MORPHOLOGICAL-ANTROPHOMETRIC STRUCTURE AS A (LONGTERM) PREDICTOR OF PLAYERS' ACHIEVMENTS IN TEAM SPORTS – EXAMPLE BASKETBALL

Mario Jeličić

Faculty of Kinesiology Split, Croatia

ABSTRACT

The aim of this paper was to present an original methodological approach in the analysis of the impact of the morphological-anthropometric status on the players' final career achievement. For the purposes of this paper, a sample of top junior basketball players with their morphological-anthropometric status data was analyzed when they were 18. This data then served as a predictor of their successful game play over the next 17 years of their careers. The sample of the respondents consisted of 133 basketball players, of which 53 players were at the shooting guard position, 29 at the small forward (wing) position, and 51 at the center, with an average age of 17.8 years. The predictor set consisted of 13 morphological-anthropometric variables. The criterion variable was represented by the career achievements of these players grouped into three qualitative categories. The results justified the use of this methodological approach, which established that a part of the anthropological status determines player's success during their careers. Such research must be conducted within other team sports, taking into account the importance of certain parts of anthropological status and the specificities of each particular sport. Of course, a position-specific approach is recommended, given the roles and tasks of the players in the game between different team sports.

Key words: team sports, juniors, seniors, morphological anthropometry, sports achievement

INTRODUCTION

Team sports generally differ according to sport-specific requirements. Therefore, it is of a particular interest for each coach to assess the method of selecting those juniors who will potentially achieve outstanding results. For example, in modern football, characterized by the basic division of players (with the exception of goalkeepers) to offense, midfielders and defense, it can be assumed that given the nature of this game today, in which a large number of players (in particular, the wings) participate in both offense and defense actions (total football, for example, center offensive shot and defense on return), and the match lasts relatively long, it is extremely important for achieving the highest rank of player's quality, have appropriate morphological-anthropometric characteristics, physical condition and psychosocial characteristics. The assumption is, of course, that these are top juniors (condition - the correct selection and focus on adequate positions and timely entry into the first team) who have a high level of technical-tactical knowledge, skills and habits in the game. It is also desirable for offensive midfielders to be more longitudinal (primarily for an offense jump and heading the ball) as opposed to the wingers, who are generally shorter with a large movement radius and therefore in a need for a pronounced value of VO2max (Marković and Bradić, 2008). They should be explicitly quick and when it comes to their personality traits, they are characterized by their ambition, competitive spirit, courage and aggressiveness. Midfielders are, in principle, shorter players with exceptional motor skills and

functional abilities (VO2max - due to the large movement radius and concentration, according to Verheijen, 1997, and Markovic and Bradic 2008), as well as cognitive speed. Defense players (especially center field ones) graced with the explosive power of the jump type and pronounced skeleton longitudinal dimensionality precisely due to the jump and duel games (contact readiness), but also the ability to predict situations (e.g. long balls) and tactical responsibility in the game. In addition, other motor skills such as agility, coordination, precision and balance are also of great importance. They manifest greatly through almost all functional respects of players in the field, at all positions. When it comes to team sports from the aspect of psychological evaluation of young players, it is quite certain that the selection problem among juniors should include the mentioned personality traits as one of the crucial variables that should serve for this purpose. When it comes to handball, for example, morphological anthropometry in terms of expressed longitudinality on the outer positions, with the explosive force of the vertical jump type and the arms and the shoulders strength due to the external shot over the defense with the low centre of body mass, the speed and explosiveness of the long jump type due to the rapid running into the counterattack and the shots from the 6m line from the winger positions (Čavala, 2012), are probably, along with mental and physical strength, factors for possible selection of player in these positions for top-quality handball. Similarly, the player at the pivot position should, with pronounced longitudinality, voluminosity and transfersality,

have controlled aggressiveness, since he has often been in contact with the opponent in the battle for the position and 6m line shot and when extorting the seven-meter throw. When selecting the goalkeepers for top quality handball, however, we would look among those juniors with long extremities who would be able to cover the goal in the best way possible and with a distinct flexibility and balance that help them when they defend it (a greater range of gestures, one leg hold etc.). One of the psychological characteristics among the majority of top goalkeepers is also a kind of introvertedness, since they often experience the game situations themselves (Rogulj et al., 2005).

From the point of view of basketball games today and in the coming times, many authors consider that it would be optimal for each team to have polyvalent and *swingman* players in their roster, as well as players - who are specialized for certain roles in the game. Such an approach to creation of basketball team asks for carefully chosen players from the aspect of the functional division of players and considering their morphological characteristics - e.g. expressed longitudinal dimension of the skeleton (Dežman, 1990). The tactical system of the game should be chosen in a way that the overall potential of the team is used to full extent. This is largely based on the morphological-anthropometric characteristics of the whole team from the point of view of the influence of the relative proportions of the physical components in the sports performance - for example, the player's body height to a large extent determines his positions and roles in the game. Similarly, the appropriate height of the player's body is one of the prerequisites for creation of a polyvalent technique, tactics and game, giving coaches the opportunity for various options within the transition and set-up defense and offence game with a lower risk during the adjustment to the geometry of the opponent's game (Trninić, 1996). Other morphological characteristics are more or less related to successful performances in the game. Therefore, the developed musculature of the leg, torso, arms and shoulders will enable the player to properly solve various defense and offense tasks (the low center of gravity of the body in the basic defense and offense stance, sprinting efficiency, etc.). Higher percentage of fat tissue, on the other hand, will impede the realization of motor tasks in basketball game (Matković Br. And Blašković, 1983; Dežman, 1990; Trninić, 1996). It can be assumed that the morphological structure of basketball players largely determines the variance of overall performance in basketball. Furthermore, by reviewing the existing research mentioned in the following text, it is evident that there is a lack of concrete scientific knowledge about this

problem. Similarly, there is no concrete scientific knowledge related to the impact of morphological characteristics on the quality of players observed through their career achievements. Firstly, the precise indicators of the impact of morphological characteristics on the situational efficiency of players in certain positions in the game are missing. In other words, the data on relations between the morphological characteristics and the situational efficiency of players in the overall sample (the so-called suppressor effect) of the senior basketball players exist (e.g. Matković, Bo. and Matković, Br., 1986; Trninić, Dizdar and Jaklinović-Fressl, 1999). However, it is quite certain that it is actually about the influence of the role and tasks in the game on player's success, and the roles and tasks are partly determined by the morphological characteristics of the players, which is confirmed by the discussions and conclusions of the great number of scientists (Trninić, 1996; Dežman, Trninić and Dizdar, 2001). Therefore, in order to get accurate indicators on the impact of any characteristics of basketball players on their game play quality, even the morphological ones, it is necessary to separately determine the connection between these two spaces for sub-samples consisting of, for example, three basic types of players: guards, wings and centers.

The knowledge base on the athlete's model characteristics (the analysis of real and future model characteristics) makes the basic part of the discovery, selection and development of athletes, because it is based on specifically defined criteria for assessment of the athlete's potential and their real quality assessed during the sports game. The selection of athletes is also achieved by comparing athlete's characteristics with model characteristics for individual sports, which should firstly include the development of players' potential in relation to his biological and training age. Given that the selection of top basketball players is at junior age, it also represents the hardest transition to seniors. It is therefore of the utmost importance to define some of the factors that will determine the ultimate success, and this is what we are trying to achieve in this paper.

In accordance with the above mentioned, the main goal of this paper was to determine whether the three categories of player's qualities grouped by their achievements differed by observing them from the aspect of the morphological anthropometric structure when, in 2000, as top juniors, they were measured and analyzed at the European Championship. This paper is aimed to give a specific contribution to the development of quality criteria for the selection of future basketball players, which

implies the identification and explanation of the morphological characteristics of top-quality junior basketball players. The results obtained can be directly manifested on the development of a monitoring strategy and development control of a particular type of player.

Finally, the aim of this paper was to determine the possible correlation between the morphological-anthropometric characteristics of the top junior basketball players with their game play achievements during their careers. Therefore, the anthropometric status of subjects was analyzed when they were 18 years old, and the player's achievement was defined throughout the next 17 years. The basic idea was to examine the possibility of such an experimental approach in basketball, but if the justification of the methodological approach was confirmed, it could also be applied in other team sports.

METHODS OF WORK

The sample of the respondents consisted of 133 basketball players, of which 53 players were at the guard position, 29 at the wing position, and 51 at the center, with an average age of 17.8. The predictor set was represented by 13 anthropometric variables (body height, body mass, arm span (R-RUKU), body mass index

(BMI), endomorphic (ENDO), ectomorphic (ECTO) and mesomorphic body types (MEZO), sum of seven skin-folds (SUM7KN), the amount of fat tissue (PMT) in percentage of body weight and kilograms and body muscle mass (BMM). The usual measurement protocols were adopted (Norton et al., 2000). The criterion variable was represented by the achievements of the stated players in their careers. Players are actually grouped into three qualitative categories, as follows:

1st. GROUP: National team representatives, NBA players (the strongest league in the world), Euroleague (national championship champions), Euro Cup (second, third, fourth-ranked teams of the national championships) and Fiba Cup (fifth and sixth placed teams of national championships).

2nd. GROUP: ABA-regional league and players who perform in national championships; Spain, Italy, Greece, Turkey and Germany, VTB league.

3rd. GROUP: Players who are not in any of the listed groups (leagues whose clubs do not participate in any Euro Cup - for example, the Croatian Premier League, Slovakia, Hungary, Austria, Romania, etc., A1 Croatian league, A2 National League and lower leagues (e.g. Germany 4ta...).

Figure 1. Display of experimental scheme
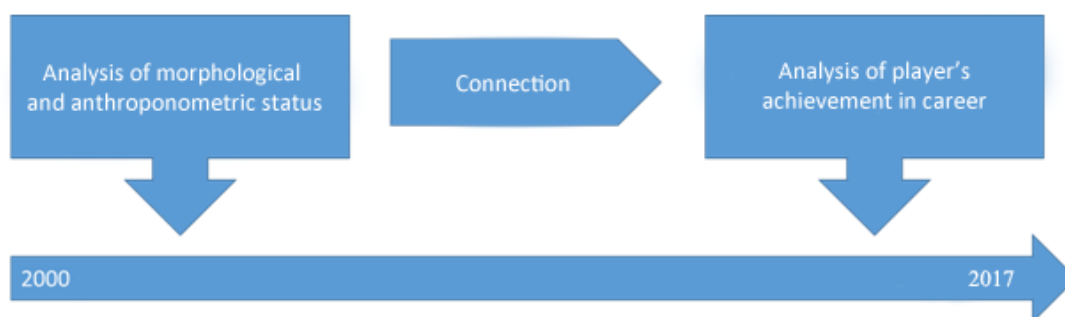
Statistical processing included descriptive statistical analysis (arithmetic mean, standard deviation). In order to determine the correlation between anthropometric variables and body type variables and somatotypes with player's achievement, variance analysis was applied. The analyses were conducted for the three basic types of players (guards, wings, centers).

RESULTS

Table 1. Descriptive statistics for analyzed variables by positions

	GUARDS		WINGS		BIG MAN	
	AS	SD	AS	SD	AS	SD
HEIGHT (cm)	188,0	4,9	196,8	4,3	202,3	5,2
WEIGHT (kg)	81,4	5,7	87,4	5,9	97,5	8,3
BMI (kg/m**2)	23,0	1,3	22,6	1,7	23,8	2,2
ARM SPAN (cm)	192,9	5,9	203,6	6,6	209,5	6,0
SUMA7KN (mm)	58,1	10,9	58,8	12,6	74,3	21,0
PMT (%)	12,2	1,7	12,4	2,2	14,7	3,0
PMT(kg)	10,0	1,8	10,9	2,4	14,5	3,8
BMM (kg)	71,4	4,7	76,5	4,5	83,0	5,7
ENDOM	2,4	0,4	2,4	0,6	3,1	0,9
MESOM	2,5	0,9	1,8	0,9	1,5	0,9
ECTOM	3,2	0,7	3,9	1,0	3,6	1,1

Table 2. Analysis of differences between qualitative categories of players based on morphological-anthropometric status variables

	GUARDS		WINGS		BIG MAN	
	F test	p	F test	p	F test	p
HEIGHT (cm)	2,25	0,12	5,48	0,01	1,20	0,31
WEIGHT (kg)	0,43	0,65	0,34	0,72	0,51	0,60
BMI (kg/m**2)	0,43	0,65	1,48	0,25	0,18	0,84
ARM SPAN (cm)	1,32	0,28	7,74	0,00	2,08	0,14
SUMA7KN (mm)	0,66	0,52	2,91	0,07	0,29	0,75
PMT (%)	0,82	0,45	2,21	0,13	0,68	0,51
PMT(kg)	0,31	0,73	1,80	0,18	0,47	0,63
BMM (kg)	0,86	0,43	0,31	0,74	0,99	0,38
ENDOM	0,86	0,43	2,16	0,14	0,73	0,49
MESOM	3,39	0,04	0,20	0,82	0,04	0,96
ECTOM	1,26	0,29	2,55	0,10	0,23	0,80

Table 1 shows the results of descriptive analyses in order to obtain an image of the morphological anthropometric structure of the analyzed sample of basketball players.

Table 2 shows the results of the analyses used to determine the differences between the trio-qualitative groups of players (grouped by career achievements) in their morphological anthropometric status in the 18th year of their lives. As can be seen with the guards, the only significant difference between the three qualitative groups is noticeable in the MEZO (mesomorphic body type component) variable. Specifically, the top quality players even as juniors had the same pronounced mesomorphic body type (3.07±1.03; 2.26±0.88; 2.33±0.81; among the most successful, average and least successful players). When it comes to wings, significant difference was found in the variables of body height and arm span. More precisely, players who achieved the best results during their career at junior age were extremely tall (200.91±4.23; 195.61±4.55; 195.55±3.10 cm; among the most successful, average and least successful). This logically follows significant differences in arm span (210.11±6,00; 202,21±6,84; 200,92±4,64 cm, among the most successful, average and least successful). No significant differences were found for the position of the center.

DISCUSSION

There are three main findings in this study. Firstly, at the position of the guards, the only variable that showed significantly associated with the ultimate player's achievement was the measure of mezomorph body type. Secondly, in the wing's sample, longitudinal dimensional measures are a significant factor of success in a player's career. Thirdly, in a sample of centers, none of the variables of anthropometric status have had any significant correlation with the player's achievement in their careers. The best guards in Europe were in their junior age non-adipose (average) voluminous or mesomorphic types of players (Jeličić et al., 2002), which gives them the ability to manage the pace of the game more successfully. The non-adiposity, amongst other things, enables them greater endurance, and therefore greater ability for recovery during game breaks, while they are likely to have a significant amount of voluminosity reflect on the explosive power of the first move in the game (Jeličić, 2006). These are, therefore, athletic types of players with pronounced muscularity, but also aggressiveness, who take greater risks in the game (LeUnes, 2008). Consequently, they have morphological as well as psychological preconditions to achieve specific roles and tasks in the game at high-level. In addition, such a game allows them a greater number of inside shot between the baseline and the endline, and therefore a greater number of successful two point shots. We can assume that the aforementioned morphological-anthropometric characteristics (with 18 were already quite formed as such) positively reflected on their development throughout their careers, meaning that they achieved great achievements during their careers as seniors. The assumption of the author of this paper was that the height of the guards in junior age would represent a predictor of success in their ongoing career from the point of view of the basketball game development. However, that was not the case. It is possible that the height did not prove important because the exceptionally high guards, among other things, probably are weaker at ball control, and thus have a slightly higher number of lost balls than the average height guards (Jeličić, 2006). The aforementioned reasons give the coaches a logical justification that mesomorphy among the guards is more important than more pronounced body height, and such (non-adipose, voluminous and medium-high) guards are used more in the game. Furthermore, the number of minutes spent in the game develops a specific situational preparedness among these athletes, which further increases the differences between these types of players on the guard

position. We can conclude that mesomorphy (non-adipose voluminosity) among the guards is a factor that shows what will determine them even in the senior age. This will enable them to create greater forces, speeds and agility, and they will be able to manifest their technical-tactical knowledge at a higher level (Berg et al., 1998).

Wings in modern, contemporary basketball increasingly must strive for multifaceted polyvalent and versatile universal type of players. The modern type of wings play different roles in the game, and within them, they perform various tasks and duties in all areas of the field, i.e. inner and outer game. Wing players are therefore in principle multifaceted and versatile types of players and have such a structure of features and knowledge that allows them to successfully play more roles in the game (Trninić, 1996). The height of wing players at junior age proved to be a predictor of their achievement in sports career. The reason is that these players were tall, but also less voluminous than the "better ones". They were not the most effective because they probably did not succeed to adequately answer the demands of the game in terms of agility and speed which reflected on all of the technical-tactical aspects of the game (for example, stopping the dribble penetration and opposing offence shots, etc.) These players probably gained a certain amount of weight later on and achieved the demands expected from the players on this position. They also quite certainly gained faster reactions from the motor and the cognitive aspects, or the situational effect in the game. Such players should, therefore not be left out when selecting the seniors for the competitions. Interestingly, a study from the European Junior Championship in 2000 showed that the most successful wings are as juniors, a short torso and pronounced voluminosity (Jeličić, 2006). However, the results shown here indicate that these and such wing players will not be the most successful in their career. The likely reason is that these junior players were accelerators, and it is well known from the practice that they are the retardants who have the highest it is known that the retardants are those that have great prerequisites on their own development and player's achievement. From the aforementioned, we can conclude that coaches should not strive for the highest score achieved by the players on the wing position at 18 years of age. When selecting players, they need to keep the more longitudinal ones and less voluminous ones as those players will later show to be better than those who were very effective as juniors (smaller torso and more voluminous ones). Therefore, the longitudinal and the lesser voluminous wing

players, compensated these aspects later (primarily voluminosity), which eliminated their initial disadvantage, and the prerequisite for this is primarily - lack of agility and speed.

Among center position players, morphological features (primarily longitudinality and voluminosity) did not appear to be their predictors for career success. There are two potential reasons for this. Firstly, it was logical to expect that the centers of the group that was defined as the most successful one throughout the player's career, at junior age would be extremely tall and that their junior age height would determine player's achievement. However, this did not happen because the centers were already mature young players at junior age. They changed very little throughout the course of their career. It happens that in fact, their morphological structure is at this point definitive and that as such it no longer determines their development, but it is determined by some other variables. Namely, the morphological structure of top center players at junior age in defense and offense positions consisted of the strong skeleton longitudinality, the voluminosity and the transversality (Jeličić et al., 2002). Therefore, the characteristic physique of center players was one of the prerequisites for the successful execution of tasks and roles, especially in the inner positions of the game at the age of 18. All three of these morphological factors enabled the centers to play the game closer to the hoop. The game underneath the hoop also caused a large number of inner shots, forced personal fouls, and thus the ability to perform a free throw shot. However, with center position players, the range of specific motor skills is the smallest in relation to the wings and guards so that those with two to three "specials" can successfully fulfill their roles and tasks in the game. There are still defense and offense jumps, a shot from the free throw line, but also their health status, which is not described as such by the morphological structure. The complexity of their game was similar when they were top junior players and later as seniors. Therefore, we can conclude that center players should not be selected primarily based on their morphological structure (e.g. body height) in juniors, but should be chosen while using other factors that affect their sports achievement. Secondly, it was to be expected that the centers that were voluminous as juniors would in the later career achieve excellent results. However, that was not the case either. In today's modern basketball, there increasing number of center players in outer positions and even on three positions in the game, facing the hoop. They are less voluminous and highly mobile with remarkable efficiency from outer positions, which is also potentially one of the

reasons why these factors did not prove to be significant in their final achievement.

Limitations of research

The author of the paper is aware of the numerous limitations of this research. One of them is that the research could also be carried out on five player positions instead of three, as is the case here. This is not implemented here because it would reduce the number of respondents per group and/or would not have the normality of the respondent distribution within each group even if the groups were of equal sizes.

In addition, data on individual players' injuries is omitted. Those injuries would have objectively (early career end or its redirection) made it impossible for them to reach their maximum potential. Therefore, this has potentially reduced their coefficient of participation within a particular qualitative group. Furthermore, it is possible that the quality assessment scales, in which players are sorted, is not ideal but is based on the experience of the author. It certainly stands that any further explorations should consider alternative ways of assessing quality.

Finally, we can conclude that this study analyzed only the morphological-anthropometric structure, which was analyzed in detail and was used in the classification of players in the groups. It is obvious that the anthropometric structure of players represents only one part of the player's potential. However, anthropometric features are certainly an important factor of success in basketball, and the primary goal was to present the concept of an original research approach that could be widely applied in other sports.

CONCLUSION

Mesomorphic body type at the position of player in guard position at their junior age proved to be the only variable that is significantly associated with the ultimate player's career achievement. Among the sample of players in wing position, longitudinal skeletal dimensions are a significant factor in the performance of a player's career, which points to the need to consider the same when selecting the players in senior basketball at the said position. The investigation revealed the importance of the morphological dimensions (primarily body height, arm span and available height among players at wing positions and the mesomorphosis of players playing primarily at the guard position) taking into consideration their career achievement. However, only one part of the anthropological status was analyzed, and further research would require results to be

verified on a number of variables, including analysis of situational performance and make an analysis on five players' positions.

One of the comparative advantages of this work is related to the fact that it is possible to observe players from a certain time distance from 2000, when they were juniors, to this day. Consequently, their "game play development" can be established through a specific period and it is possible to talk about their overall quality in senior basketball. Since this paper was intended to give a specific contribution to the creation of quality criteria for the selection of future basketball players, which implies formulation and an explanation of the top junior basketball players' morphological characteristics, the results obtained can be directly implemented in the development of the tracking strategy and control of the development for each type of player.

LITERATURE

1. Berg, K., R.W. Latin, C. Coffey (1998). Relationship of somatotype and physical characteristics to distance running performance in middle age runners. *Journal of Sports Medicine and Physical Fitness*, 38(3): 253-7.
2. Čavala, M. (2012). Morfološke, motoričkeipsiho-socijalne karakteristike mladih rukometašica različite igračke kvalitete i pozicije. Doktorska disertacija. Split: Sveučilište u Splitu, Kineziološki fakultet.
3. Dežman, B. (1990). Pregled izsledkov raziskav, ki obravnavajo modele igre in modelne razsežnosti košarkarjev. *Šport,* 38: 39-43.
4. Dežman, B., S. Trninić, D. Dizdar (2001). Expert Model of Decision-making System for Efficient Orientation of Basketball Players to Positions and Roles in the Game – Emprical Verification. *Collegium Antrpologicum*, 25(1): 141-152.
5. Jeličić, M., D. Sekulić, M. Marinović (2002). Anthropometric characteristics of high level European junior basketball players. *Collegium Antropologicum*, 26(2): 69-77.
6. Jeličić, M. (2006). Veličina i obilježja morfološke uvjetovanosti situacijske učinkovitosti vrhunskih juniorskih košarkaša. (Doktorska disertacija) Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.
7. LeUnes, A. (2008).*Sport Psychology* (4th ed.) New York: Psychology Press.
8. Marković, G., Bradić, A. (2008). *Nogomet – integralni kondicijski trening*. Kineziološki fakultet, Zagreb.
9. Matković, Bo., Br. Matković (1986). Utjecaj morfoloških karakteristika na uspješnost u košarci. *Kineziologija*, 18(2): 95-98.
10. Matković, Br., M. Blašković (1983). Odnosi između latentnih antropometrijskih dimenzija i uspješnosti u košarci. *Kineziologija,* 15(2): 17 - 25.
11. Norton, K., M. Marfell-Jones, N. Whittingham i sur. Anthropometric assesment protocols. U: Gore, C.J., ur. Physiological tests for elite athletes. Human kinetics 2000: 66-86.
12. Rogulj, N., Srhoj, V., Nazor, M., Srhoj, Lj., Čavala, M. (2005). Some Antropologic Characteristics of Elite Female Handball Players at Different Playing Positions. *Collegium Antropologicum*, 29(2): 705-709.
13. Trninić, S. (1996). *Analiza i učenje košarkaške igre*. Pula: Vikta.
14. Trninić, S., Dizdar, D., Jaklinović-Fressl, Ž. (1999). Analysis of differences between guards, forwards and centres based on some anthropometric characteristics and indicators of playing performance in basketball. *Kinesiology*, 31(1): 29-36.
15. Verheijen, R. (1997).*Handbuch fuer Fussballkondition*. BPF Versand, Leer.