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Relationship of anthropometrical, physiological and motor attributes to sport-specific skills

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The purpose of this pilot study was to investigate the importance of the athlete's motor capabilities in success in sport. More precisely, the association of anthropometrical and physiological attributes, as well as motor abilities of elite basketball players with play elements of basketball. The subjects were seven elite basketball players. At the end of the competitive season, the anthropometrical and physiological features were measured to establish the physical fitness of the subjects. Both general and sport-specific motor tests were done. The coach estimated the performance of each player during the games of the competitive season. The coach's data sheet incorporated 14 parameters of the game. Regression analyses indicated significant correlation between certain variables of the laboratory tests and the data of the coach's estimation statistics. Knowing these relationships provides us with valuable predictive information about player's capabilities in sport.

Keywords: anthropometrics, basketball, motor abilities, physiological characteristics, sport-specific skills

The success in a given sport is affected by various factors both at individual and team level. Common experiences confirm the importance of social, cultural and environmental influences. Evidences on the role of cognitive, perceptual, and motivational factors in basketball have been published (6, 10). There is a strong relationship between team cohesion and success (2). In addition, the importance of the coach is emphasized as a creator of the team success (10). Recently the important role of genetics in sport effectiveness has been highlighted (9). This short list of the aspects of current research shows clearly that the determinants of achievement in sport are multi-factorial. Our intention in this pilot study was to examine the contribution of the

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athlete's anthropometrical, physiological and motor attributes to the success in sport. The association of the laboratory data with the performance of play elements may be useful for talent selection and for preparing training programs.

Subjects and Methods

Seven male professional basketball players were selected as subjects (21.6±2 yr.). All subjects participated in the examinations voluntarily with written informed consent. The Ethics Committee of the Medical School of University of Pécs permitted the study.

Anthropometrical measurements (body height, circumferences of upper arm, thigh, lower leg and chest at the level of xiphoid process of the sternum), and waist to hip ratio were taken with the individual standing erect on a smooth surface. For body weight measurements the subjects, wearing sports clothing, stood in the centre of the scale. Body fat was determined by bioelectrical impedance measurements (Omron bf 300) giving the normal range between 10 and 19%.

The systolic and diastolic blood pressure, heart rate, and vital capacity were measured before, during and after performing an exercise protocol with increasing inclination on the cycle ergometer. The duration of the exercise was regarded as endurance capacity.

The motor tests involved one-leg standing balance test, handgrip and back muscle dynamometry, flexibility test, bent arm hanging, and vertical jump from a standing start. For the one-leg standing balance test the subject was standing on one shoeless leg on a 50-cm long, 4 cm high and 3 cm wide wood beam. The number of attempts needed to keep in balance on the beam for one whole minute was recorded. The static strengths of hand and back muscular groups were measured by appropriate dynamometers (Jamar grip tester, Back-a). Flexibility was measured by a lower back and rear thigh test. The subject was standing on a footstool with feet together and knees straight. The task was to bend forward to reach for the maximum bending, and maintaining this position for 2 sec. The maximum distance between the surface of the footstool (0 level) and the middle finger tip was measured, and expressed by negative numbers above the 0 level, and positive numbers below the 0 level. The result is given in cm. The arm and shoulder muscular endurance was measured by maintaining a bent arm position while hanging from a bar. The result is given in sec. The explosive strength was measured by vertical jump test. The difference in distance between the reach height and the jump height is the score. The result is given in cm.

The sport-specific tests were: [1] running to 20 m, [2] 10 free-throw shootings with basketball from the distance of 4.8 m, and [3] Zigzag dribble to 14 m among traffic cones 2 m apart.

The coach estimated each player's performance during the games of the competitive season, and averages were calculated at the end. The estimation data sheet incorporated 14 parameters, [1] Number of games played by the player during the basketball competition season. [2] Playing time, the amount of time the player actually played per game. [3] Points per game. [4] Defensive rebounds per game. [5] Offensive rebounds per game. [6] Total rebounds per game. [7] Steals per game. [8] Lose the ball per game. [9] Forced opponent's personal foul per game. [10] Personal foul per game. [11] Assist per game. [12] Technical foul per game. [13] Block the shot per game. [14] Total score calculated from the above parameters by a formula.

Descriptive statistics and regression analyses were used for statistical analysis. To reduce the Type I error rate we adjusted the *P* value downwards for declaring statistical significance.

Results

The coach estimated the performance of each player during the games of the competitive season. The average values are summarized in Table I.

The laboratory tests were made after the last game of the competitive season. The results of the anthropometrical and the physiological measurements are shown in Table II. As it is typical for basketball players, the body height was above the average of the population (mean 196.1 cm, minimum 177 cm, maximum 207 cm). The other anthropometrical measures were in the normal range.

Table I

The estimation of the players

Players	A	B	C	D	E	F	G	H	I	J	K	L	M	TS
1	8	24	9.7	1.3	0.73	2.03	3	1.1	1.7	2.9	3	0.07	0.07	14.75
2	9	29.4	14.6	1.8	0.59	2.39	3.4	1.9	1.8	2.4	2.4	0.06	0.52	17.8
3	13	32.5	15	6.6	3.7	10.3	3.0	1.4	3.2	2.9	1.1	0.4	0.7	27.55
4	5	20.1	7.7	1.6	0.19	1.79	1.7	1.9	3.4	2.8	2.4	0.18	0.12	12.89
5	15	15.5	6.3	0.75	0.5	1.25	1	1	2	3	0.75	0	0	9.45
6	6	22.8	9.5	2.6	1.6	4.2	2.2	2.3	2.8	3.4	1.2	0.4	0.17	14.72
7	12	33.4	10.4	2	0.75	2.75	3.9	2.3	3.8	2.6	4.4	0.12	0.06	20.25

Abbreviations:

A = Number of games played by the player during the basketball competition season.
B = Playing time, the amount of time the player actually played per game.
C = Points per game.
D = Defensive rebounds per game.
E = Offensive rebounds per game.
F = Total rebounds per game.
G = Steals per game.
H = Lose the ball per game.
I = Forced opponent's personal fouls per game.
J = Personal fouls per game.
K = Assist per game.
L = Technical foul per game.
M = Block the shot per game.
TS = Total score.

Table II

Anthropometrical and physiological data

Variables	Mean	Sx
Body height (cm)	**196.1**	2.7
Body mass index	**22.6**	0.57
Body fat (%)	**10.75**	1.77
Waist to hip ratio	**0.94**	0.04
Systolic blood pressure (mmHg)	**111**	3
Diastolic blood pressure (mmHg)	**67**	2.8
Heart rate (beats/min)	**59.7**	2.3
Vital capacity (L)	**6.1**	0.17
Endurance (min)	**10.6**	0.57
Exercise peak heart rate (beats/min)	**169**	5.3

The cardiorespiratory data were at the lower border of the normal range before the exercise on cycle ergometer. Also, the exercise-induced changes in blood pressure and heart rate were typical for the healthy athletes. The endurance capacity was somewhat above the upper level of the normal range for healthy young unsportsman (10 min). The blood pressure and heart rate returned to the pre-exercise level during 3 minutes following the stop of exercising.

The results of the general and special motor tests are summarized in the Table III.

Table III

Results of the motor tests

Motor tests	Mean	Sx
Hip flexibility (cm)	**7.7**	3.1
Balance (attempts/min)	**8.7**	2
Hanging (sec)	**44.6**	6.6
Jumping (cm)	**62.7**	0.7
Hand grip strength (kg)	**53.3**	2.1
Back muscles strength (kg)	**161.3**	9.9
Running 20 m (sec)	**3.4**	0.11
Zigzag dribble (sec)	**7.7**	0.2
Free throw shooting (10 trials)	**7.1**	0.6

We used the Pearson's correlation to determine the degree to which the play elements computed by the coach are related to the anthropometrical, physiological and motor variables. The results are shown in Table IV.

Table IV

Correlations between variables and coach's estimation data

Variables	Parameters of the coach' estimation	Pearson's correlation coefficient	P
Body height	Block the shot per game	0.929	0.004
Hanging	Playing time per game Steals per game	0.854 0.834	0.015 0.020
Jumping	Playing time per game Steals per game Personal fouls per game	–0.893 –0.912 0.816	0.008 0.006 0.024
Running	Points per game Total rebounds per game Total score	0.854 0.831 0.839	0.015 0.020 0.018
Zigzag dribble	Total rebounds per game Total score	0.914 0.842	0.005 0.018
Back muscles strength	Personal fouls per game	0.849	0.016
Endurance	Number of games	–0.888	0.009

Discussion

The first question is whether the estimation method used by the coach is accurate to assess the performance of the players. The answer has two aspects. [1] The data sheet incorporates essential and sufficient parameters to describe the play. [2] These elements of play differentiate well between high and low performers. It is clear that the different positions in the team need players of dissimilar abilities, so they perform the various elements of the play differently. However, the total score that was calculated by a formula combining the single elements may grade the players. We put the question whether the performance of the elements of play is associated with the results of the laboratory tests. By other words, which anthropometrical, physiological, and motor characteristics of a player are beneficial for the various elements of the play?

The laboratory tests revealed good physical condition of every player, abnormal results were not found. This fact is supportive for searching correlations between the laboratory variables and the elements of the play.

The anthropometrical characteristics are known to influence sport activities, and certain factors are preferable for a given sport (3, 4, 11, 13, 14). So, high body height is an important attribute of the basketball player. It is frequently believed that body height determines the success in basketball. Regarding this expectation it is surprising that only the block the shot per game has significantly correlated with the height. There was a positive correlation between the height and points, total rebounds, and technical foul per game, but none of them was statistically significant. These results seem to lessen the importance of body height, but all players examined in this study were high, being the highest 207 cm and the lowest 177 cm. So, the present data indicate that even this difference of 30 cm in body height may result in significantly better performance in the block the shot.

The effect of body fat on basketball performers has been studied from different aspects (1, 3, 5, 14). The metabolic importance of the fat is well known. Also the distribution of the fat in the body, may affect the motor skilfulness. The shape of the body is shown by the waist-hip ratio. Both the body fat (%) and the waist-to-hip ratio were in the normal range. Under these conditions, the body fat has no significant association with the performance of the play.

It is important to note that the correlations between the body mass index and the elements of the coach's estimation were insignificant in all cases.

Considering the high cardiovascular stress during competitive basketball (7, 12), it may be surprising that insignificant correlations were found between the cardiorespiratory variables and the factors of basketball performance. However, it is possible to argue that the cardiorespiratory fitness is required to fulfil the metabolic demands of the motor performance, and has no specific effect on the various skills. This assumption is supported by the negative correlation between endurance capacity and the number of games played by the player during the basketball competition season. The player who played more games during the season is more fatigued than those who played fewer games, thus at the end of the season the less tired player exercises longer on the cycle ergometer.

It seems plausible that motor abilities tested in the laboratory are associated with the sport-specific skills. However, such a generalization has no practical outcome. Actually, certain motor abilities are closely related to the motor performance, others have no direct connection. Furthermore, some correlations are clear, but others are difficult to explain. Positive correlations were found between the hanging (static strength endurance) and the playing time and steals per game. It is evident that these elements of the play need muscular endurance, but it is true for other factors, too. Therefore, we cannot explain adequately these results. Also, the associations of vertical jumping with playing time, steals, and personal fouls are difficult to explain. Why just these elements are correlated strongly with vertical jumping and the others not? Probably the stronger dynamic force makes the player more active, and his briskness may lead to faults. Similarly, we do not know the grounds for positive correlation between the back muscles strength and the personal fouls. The answer to these questions needs further research. It is possible to hypothesize that the general motor abilities are important as components of the physical condition, which is a base for development of sport-specific skills.

Contrary to the general motor abilities the correlations between sport-specific variables (running, Zigzag dribble) and the points, total rebounds and total score are reasonable. These motor abilities are essential elements of the play. Even the fact that no significant correlation was found between the free throw shootings and the points per game is clear, because the circumstances of shootings are different. A shooting in competitive situation is more complex behaviour than free throw.

The above significant correlations show clearly that certain laboratory data have predictive value for the success in sport. Consequently, these variables are useful in talent selection, and for the coach preparing the training program for the basketball team.

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