightly changes the direction and points to the upper right quadrant of the diagram, indicating a positive correlation. So, a more pronounced BH does not influence the 3P performance until approximately 188 cm of a player's BH. From this point onward, one can expect that body height will significantly influence shooting percentage in guards.

Although not revealing anything different from the previously discussed BH→3P relation, the BMI→3P non-linear relation (Figure 2) is presented as a certain proof of appropriateness of the non-linear relation approach. In this case, on the left side of the dispersed graph (»scatterplot«), we presented the guards with a more pronounced

TABLE 2

LINEAR (LIN) AND NON-LINEAR (NONL) REGRESSION INDICATORS – COEFFICIENT OF THE CORRELATION FOR GUARDS (G), FORWARDS (F) AND CENTRES (C)

Criteria	Model	BH			BMI			BM		
		G	F	C	G	F	C	G	F	C
1P (%)	LIN	0.02	–0.17	–0.01	0.00	0.13	–0.12	0.01	0.04	–0.14
	NONL	–	–	–	–	–	–	–	–	–
2P (%)	LIN	0.02	–0.02	–0.05	0.20	0.22	0.03	0.19	0.23	0.02
	NONL	–	–	–	–	–	–	–	–	–
3P (%)	LIN	0.36*	–0.07	0.22	–0.35*	–0.03	–0.19	–0.03	–0.06	–0.11
	NONL	0.44*^{C}	–	–	0.39*^{C}	–	–	–	–	–
DR	LIN	–0.01	–0.06	0.25	0.12	0.35*	0.21	0.08	0.34*	0.41*
	NONL	–	–	–	–	–	–	–	0.35*	0.41*
OR	LIN	0.19	0.19	0.33	0.30*	0.00	–0.04	0.37*	0.12	0.15
	NONL	–	–	–	0.57*^{C}	–	–	0.37*	–	–
A	LIN	–0.10	–0.22	–0.08	–0.04	0.28	0.05	–0.09	0.17	0.03
	NONL	–	–	–	–	–	–	–	–	–
TO	LIN	0.01	–0.13	–0.13	–0.16	0.03	–0.14	–0.14	–0.04	–0.23
	NONL	–	–	–	–	–	–	–	–	–
ST	LIN	0.17	0.15	0.13	0.23	0.03	0.09	0.06	0.06	0.18
	NONL	–	–	–	–	–	–	–	–	–
PF	LIN	0.01	0.20	0.31	0.12	0.04	–0.07	0.12	0.17	0.13
	NONL	–	–	–	–	–	–	–	–	–
B	LIN	0.07	0.38*	0.49*	–0.15	–0.21	–0.12	–0.07	0.02	0.15
	NONL	–	0.38*	0.53*^{C}	–	–	–	–	–	–

BH – body height; BMI – body mass index; BM – body mass; 1P – free throws ratio; 2P – two points ratio; 3P – three points ratio; DR – defensive rebounds (per minute); OR – offensive rebounds (per minute); A – assists (per minute); TO – turnovers (per minute); ST – steals (per minute); PF – personal fouls (per minute); B – blocks (per minute); * – significant coefficients; ^{C} – non-linear equation models where non-linear coefficient reached acceptable statistical significance; Criteria – criterion variables

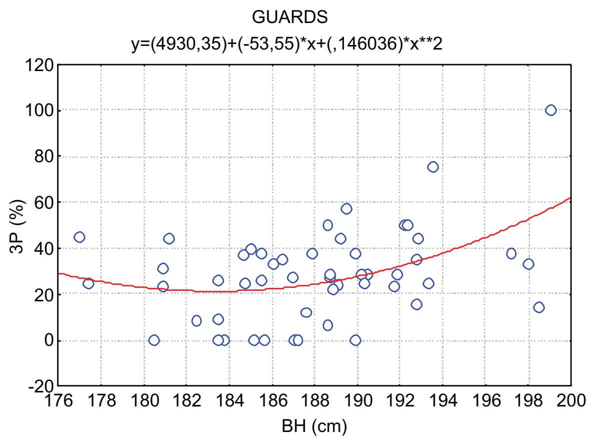

Fig. 1. Non-linear correlation model for the variables body height (BH) and 3-point scoring (3P) in guards.

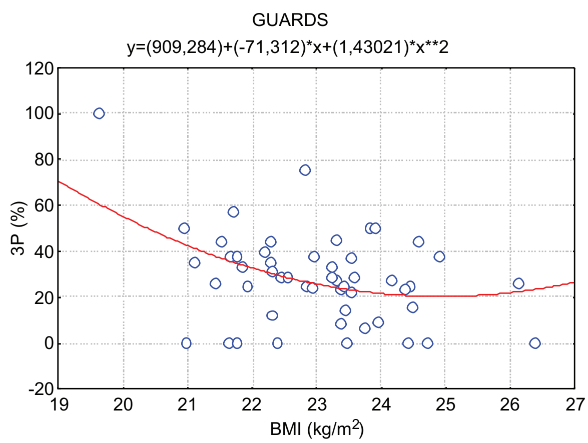

Fig. 2. Non-linear correlation model for the variables body mass index (BMI) and 3-point scoring (3p) in guards.

BH. Certainly, BMI is the used index and its prediction of 3P success is not as accurate as BH prediction (0.39 *vs.* 0.44, respectively).

In Figure 3, there is a negative BMI→OR correlation on the left side of the scatterplot (below the mean results of BMI), in spite of the positive correlation on the right side. It means that for the guards positioned on the left side of the BMI variable (the taller guards), as well as for the guards positioned on the right side of the same variable (the heavier ones), a high effectiveness in offensive rebounds (OR) can be expected.

Since previous studies[13,14] enabled precise modelling of sport performance by the combination of both the linear and non-linear predictors in multiple regression, two predictors were selected and calculated in the combined linear–non-linear multiple regression of SE predictors. The results are presented in Figure 5.

Evidently, the combined linear–non-linear regression of the simple anthropometric predictors explains SE criterion more accurately (R=0.62) than exclusively single predictors (see Table 1).

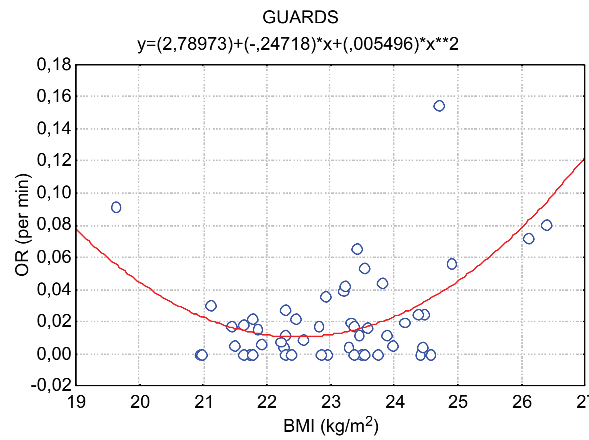

Fig. 3. Non-linear correlation model for the variables body mass index (BMI) and offensive rebounds (OR) in guards.

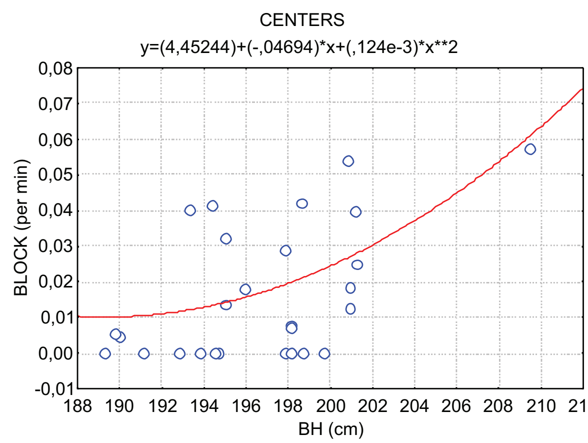

Fig. 4. Non-linear correlation model for the variables body height (BH) and blocks (B) in centres.

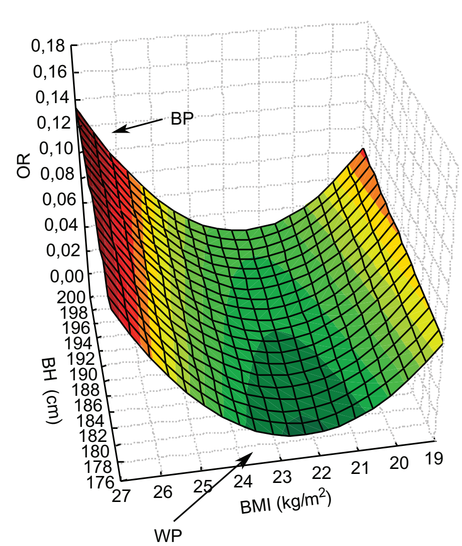

Fig. 5. Graphical presentation of non-linear multiple regression for offensive rebounds in guards (the best performers' positioning – BP; the poorest performers' positioning – WP).

Discussion and Conclusion

Previous studies have already demonstrated importance of BH in basketball[17]. Taller athletes are in clear advantage to their shorter opponents because of the natural demands in the game of basketball and the height of the target players are aiming at – the basket height is 3.05 m. However, when in most of previous studies researchers tried to define the influence of anthropometric variables (including BH) on situation-related measures of effectiveness, an evident methodology-related mistake was repeatedly disregarded. In short, such studies[31] mostly defined AP→SE relations by including all basketball players in the same sample. It led to the evident statistical suppressor effect, where a playing position in basketball game (guards, forwards and centers) was defined by AP (AP→ Position), and consequently SE was directly defined by playing positions (Position→SE). To make it simple, centers are tall players[17] (AP→Position), and they perform poorly in 3P-scoring variable (Position→SE), but not because their anthropometric status (primarily body height); it is primarily due to the fact that most of their playing time they are engaged in the post area, within the two-point are, i.e. behind the three-point line. Consequently, they have few chances to shoot from perimeter, or distance, and make 3P scores. In other words, when all players (guards, centers and forwards) are observed as a whole, one may conclude that body height (BH) directly influences 3P scores negatively. This is a clear misinterpretation, although, most likely, no mistake has been made when interpreting the results of statistical analyses.

Body height plays an important role in a sample of guards, but surprisingly – in the shooting performance from distance (3P). To explain such a relationship, the interpreter must have some knowledge of basketball game. The guards' overall scoring rate from distance directly determines the final outcome since they are tactically positioned outside the three-point (3P) line[27,32,33]. Evidently, although it has not been studied so far, BH is also an important factor in guards' 3P measure of effectiveness since a higher value of body height facilitates players' attempts to score over the opponent, especially when compared to the shorter guards.

Logic of the BMI→3P relation in guards is very much the same as the previously discussed BH→3P association.

Relative shortness of guards does not allow them to play effectively in the post area[27,32]. However, in the within-group comparison of guards, a precise timing in skill performance combined with a stronger physical constitution (BM) will enable such players to act accurately even in offensive rebounds[27,33]. The BMI→OR relation follows the logic of the relation BM→OR.

The results confirmed that BM is an important factor in performance of defensive rebounds (DR), especially for centers and forwards. However, we considered the fact that BH was not directly correlated to OR and DR as a more interesting one, although this finding is not in accordance with some previous studies, (for details)[17]. This emphasizes appropriateness of our decision to use a different methodological approach, that is, to calculate relations separately for guards, forwards and centers. Namely, body height (BH) plays certainly an important role in the »rebound-effectiveness« only when the sample of participants is highly variable in this anthropometric measure (that is, when the total sample of basketball players is observed). On the other hand, when studying players separately (e.g. centers exclusively), another anthropometric measure becomes more essential for their performance. In our case it is body mass (BM) since it enables a player to perform successfully in shot blocking, while closing the space and interfering with the opponent's shooting rhythm (stable stance and positioning). To make it simple, let us say: »If you are a basketball center, you are surely tall, but you would better be tough at the same time«.

Body height enables guards to perform well in ORs due to the pronounced reach height. The same is valid for a more expressed BM which is one of the preconditions for efficient fighting for space and the inner position, thus enabling powerful contact-play in offence[31]. For instance, a taller shooting guard is able to frequently perform post-up maneuvers; he/she more frequently shoots in the post area and has more opportunities for short rebounds in the phase of offence and in the phase of defense as well, when taking control over the opposing shooting guard[34]. Since the linear correlation between BMI and OR in the obtained results was significant and positive, the non-linear one did not seem justified. However, it is. First, it must be stressed that the non-linear correlation is almost twice smaller than the linear one (0.30 *vs.* 0.57). It means that the linear correlation is »randomly« and not »truly« significant. In explaining the obtained results, one must use an example based on evidence. Body mass index is frequently used in medical studies when searching for relations between physical constitution and cardiovascular status (CS)[35,36]. Interestingly enough, BMI is a significant predictor of CS[37,38] almost only when studying obese people. Why? Because obese participants are projected on the right side of the BMI→CS scatterplot, and the relation is evident – the higher BMI, the lower CS status can be expected. But, does it mean that BMI significantly influences CS in all circumstances? It evidently does not. Such relation exists only for the »right side of the scatter plot«, but it can be proven only if the non-linear regression is used.

Such an approach in defining the true nature of the relationship between variables was recently confirmed by the authors who studied relationship between BM and freestyle swimming performance on the sample of young swimmers[14]. The question is why the BH→BLOCKS relation in the sample of centers is non-linear (Figure 4)? Evidently, BH is crucial in the performance of basketball defensive blocks, but only when BH exceeds 195 cm. In other words, at the junior level, there is no influence of BH on the block (B) performance if centers are below 1.95 m of body height (because from this point onward, effectiveness rises with the increased BH). This seems an elementary clear and logic conclusion. However, once again, if one tries to explain BH→B relations by following the linear correlation exclusively, serious interpretative mistakes will occur.

Regarding the interpretation of the combined linear-non-linear multiple regression results, it can be said that the best achievement of guards in OR can be expected from the tall ones, but at the same time also from the guards with the marked BMI who perform a greater number of post-up offensive maneuvers in their play. Their body height and higher values of BMI will enable them to have a comprehensive reach height, and also to be successful in powerful contact-play on post position, which enables offensive rebounding. Low achievement level in this criterion can be expected for short and light guards.

The first hypothesis of the study specified our expectations that anthropometric influence on situation-related measures of effectiveness in basketball will be different for the three playing positions. This hypothesis was only partially confirmed since the influence of anthropometric predictors on the situation-related measures of effectiveness of guards differed from the influence in forwards and centers. In guards, body height plays a significant role in 3P scoring as well as BM in offensive rebound effectiveness. In forwards and centers body mass is a significant linear predictor of defensive rebounding as well as body height in block effectiveness.

Further, non-linear regression models enabled us to interpret data and relations more accurately, especially the true logic of explaining the obtained data. The second hypothesis of the study was directly confirmed since we can conclude that, if calculated simultaneously with the linear ones, the non-linear regression models are confirmed to be superior in the interpretation of results.

We consider that modern kinesiology/sport science must strive towards the understanding of non-linear relationships which characterize complex and dynamic systems, athletes and team sports included. Introduction of non-linear regression models can be considered just as a first step of more holistic approach that is based on non-linear paradigm.

Also, it is important to highlight that successful sport prognostics cannot exist without the prediction of performance of players and team over a certain time period. Therefore, it would be advisable to use techniques such as non-linear regression models.

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U KINEZIOLOGIJI BI TREBALO DATI PREDNOST NELINEARNOM PRISTUPU PRED LINEARNIM – PRIMJER KOŠARKE

SAŽETAK

U sportskoj znanosti, medicini, biologiji i psihologiji koje istražuju žive dinamičke i samoorganizirane sustave postoje složene unutarnje veze među varijablama. U ovom istraživanju se raspravlja o nelinearnoj prirodi složenih sustava, a isto tako se ona pokušala objasniti. Tako su, primjera radi, analizirani nelinearni antropometrijski prediktori izvedbe u košarci. Dosadašnja istraživanja redovito su interpretirala relacije između antropometrijskih varijabli i učinkovitosti (uspješnosti) u košarci rabeći (a) linearne korelacijske modele i (b) ukupan uzorak košarkaša neovisno o poziciji na kojoj igraju. Stoga smo pokušali utvrditi značajnost i karakter linearnih i nelinearnih relacija između jednostavnih antropometrijskih prediktora (AP) i kriterija koje su činile varijable situacijske učinkovitosti (SE) u košarci. Uzorak ispitanika činili su najbolji juniorski košarkaši Europe, podijeljeni u tri grupe, ovisno o poziciji koju primarno igraju u košarkaškoj igri: bekovi (N=42), krila (N=26) i centri (N=40). Linearni (y=a+bx) i nelinearni (y=a+bx+cx) regresijski modeli izračunati su istodobno za svaku odvojenu grupu ispitanika. Zaključno, ako se izračunavaju i uspoređuju s linearnim korelacijama, nelinearne regresije nerijetko se pokazuju superiornijima u interpretaciji istinske logike povezanosti među varijablama.