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Significance and Characteristics of the Connection between Morphological Variables and Derived Indicators of Situation-Related Efficiency in Elite Junior Basketball Players for Three Basic Types of Players

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A B S T R A C T

The purpose of this research was to establish and explain the significance and characteristics of the connection of morphological variables and situation-related efficiency in basketball players for three basic types of players. Based on the obtained results, we can claim that the latent morphological structure is not significantly connected to the applied indexes of situation-related efficiency of players on the sample of guards and forwards. Further on, there is no significant influence of the morphological status on the situation-related efficiency of players in guard and forward positions. On the other hand, latent morphological structure is significantly connected to all five used indexes of situation-related efficiency of players on the sample of centres. In accordance with this, optimal morphological structure of centres in offence involves marked longitudinality, voluminousity and transversality of the skeleton with unmarked sub-skin adipose tissue. When referring to the index of the absolute situation-related efficiency of the centres in defence, it is evident that high quality centres, unlike low quality ones, are characterised by longitudinality and voluminousity. Further on, AEG index, which includes two previously mentioned indexes (AEO and AED), describe absolute situation-related efficiency of the players in offence and defence phase and both indicate that the morphological structure of high quality centres in both phases of the game consists of extreme longitudinality of the skeleton, voluminousity and transversality. In PPLC1 index, three out of four beta-ponders are significant and these are: longitudinality, voluminousity and transversality. Finally, in PPLC2 index, as well as in the previously mentioned PPLC1 index, high quality centres differ from low quality ones in morphological structure which includes marked longitudinality, voluminousity, transversality and unmarked level of sub-skin adipose tissue

***Key words**: basketball, types of players, top juniors, morphological structure, situation-related efficiency*

Introduction

The types of players in basketball are groups of players with relatively similar abilities and characteristics enabling them to play in a position where they can achieve different tasks within their role in the game[1,2]. The expert coaches reveal that certain types of players within the same team should not be compared to each other, but to the players in other teams playing in the same positions, with equally defined roles or we should compare their own situation-related efficiency results in different stages of their playing career[3].

Contemporary basketball gives more importance to how many tasks can a player perform and how much he helps in all the phases of the game, instead of what position he plays in, which is significantly determined by the morphological status of a player[4]. The modern system of the sport preparation enables the development of poly-

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valent dispositions and the adoption and upgrading of polyvalent technique, tactics and game. In accordance with this, physical height variable is an important guideline of playing in multiple positions in all phases of the game[5,6].

In basketball, morphological characteristics significantly influence the determining of the position and the role in the game of a certain player[7,8]. Empirical researches have shown that players differ in positions according to their anthropometrical status[9]. Efficient fulfilment of tasks in the game, manifested through situation-related efficiency indicators, determine morphological features of athletes since they make an important part of their preparation[10].

Morphological features, in interaction with other dimensions forming the anthropological status of a certain player, determine performance and sport achievement[10,11]. Based on morphological structure, in any athlete we can determine the portion of ectomorphic, mesomorphic and endomorphic constitution[7]. The data on the state of morphological features of basketball players during the process of sport preparation can be multiply used in the assessment of: preparedness of athletes, anthropological status, and the potential of a certain player in relation to both normative and model values for a certain age[12]. At the same time it is important to stress that model characteristics of players in team sports are characterised by achieved results of elite basketball players in the preparation indicators of athletes of a certain age as well as in the standard and derived indicators of situation-related efficiency[7]. In accordance with this, situation approach in the contemporary kinesiology of sport or sport science should be the basis for interpretation of a player's efficiency and his overall actual quality. It is important to stress that we calculate derived playing efficiency variables in offence, defence and on the whole from the basic indicators of playing efficiency[13-16,]. Derived indicators suggest absolute and relative efficiency. The indicators of absolute playing or situation-related efficiency suggest all efficient actions in offence, defence and /or on the whole immediately affecting the result of the match, while the relative efficiency indicators refer to the relation between efficient and all the actions in offence, defence or on the whole. The results obtained from the indicators of absolute and relative efficiency are mutually complementar[2,4,7,15]. Values achieved by teams or individuals in basic and derived indicators of playing efficiency are not absolute, but relative. Namely, they depend on the opponent and the playing style of both teams. Scientific researchers have shown there are no great differences in the playing efficiency in basic types of players in cadet, junior or senior national teams, which supports the idea suggested by the authors in this paper, that the assessment system of a player's actual quality in defence and offence should be applied from the age of 14[4].

By assessing the situation-related efficiency indicators or the actual player's quality indicators, we come to the situation-related efficiency profile for a certain type of a player or the actual player's quality profile[5,15]. The results of the previous researches on situation-related efficiency have proved high practical value and usability of assessment and efficiency procedures. Using basketball statistics, i.e. by noting final actions, one can calculate a player's or a team's efficiency in certain game phases (offence, defence) or the efficiency in the game using given formulas, i.e. efficiency indexes. Thus certain players, types of players or teams can be compared according to their efficiency in offence, defence or in both phases together[18,19].

Materials and Methods

Sample of entities

The research was done on the sample of 108 top junior basketball players, the participants of the 19th European Junior Championship in 2000 in Zadar who played minimally 8 minutes per match on average and in more than 3 games, and were selected from 11 teams which played in 46 matches. According to the data from the official applications for the tournament, the players were divided in three groups based on playing in a certain position: 42 players who dominantly play in positions 1 and 2 (guards), 26 in position 3 (forwards) and 38 players in positions 4 and 5 (centres). The average age of the players was 17.8 (± 0,7σ). All the respondents agreed to participate in measuring, based on a permission granted by FIBA (Federation International de Basketball Amatuer).

Sample of variables

The sample of variables presented the set of 30 anthropometrical variables which were measured according to the protocol described in researchers[20,21]. The measuring was done on the players' dominant extremities, which is in accordance with previous researches in this domain[21]. The variables were chosen with the intention of covering all the hypothetical dimensions of the morphological domain with the same number of measures[22].

The variables to assess longitudinal skeleton dimensionality are: Stature (STATURE), Sitting height (SITTING H), Arm length (ARM L), Arm span (ARM S), Reach height (REACH H)-was obtained by measuring one arm maximal reaching height in standing position, Leg length (LEG L), Hand length (HAND L), Foot length (FOOT L). Variables to assess body voluminousity and body mass are: Body weight (BW), Upper arm girth (UPPERARM G), Forearm girth (FOREARM G), Chest girth (CHEST G), Waist girth (WAIST G), Thigh girth (THIGH G), Calf girth (CALF G). The variables to assess transversal skeleton dimensionality are: Biacromial breadth (BIACROMIAL B), Bitrochanter breadth (BITROCHANTER B), Humerus breadth (HUMERUS B), Wrist breadth (WRIST B), Hand breadth (HAND B), Femur breadth (FEMUR B), Maleolus breadth (MALEOLUS B), Foot breadth (FOOT B). The variables to assess sub-skin adipose tissue are: Triceps skinfold (TRICEPS S), Biceps skinfold (BICEPS S), Subscapular skinfold (SUBSCAP S), Abdominal skinfold (ABDOMINAL S), Suprailiac skinfold (SUPRAILIAC S), Front thigh skinfold (FRONT THIGH S), Medial calf skinfold (MED CALF S).

Further on, we calculated situation-related efficiency indexes: absolute efficiency index of the players in offence (AEO); absolute efficiency index of the players in defence (AED); absolute efficiency index of the players in a game (AEG); PPLC1 – partially pondered linear combination – one[15]; PPLC2 – partially pondered linear combination – two[15]. The given indexes were calculated based on formulas suggested and validated in researches[15,16].

In accordance with previously mentioned, we applied: absolute situation-related efficiency index of the players in offence (AEO); absolute situation-related efficiency index of the players in defence (AED); absolute situation-related efficiency index of the players in a game (AEG)[18] which were calculated as it is described further on.

Absolute situation-related efficiency index of the players in offence (AEO)

$$AEO = POINTS + A/2$$

where AEO is – absolute situation-related efficiency index of players in offence, POINTS – the number of scored points and A – the number of assists.

Absolute situation-related efficiency index of the players in defence (AED)

$$AED = OR + DR + ST + B/2$$

where AED is – absolute situation-related efficiency index of players in defence, OR – the number of offensive rebounds, DR – the number of defensive rebounds, ST – the number of steals and B – the number of blocked shots.

Absolute situation-related efficiency index of the players in a game (AEG)

$$AEG = AEO + AED$$

where AEG is – absolute efficiency index of players in a game, AEO – absolute efficiency index of players in offence, AED – absolute efficiency index of players in defence.

Partially pondered linear combination 1[15]

Considering the fact that we may assume all the variables (13 standard situation-related efficiency indicators) involved in the linear combination do not have the same significance for the final result of a match, and thus not even the same significance in determining the overall situation-related efficiency of players, variables may be pondered by significance.

The simplest formula where variables are pondered: efficient shots for two points are pondered by 2, efficient shots for three points are pondered by 3, and blocked shots and inefficient free throws by 0.5. Due to its simplicity and clearness, this method is frequently used in today's basketball practice (for instance, in the final tournament, the so-called Final Four of the European Championship in 1998/99, the overall situation-related efficiency of players was calculated by this method).

$$PPLC1 = x_{p1} + 2 \cdot x_{p2} + 3 \cdot x_{p3} + x_{jd} + x_{ja} + x_a + x_{wb} + 0.5 \cdot x_b - 0.5 \cdot x_{n1} - x_{n2} - x_{n3} - x_{lb} - x_{pf}$$

where PPLC1 is – overall situation-related efficiency of players, x_{p1} – the number of efficient free throws, x_{p2} – the number of efficient shots for two points, x_{p3} – the number of efficient shots for three points, x_{jd} – the number of defencive rebounds, x_{ja} – the number of offencive rebounds, x_a – the number of assists, x_{wb} – the number of steals, x_b – the number of blocked shots, x_{n1} – the number of inefficient free throws, x_{n2} – the number of inefficient shots for two point, x_{n3} – the number of inefficient shots for three points, x_{lb} – the number of turnovers and x_{pf} – the number of personal fouls. This formula may be written in the following form.

$$PPLC1 = x_{points} + x_{jd} + x_{ja} + x_a + x_{wb} + 0.5 \cdot x_b - 0.5 \cdot x_{n1} - x_{n2} - x_{n3} - x_{lb} - x_{pf}$$

where variable $x_{points} = x_{p1} + 2 \cdot x_{p2} + 3 \cdot x_{p3}$ presents the total number of points scored by a player.

The assessment of shooting efficiency in the basketball game definitely presents the most important part of situation-related efficiency both of teams and players. Here are the coefficients which enable us to assess the shooting efficiency of players and teams, very frequently calculated in basketball practice:

Two-points shot utilization coefficient (x_{k2})

$$x_{k2} = \frac{x_{p2}}{x_{u2}}$$

where x_{k2} is – two-points shot utilization coefficient, x_{p2} – the number of efficient shots for two points, x_{u2} – the number of shots for two points, three-points shots utilization coefficient (x_{k3})

$$x_{k3} = \frac{x_{k3}}{x_{u3}}$$

where x_{k3} is – three-points shots utilization coefficient, x_{p3} – the number of efficient shots for three points, x_{u3} – the number of shots for three points, free throws utilization coefficient (x_{k1})

$$x_{k1} = \frac{x_{p1}}{x_{u1}}$$

where x_{k1} is – free throws utilization coefficient, x_{p1} – the number of efficient free throws and x_{u1} – the number of free throws

Partially pondered linear combination 2[15]

By using the given coefficients to assess shooting efficiency instead of the number of scored points and the number of inefficient shots, we may assess the overall situation-related efficiency by the following formula:

$$PPLC2 = x_{ftec} + x_{2pec} + x_{3pec} + x_{dr} + x_{or} + x_a + x_{st} + 0.5 \cdot x_b - x_{to} - x_{pf}$$

where PPLC2 is – overall situation-related efficiency of players, x_{ftec} – free throws efficiency coefficient, x_{2pec} – two-points shot efficiency coefficient, x_{3pec} – three-points shot efficiency coefficient, x_{dr} – the number of defencive rebounds, x_{or} – the number of offencive rebounds, x_a – the number of assists, x_{st} – the number of steals, x_b – the number of blocked shots, x_{to} – the number of turnovers and x_{pf} – the number of personal fouls.

Statistical analysis

By factor analysis with varimax rotation of coordinate system, we established latent structure of the morphological characteristics. All the respondents were divided in three groups: guards (G), forwards (F), and centres (C). By multiple regression analysis we established the connection between latent morphological variables and situation-related efficiency index separately for guards, forwards and centres. However, we should stress that the connection between the given sets of variables (morphology and situation-related efficiency) was not established by usual procedures of the canonical correlation and/or multiple regression analysis since this approach was unacceptable due to a relatively great number of analysed variables compared to the number of respondents in certain groups (playing positions). Therefore we approached a more complex methodological structure which, before the given multiple regression, involved: defining of homogenous groups of players in a certain playing position based on situation-related efficiency variable by applying taxonomic analysis, defining the differences between previously formed homogenous groups of players in situation-related efficiency variables by applying discriminative canonical analysis and finally defining the differences between previously formed homogenous groups of players in the morphological structure by applying discriminative canonical analysis. In this way, we enabled the establishing of the connection between morphology and situation-related efficiency with the decrease of potential negative influence of a relatively great number of variables on the decrease of the number of freedom degrees.

Results

Table 1 displays factor analysis results which established latent structure of the morphological features in top junior basketball players. Four factors are extracted explaining 72% of the total variance. The first one is longitudinal dimensionality factor (defined by the length of the bone system and the breadth of pelvis – FLONGIT), the second one is the sub-skin adipose tissue factor (defined by the measures of the skinfold girth – FPMT), the third one is the absolute voluminousity and body mass factor (defined by circular measurements, body weight and shoulder breadth – FVOLMT), whilst the fourth factor is transversal dimensionality of the skeleton factor (defined by the measurements of the bone and joint system diameter – FRTANSV).

Table 2 displays the multiple regression analysis results where the prediction of efficiency index was done based on the latent morphological variables on the sample of guards. The obtained results presented in Table 2 reveal that the latent morphological structure of guards is not significantly connected to any of the absolute situation-related efficiency indexes in basketball players.

TABLE 1
FACTOR ANALYSIS WITH VARIMAX ROTATION – MORPHOLOGICAL VARIABLES – TOTAL SAMPLE

VARIABLE	F1	F2	F3	F4
STATURE	0.93	0.09	0.10	0.16
SITTING H	0.74	0.11	0.09	0.01
REACH H	0.93	0.04	0.17	0.20
LEG L	0.90	0.10	0.11	0.17
ARM L	0.83	0.01	0.14	0.24
ARM S	0.89	–0.03	0.18	0.23
HAND L	0.72	0.06	0.26	0.30
FOOT L	0.77	0.12	0.15	0.29
BW	0.54	0.39	0.61	0.37
UPPERARM G	–0.08	0.40	0.68	0.40
FOREARM G	0.08	0.25	0.65	0.59
CHEST G	0.31	0.28	0.71	0.31
WAIST G	0.30	0.37	0.70	0.20
THIGH G	0.10	0.54	0.63	0.32
CALF G	0.29	0.32	0.47	0.46
BIACROMIAL B	0.45	–0.17	0.54	0.16
BITROCHANTER B	0.69	0.12	0.01	0.08
HAND B	0.32	0.06	0.29	0.73
HUMERUS B	0.50	0.10	0.22	0.57
FEMUR B	0.48	0.28	0.16	0.57
MALEOLUS B	0.50	0.06	0.13	0.44
WRIST B	0.50	0.02	0.16	0.54
FOOT B	0.38	0.09	0.04	0.49
TRICEPS S	0.06	0.88	–0.01	0.15
BICEPS S	0.03	0.76	0.21	0.19
SUBSCAP S	0.08	0.60	0.62	0.04
ABDOMINAL S	0.16	0.67	0.58	–0.11
SUPRAILIAC S	0.15	0.62	0.63	–0.13
FRONT THIGH S	0.08	0.81	0.25	0.05
MED CALF S	0.07	0.83	0.20	0.11
Expl.Var	8.24	5.08	4.82	3.52
Prp.Totl	0.27	0.17	0.16	0.12

STATURE-stature, SITTING H-sitting height, ARM L-arm length, ARM S-arm span, REACH H-reach height, LEG L-leg length, HAND L-hand length, FOOT L-foot length, BW-body weight, UPPERARM G-upper arm girth, FOREARM G-forearm girth, CHEST G chest girth, WAIST G-waist girth, THIGH G-thigh girth, CALF G-calf girth, BIACROMIAL B-biacromial breadth, BITROCHANTER B-bitrochanter breadth, HUMERUS B-humerus breadth, WRIST B-wrist breadth, HAND B-hand breadth, FEMUR B-femur breadth, MALEOLUS B-maleolus breadth, FOOT B-foot breadth, TRICEPS S-triceps skinfold, BICEPS S-biceps skinfold, SUBSCAP S-subscapular skinfold, ABDOMINAL S-abdominal skinfold, SUPRAILIAC S-suprailiac skinfold, FRONT THIGH S-front thigh skinfold, MED CALFS-medial calf skinfold

Expl. Var – variance of a certain factor, Prp. Totl – the percentage of the explained total variance of the applied variable system

TABLE 2
MULTIPLE REGRESSION ANALYSIS – THE PREDICTION OF EFFICIENCY INDEX (PARTIALLY PONDERED LINEAR COMBINATION – TWO) BY LATENT MORPHOLOGICAL VARIABLES – THE SAMPLE OF GUARDS

EFFICIENCY INDEX	AEO		AED		AEG		PPLC1		PPLC2	
VARIABLE	β	p	β	p	β	p	β	p	β	p
FLONGIT	0.15	0.38	0.07	0.66	0.14	0.39	0.16	0.35	0.12	0.49
FPMT	–0.17	0.39	–0.22	0.28	–0.18	0.37	–0.15	0.45	–0.06	0.78
FVOLMT	–0.01	0.97	–0.14	0.40	–0.02	0.91	0.01	0.95	0.04	0.83
FTRANSV	–0.07	0.72	–0.06	0.78	–0.07	0.72	–0.03	0.87	0.04	0.84
R	0.18		0.22		0.19		0.19		0.14	
Rsq	0.03		0.05		0.04		0.03		0.02	
P	0.85		0.77		0.85		0.83		0.95	

R-multiple correlation coefficient, Rsq-determination coefficient, p-level of significance, β-prediction variables beta ponders, AEO-absolute situation-related efficiency index of the players in offence, AED-absolute situation-related efficiency index of the players in defence, AEG-absolute situation-related efficiency index of the players in a game, PPLC1-partially pondered linear combination 1, PPLC2-partially pondered linear combination 2, FLONGIT-longitudinal dimensionality skeleton factor, FPMT-sub-skin adipose tissue factor, FVOLMT-voluminousity factor and body mass, FTRANSV-transversal dimensionality skeleton factor

Table 3 displays multiple regression analysis results where the prediction of efficiency index was done in the competition by latent morphological variables on the sample of forward players. Based on the obtained results presented in Table 3 we may establish that the latent morphological structure of forward players is not significantly connected to any of the absolute situation-related indexes in basketball players. Considering none of the individual predictors (latent morphological variables) is not regressionally significantly connected to the criterion, beta ponders values are not even displayed in any of the index tables for guards and forwards.

Table 4 displays the predictor set of variables significantly connected to the criterion of derived situation-related efficiency indicators. Latent morphological variables explain for 65% of the criterion variance – absolute efficiency index of the centres in offence. Three out of four beta ponders of predictor variables are significant. It is evident that longitudinality, voluminousity and transversality significantly contribute to the offence efficiency in centres – manifested through index (AEO). It is evident from Table 4 that four latent morphological variables explain for the 67% of the variance of absolute efficiency index of the centres in defence (Rsq = 0.67). The given factors (latent dimensions) are connected to the criterion on the level of significance (p<0.001). Unlike AEO index, in AED index, two out of four beta ponders of predictor variables are significant and these are longitudinality and voluminousity. The given factors significantly contribute to the efficiency of centres in defence. Further on, in Table 4 it is evident three out of four beta ponders are significant and these are: FLONGIT, FVOLMT and FTRANSV. The three given latent dimensions of the morphological status in basketball players significantly contribute to the efficiency of centres in a match presented by index AEG. The prediction of overall situation-related efficiency index by four obtained morphological factors of players in PPLC1, leads to the following. The presented morphological factors explain for 51% of the variance of the given index. The percentage is

TABLE 3
MULTIPLE REGRESSION ANALYSIS – THE PREDICTION OF EFFICIENCY INDEX (PARTIALLY PONDERED LINEAR COMBINATION – TWO) BY LATENT MORPHOLOGICAL VARIABLES – THE SAMPLE OF FORWARDS

EFFICIENCY INDEKS	AEO		AED		AEG		PPLC1		PPLC2	
VARIABLE	β	p	β	p	β	p	β	p	β	p
FLONGIT	0.36	0.13	0.35	0.17	0.38	0.12	0.22	0.39	0.18	0.46
FPMT	–0.15	0.51	–0.10	0.67	–0.15	0.51	–0.25	0.31	–0.35	0.16
FVOLMT	0.28	0.19	0.30	0.18	0.29	0.17	0.23	0.30	0.28	0.21
FTRANSV	0.25	0.21	0.16	0.44	0.25	0.21	0.12	0.58	0.12	0.57
R	0.53		0.45		0.54		0.43		0.49	
Rsq	0.29		0.20		0.29		0.18		0.24	
P	0.13		0.30		0.12		0.38		0.22	

R-multiple correlation coefficient, Rsq-determination coefficient, p-level of significance, β-prediction variables beta ponders, AEO-absolute situation-related efficiency index of the players in offence, AED-absolute situation-related efficiency index of the players in defence, AEG-absolute situation-related efficiency index of the players in a game, PPLC1-partially pondered linear combination 1, PPLC2-partially pondered linear combination 2, FLONGIT-longitudinal dimensionality skeleton factor, FPMT-sub-skin adipose tissue factor, FVOLMT-voluminousity factor and body mass, FTRANSV-transversal dimensionality skeleton factor somewhat lower likely due to the fact that the given index, unlike previously interpreted ones, includes all thirteen variables to assess situation-related efficiency in players. Three out of four beta ponders are significant and these are: longitudinality, voluminousity and transversality. Further on, in Table 4, one can observe almost identical significant connections between the morphological latent domain and the overall situation-related efficiency of players (PPLC2) which, unlike PPLC1 index which uses the number of scored points and the number of inefficient shots, uses efficiency shots coefficients for one, two and three points. Latent morphological variables in this case explain for 53% of the variance of the given criterion (index).

Discussion

Based on the obtained results, latent morphological structure is not significantly connected to any of the applied situation-related indexes of players on the sample of guards and forwards. On the other hand, optimal morphological structure of centres in offence presumes marked longitudinality, voluminousity and transversality of the skeleton with unmarked sub-skin adipose tissue. Such morphological structure without any doubt enables the centres in the low-post positioning with an appropriate technique of choosing the front position to actively receive the ball near or inside the key, the area with the highest density in the court[1]. The given morphological features of inside players are a condition for creating contact by coordinated footwork which enables a certain player to use his own body to control the opposing player[1]. Such correct setting in a vast and low stance, contact and maintaining contact to a defence player, enables a centre to win some space, a position and to protect and open the passing line in a one to one game[4].

Regardless of the fact that basketball is a sport where speed, explosive power, agility and anaerobic endurance make the most important variables to create space advantage in a game, considering the energy component, we might say that basketball game, as an interaction sport, is becoming more of a contact sport, particularly in positioning defence and offence. This particularly refers to the game in inside positions where maximum strength in many situations enables inside or the first position as well as setting of movement in the contact with an opponent with the aim of opening or setting free one side of the body to receive the ball[4]. The usage of body is evident in setting screens and roll. Additionally, in rebounds while in the contact with an opposing player, voluminousity can be a deciding factor when preparing for contact game.

Regarding the absolute efficiency index of centres in defence, Table 4 evidently presents that high quality centres unlike low quality ones are characterised by longitudinality and voluminousity which enables them to be in control of the key, i.e. to stop the opponent's offence under the basket. This is manifested in stopping dribbler drives and inside passes and in dealing with defensive rebounds. Greater body height and voluminousity (abosilte body volume) are one of the conditions to decrease the effects in the inside game of the opponent's offense. Players with longer levers, presuming they have skilled and fast footwork, can control the key in one or two steps. Further on, longitudinality expressed through a large arm span is one of the preconditions to prevent inside passes. Finally, the given morphological factors enable the centres to be efficient in shot blocks. Efficient centres that control the key immediately decrease the number of drives, inside passes and rebounds of the opposing team, and at the same time they decrease their shooting percentage in offence.

AEG index involves two previously given indexes (AEO and AED), i.e. absolute efficiency of players in offence and defence together. It is evident from Table 4 that the morphological structure of quality centres in defence and offence is made by marked skeleton longitudinality, voluminousity and transversality[23]. Therefore, the characteristics of physical constitution of centres are one of

TABLE 4
MULTIPLE REGRESSION ANALYSIS – THE PREDICTION OF EFFICIENCY INDEX (PARTIALLY PONDERED LINEAR COMBINATION – TWO) BY LATENT MORPHOLOGICAL VARIABLES – THE SAMPLE OF CENTRES

EFFICIENCY INDEX	AEO		AED		AEG		PPLC1		PPLC2	
VARIABLE	β	p	β	p	β	p	β	p	β	p
FLONGIT	0.62	0.00	0.72	0.00	0.64	0.00	0.40	0.05	0.45	0.02
FPMT	0.13	0.38	0.14	0.32	0.13	0.36	0.13	0.46	0.13	0.44
FVOLMT	0.84	0.00	0.70	0.00	0.84	0.00	0.79	0.00	0.81	0.00
FTRANSV	0.47	0.01	0.26	0.14	0.46	0.01	0.59	0.01	0.60	0.01
R	0.80		0.82		0.82		0.71		0.73	
Rsq	0.65		0.67		0.66		0.51		0.53	
P	0.00		0.00		0.00		0.01		0.01	

R-multiple correlation coefficient, Rsq-determination coefficient, p-level of significance, β-prediction variables beta ponders, AEO-absolute situation-related efficiency index of the players in offence, AED-absolute situation-related efficiency index of the players in defence, AEG-absolute situation-related efficiency index of the players in a game, PPLC1-partially pondered linear combination 1, PPLC2-partially pondered linear combination 2, FLONGIT-longitudinal dimensionality skeleton factor, FPMT-sub-skin adipose tissue factor, FVOLMT-voluminousity factor and body mass, FTRANSV-transversal dimensionality skeleton factor the preconditions to efficiently perform tasks and roles in the inside positions in the game.

Presented morphological factors explain for 51% of the variance of PPLC1 index (Table 4). Three out of four beta ponders are significant: longitudinality, voluminousity and transversality. When analysing this kind of the morphological structures in centres, we can conclude that all three given morphological factors enable the centres to play near the basket. Further on, playing under the basket involves a great number of inside shots, received personal fouls, and at the same time the possibility to perform shots from the free throw line.

The number of rebounds in defence and offence, the number of assists, the number of steals and screens are also included into the previously given index and explained through their roles and tasks in the game. It should be stated that the number of turnovers and the number of personal fouls were also included into the given index as two parameters making a difference between high quality and low quality players in the position of centre. The inside game abounds in a large number of contacts which can generate a large number of turnovers and personal fouls.

Quality and low quality centres in the derived situation-related efficiency indicators (PPLC2) and in (PPLC1) are differed by morphological structure which involves marked longitudinality, voluminousity, transversality and unmarked level of sub-skin adipose tissue. The given morphological structure enables the centres to perform all previously given roles and tasks.

Trninić[1] and Burrall[24] reveal that to efficiently perform tasks in the basketball game, centres should own the ability for realisation in and outside the key, rebounding efficiency in defence and offence, the skill of passing, setting and using screens and quality individual and team defence. At the same time, the basic role of a classic centre in the game is primarily manifested through the setting of efficient screens and in rebounds mostly based on the control of positioning in defence. On the other hand, if the team has a forward centre with highly developed shooting abilities and passing skill, then the geometry of opening the key can be achieved during an offence. Regarding relevant anthropological features, the position of forward centre and the centre inside a certain team is filled with the players with a certain morphological and motor potential. According to this, expert coaches suggest it takes much less time to form a high quality centre than to create a guard or a forward player. Unlike them, the expert coaches claim it takes at least five years to form a player in the position of a guard who will achieve the actual quality in the game[4].

Due to the given reasons, it is important to differ typical from untypical players in all the positions regarding the overall potential and/or the overall actual quality in playing. Therefore, in modern basketball players cannot be assessed based on the partial potential (functional-motor abilities and anthropometrical characteristics), but based on their specific psycho-social features[25] since these characteristics influence the efficient fulfilment of tasks in the game in the situations of training and competitive stress. Thus it is necessary to understand the differences between the partial and overall potential in basketball players and the differences between the structure of the overall situation-related effect (partial efficiency in the game – based on the statistic notes of final actions in the game) and the structure of the overall actual quality of basketball players (the overall efficiency in the game) for certain positions in the game[8,10,11,15].

It is important to emphasize the stated results in elite junior basketball coincide with research findings in senior basketball[5,7]. The results indicate that three situation-related efficiency indicators distinguish positions in the game: defensive rebounds and screens mostly distinguish centres from guards and forwards, and shots outside the three-point line distinguish guards from forwards and centres. Furthermore, in senior basketball, unlike in junior basketball, there is the fourth indicator which mostly distinguishes centres from guards and forwards, and this is offensive rebound efficiency[2].

From a pragmatic point of view, keeping track of differences of situation-related efficiency and morphological features of players in diverse game positions enables expert coaches their guidance towards adequate positions in the game[11]. On the other hand, the parameters of situation-related efficiency of elite junior and senior players should be the criterion to wether a certain player meets the efficiency standards for his position in the game.

Furthemore, when comparing the obtained results with other research[5], who investigated, among other differences, the anthropometric variability between different positions in the play in senior basketball players (the Olympic Games tournament in Atlanta in 1996), it becomes obvious that the European junior players in all positions are shorter on average than their senior colleagues. The same trend of results is evident as far as body mass measures are concerned with substantial differences in favor of senior players. The present authors suppose this may be a consequence of the considerable enlargement in the lean body or muscular mass induced by the training transformation process[7,12].

In accordance with this, the process of continuous sports selection, from the point of view of the contemporary basketball, requires mesomorphic types, tall basketball players in national teams, who can efficiently play in two playing positions (swingmen), or in multiple positions (universal or polyvalent players) in defense and offense phase and who have the ability to control the intensity of play.

Finally, it is important to note that player assessment must not be based solely on the assessment of situation-related efficiency, morphological characteristics, motor-functional abilities, but also on the whole set of an athlete's specific personality traits which enables performance cosistency and sport achievement.

Conclusion

The ideas on the mutual connection of the morphological status and situation-related efficiency of players are important to rationally manage the process of sport preparation. The assumption of this research was that the morphological structure in interaction with other anthropological variables influences situation-related efficiency of players in the game.

The obtained results can be applied in the selection of junior and senior players since they are based on referent values (the results in morphological features and standard and derived situation-related efficiency indicators) which characterise elite junior players. In relation to referent values, it is possible to detect which players fulfil the criteria in top basketball.

Research findings on the situation-related efficiency based on morphology help the expert coaches to understand that technical, cognitive and emotional skills of players are the necessary conditions for the utilization of physical structure in certain types of players and the whole team. Further on, the obtained results on situation-related efficiency and morphological features of certain types of players enable an expert coach to assess partial efficiency in the game (situation-related efficiency indicators) and partial potential (morphological status) in creating a team. An expert coach and a scientist-practitioner can use the given data when assessing the performance of certain types of players and whole teams, when establishing the state of integral preparation, or the level of their sport form.

Practical implications of the research results are manifested in discovering, recognising, developing and selecting players. Further on, the given indicators enable expert coaches to program individualised and specific training which involve the shaping of the desired morphological features with relation to a certain position in the game. Such approach enables to encourage the development of optimal morphological features manifested through desired somatotype characteristics of players in relation to their position in the game.

With regard to the future direction of researches, it is necessary to connect idiographic methodological approach (case study) directed towards finding unique characteristics in elite players in a certain position in the game which can be revealed by analysing a certain top player with nomothetic approach directed towards assessment and research in which the primary goal is to identify a common set of laws that apply to all elite players in certain positions in the game. In this way we will obtain results revealing anthropological sets of top players in a certain position as well as revealing specific characteristics of a certain elite player. In accordance with this, traditional kinesiology science with modelling of the so-called ideal type of a basketball player (guard, forward, centre), and neglects the study of untypical players who are, from the point of view of the basketball game, particularly important since they enable many teams to make preponderance in the game and sport achievement.

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ZNAČAJNOST I KARAKTERISTIKE POVEZANOSTI MORFOLOŠKIH VARIJABLI I IZVEDENIH POKAZATELJA SITUACIJSKE UČINKOVITOSTI JUNIORSKIH ELITNIH KOŠARKAŠA ZA 3 TEMELJNA TIPA IGRAČA

SAŽETAK

Svrha ovog istraživanja je bila ustanoviti i objasniti značajnost i karakteristike povezanosti morfoloških varijabli i situacijske učinkovitosti košarkaša za tri temeljna tipa igrača. Na temelju dobivenih rezultata može se tvrditi kako latentna morfološka struktura nije značajno povezana s primjenjenim indeksima situacijske učinkovitosti igrača u uzorku bekova i krila. Nadalje, ne postoji značajan utjecaj morfološkog statusa na situacijsku učinkovitost igrača na poziciji beka i krila. S druge strane, latentna morfološka struktura značajno je povezana sa svih pet upotrijebljenih indeksa situacijske učinkovitosti igrača u uzorku centara. U skladu s time, optimalna morfološka struktura centara u napadu podrazumijeva izraženu longitudinalnost, voluminoznost i transverzalnost skeleta s neizraženim potkožnim masnim tkivom. Kada je u pitanju indeks apsolutne situacijske učinkovitosti centara u obrani, očito je kako kvalitetne centre za razliku od manje kvalitetnih obilježava longitudinalnost i voluminoznost. Nadalje, indeks AUI, koji uključuje prethodno dva navedena indeksa (AUN i AUO), oslikava apsolutnu situacijsku učinkovitost košarkaša u fazi napada i obrane zajedno ukazuju kako morfološku strukturu kvalitetnih centara u obje faze igre čine izrazita longitudinalnost skeleta, voluminoznost i transverzalnost. Kod indeksa DPLK1, od četiri beta pondera značajna su tri i to: longitudinalnost, voluminoznost i transverzalnost. Na kraju, kvalitetne od manje kvalitetnih centara u indeksu (DPLK2), kao i u prethodno navedenom indeksu (DPLK1), razlikuje morfološka struktura koja uključuje izraženu longitudinalnost, voluminoznost, transverzalnost te neizraženu razinu potkožnoga masnog tkiva.