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Morphological similarities and differences of young players from selected sport team games

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Abstract

Introduction: Body physique is an important determinant of sports success. Knowledge in this area enables the effective selection of players for various sports disciplines.

Aim: Using a multidimensional perspective, to determine the degree of variation in the body physique of athletes from four sports disciplines: American football, football, volleyball and handball.

Materials and methods: The research was carried out in 2017 in sport clubs operating in the Lower Silesia Voivodship. The research group consisted of 125 male players, with a mean age of 16.27 years. They represented 4 sports disciplines and included 22 American football players, 30 football players, 49 handball players and 24 volleyball players. In the analysis, the measurements of height and weight were used as well as the Body Max Index, calculated with the following formula: body weight [kg]/body height [m]^2

Results: The American football players had the highest body weight and the highest BMI. The handball and volleyball players were the tallest. The football players were characterised by the lowest body weight.

Conclusions: Each of the analysed sports disciplines prefers players with a different body physique. Nevertheless, a greater similarity between the handball and volleyball players can be observed. American football players are more different morphologically, whereas football players are the least similar to the players from the other disciplines. The results of the study will facilitate both players' and coaches' decision-making process regarding the change of the sports discipline and the choice of a new one, if such need arises.

Keywords:

body weight, body height, BMI, team sports, morphological diversity

Introduction

Height and weight are the basic somatic features determining body physique. Morphological characteristics are one of the key factors affecting sports success (Klimczyk, 2012). In various sports disciplines, body physique provides the basis for an early selection of players with adequate predispositions. (Łaska-Mierzejewska,1980). This is in order to select players whose physical conditions combined with proper specialist training will enable high sports achievements (Burdukiewicz et. al., 2010).

American football, football, handball and volleyball, as team disciplines, differ in terms of the rules, specifics of training and competition.

American football matches are played on a grassy pitch, in the open air or in an adapted sports hall. The match involves two eleven-person teams and it consists of four quarters, lasting 15 minutes each. American football is considered one of the toughest team games. The players are required to use helmets and protectors. People with a large body weight, characterised by a high level of physical fitness are particularly suitable as American football players (Jacobson et. al., 2013).

Football matches are played on a grassy pitch, in the open air. Two eleven-person teams take part in a match. There are 10 players in the field and one goalkeeper. The match lasts 90 minutes, played in two halves, each lasting 45 minutes. Given the diversity of the positions on the football field and the respective tasks to be fulfilled during the game, as well as the importance of technical skills (Kalapotharakos et. al, 2006), football players are characterised by quite a high diversity in body physique (Gil et. al. 2007, Burdukiewicz et. al., 2013)

Handball matches are played in a sports hall on a smooth and hard surface. Two seven-person teams take part in a match. 6 players are in the field, and there's a goalkeeper. The match lasts 60 minutes and it consists of two halves, each lasting 30 minutes. The specificity of this sport dictates that tall and massive players are preferred (Burdukiewicz et. al., 2016); however, there is variation among players in different positions (Sibila & Pori, 2009).

Volleyball matches are played in a sports hall on a hard and smooth surface. Two six-person teams take part in a match. The match is played in 3 sets, whereby each set is played to a minimum of 25 points, keeping an advantage of at least 2 points over the opposing team. Volleyball is mostly suitable for players characterised by a slender body physique and high body height (Pietraszewska et. al., 2016).

The issue of morphological diversity among athletes in various sports disciplines is not only cognitively, but also practically significant. It is of interest to both competitors and coaches. For example, the issue is relevant to the process of selecting appropriate players for particular sports disciplines. Furthermore, both players and coaches often face problems related to the change of a sports discipline. In such a situation, the knowledge of the physical construction of the player preferred in particular disciplines is crucial in the decision-making process. Being aware of similarities and differences in morphological characteristics may prevent later frustration. It is also important to note that at issue here is not just the question of individual somatic features. The similarities or differences between competitors in terms of e.g. only the body height do not give a full picture. It is necessary to make comparisons of the overall construction from a multidimensional perspective - taking into account several features at the same time. A human being is not a simple sum of individual features and properties, but a complex structure in which particular structural, functional and mental elements form complexes and interact. Therefore, it is complex and multidimensional phenomena which are the object of this research. Thus, in order to explore the actual nature of the problem posed, multidimensional methods should be used, such as: the multivariate analysis of variance (MANOVA), supplemented by the one-way analysis of variance (ANOVA) with detailed comparisons (LSD tests). Cluster analysis, which is a multidimensional exploration technique, can be used to assess the similarities between groups based on a set of morphological features.

Research aims

The aim of the research is to determine the degree of differentiation in the body physique of athletes from four team sports disciplines and to determine their similarities, using a multidimensional perspective.

Research questions

1. Are there any differences in the morphological structure between groups of players with regards to the basic morphological characteristics and body proportions, taken together?
2. If so, how strongly differentiated are individual features and what are the types of differences between players in particular sports disciplines?

3. Are there any (and, if so, of what kind) similarities in terms of morphological structure between players of the four team sports disciplines?

Materials and methods

125 male players between 14 and 19 years of age took part in the study. They represented 4 sports disciplines. The research was carried out in February 2017.

The mean age of the American football players (22 competitors) was 16.8 years. Their mean number of years in the profession was 1.5. They trained on average 4 times a week and played a match once a week. The studied players represented the Panthers Wrocław club in the Juniors age category.

The mean age of the football players (30 competitors) was 15.98 years. Their mean number of years in the profession was 8.5. They trained on average 6 times a week and played a match once a week. The studied players represented the Lechia Dzierżoniów and WKS Śląsk Wrocław clubs in the Younger Juniors age category.

The mean age of the handball players (49 competitors) was 16.06 years. Their mean number of years in the profession was 4.5. They trained 4 times a week and played a match once a week. The studied players represented clubs taking part in the Brick Cup tournament in Dzierżoniów in the Younger Juniors age category. The mean age of the volleyball players (24 competitors) was 16.2 years. Their mean number of years in the profession was 2.5. They trained approximately 3 times a week and played a match once a week. The studied players represented the OFM Bielawianka Bester Bielawa and AZS AWF Wrocław clubs in the Cadets age category.

In the first stage of the study, the participants filled out a short questionnaire. The participants were asked to give their name and date of birth, information related to their sports discipline: the type of their discipline, how long they have been training for, the frequency of their training sessions and their age category.

The second stage of the research concerned measuring body height, which was measured with a Swiss anthropometer, and body weight, which was measured using electronic scales. Based on the measurements obtained, the Body Mass Index (BMI) was calculated using the formula: body weight [kg]/body height[m]^2

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Methods of statistical analysis

Having tested the normality of distributions with the Shapiro-Wilk test, which revealed no grounds for rejecting the normal distribution hypothesis, basic statistical measures were calculated: means and standard deviations.

The multivariate analysis of variance (MANOVA) was used to compare the study groups for all analysed variables describing the body physique of athletes. Its main purpose is to maximally distinguish the compared groups by means of linear combinations of the dependent variables (Grice, Iwasaki 2007). The multivariate Wilks' Lambda tests (Λ) and the partial eta squared measure (η^2_p), which is the ratio of variance associated with an effect to the sum of that effect and its associated error, were used for interpretation. One-dimensional results were evaluated using the F-Snedecor test and the post-hoc comparisons with the LSD test (Least Significant Difference) (Stanisz 2007).

For all three analysed variables, the Mahalanobis distances between the analysed groups were calculated. The Mahalanobis distance is a measure of the distance between a point and the center of the distribution of all points in the space of independent variables (Dobosz 2001). It is used, among others, in classification procedures. It is a metric based on the inverse of the intercovariance matrix. These distances are represented by a dendrogram using Ward's method (Bartkowiak 1996).

In all statistical tests used, the p-values <0.05 are indicated in the tables in bold.

A statistical computer software package Statistica 13 (Statsoft Polska) was used in the statistical analyses. The calculations were made at the Biokinetics Laboratory of the University of Physical Education, which holds Quality Management System Certificate PN-EN ISO 9001:2009 (Reg. No: PW-48606-10E).

Results

Table 1 presents the statistical characteristics of somatic features and the Body Mass Index (BMI) values, in total and in groups of sports disciplines. The mean age of the studied group of all athletes (taken together) is 16.27 years. It is a fairly homogeneous group, as indicated by the standard deviation. The age of players in individual sports disciplines is similar and ranges from 15.97 (football players) to 16.8 (American football) (Table 1). The assessment of the

diversity of groups in terms of morphological features was based on multidimensional statistics.

Table 1. Statistical characteristics of age, morphological structure features and BMI index of all tested competitors and in sports-discipline subgroups.

Groupe	General		American football		Football		Handball		Volleyball	
Variable	mean	s	mean	s	mean	s	mean	s	mean	s
Age [lata]	16,27	0,85	16,80	1,04	15,97	0,52	16,06	0,69	16,24	1,05
Body height [cm]	179,91	7,46	177,31	6,32	177,9	7,11	180,65	7,23	183,29	8,11
Body mass [kg]	71,06	11,03	75,13	12,01	65,3	9,48	72,65	11,06	71,25	9,53
BMI [kg/m^2]	21,92	2,99	23,93	3,97	20,53	1,87	22,2	2,74	21,19	2,54

The multivariate analysis of variance showed a significant difference in the analysed variables (at almost 70%) between all studied groups. This is indicated by the calculated value of the Wilks' Lambda test (Λ). The effect size of the analysed factor (the type of sports discipline) on morphological structure, however, is small and amounts to about 13.5%. This is evidenced by the calculated eta squared value (η^2) (table 2). This means that the variation of all discussed parameters is influenced by other factors, not included in the study #2. The calculated effects are statistically significant.

Table 2. Evaluation of the multidimensional variation of the studied parameters.

Effect	Wilks' Lambda test (Λ)	F	df effect	df error	η^2 fragmentary	p
Constant term	0,000	834735,202	4	118,00	0,999	**0,000**
discipline	0,680	4,104	12	312,49	0,136	**0,000**

The F-Snedecor-Fisher test established that there is a strong (statistically significant) intergroup variation with respect to all discussed morphological variables (Table 3).

Table 3. Variation of morphological features in the categories of sports disciplines – F-Snedecor-Fisher tests (ANOVA).

Parameter	F	p
Body height	3,621	**0,014**
Body Mass	4,403	**0,005**
BMI	6,986	**0,002**

Detailed comparisons with LSD tests help identify the groups between which the variation of morphological features is the greatest.

On average, volleyball players were the tallest and they were slightly taller than handball players. There were no statistical differences between these groups. Football players had similar body height to American football players and both these groups had a statistically significantly smaller body height than the two previous groups (Table 4).

The highest average body weight level was reported for American football players, who were slightly heavier than handball and volleyball players. The differences were not statistically significant. However, football players turned out to be statistically significantly lighter than all other groups (Table 4).

The studied American football players had the highest rate of BMI. The differences between them and those training in the other disciplines were statistically significant. The BMI rates of handball players did not differ statistically from those of volleyball players, but they differed from the rates of footballer players, who had the lowest BMI (Table 4).

Table 4. Detailed comparisons of somatic features with LSD tests.

	Body height			Body mass			BMI		
Sport Discipline	Football	Handball	American Football	Football	Handball	American Football	Football	Handball	American Football
Volleyball	**0,007**	0,140	**0,006**	**0,042**	0,593	0,214	0,393	0,143	**0,001**
Football		0,103	0,772		**0,003**	**0,001**		**0,012**	**0,003**
Handball			0,071			0,364			**0,012**

The assessment of the similarities between groups of competitors from particular disciplines was carried out using cluster analysis. The Mahalanobis distances were calculated for the set of morphological variables. The agglomeration of groups was performed using Ward's method. Dendrograms illustrating similarities between the groups of adolescents were generated (Figure 1).

Reducing the matrix of Mahalanobis distance using the method of strongest linkage made it possible to order the obtained values. This enabled assessing the similarities between players from particular disciplines in terms of the morphological structure. The dendrogram generated on the basis of the calculations makes it easier to evaluate this ordering. The graphical representation of the Mahalanobis distance presented in Figure 1 illustrates the clearly visible cluster of most strongly linked teams of handball and volleyball players. The proximity of clusters indicates the strong morphological similarity between the competitors in these disciplines. The players of the two other disciplines differ significantly in morphological structure. The extent of this difference is evidenced by a four times greater distance of the cluster representing American football players and almost eight times greater distance of the cluster representing football players. The results indicate that there are distinct selection preferences in these sports disciplines.

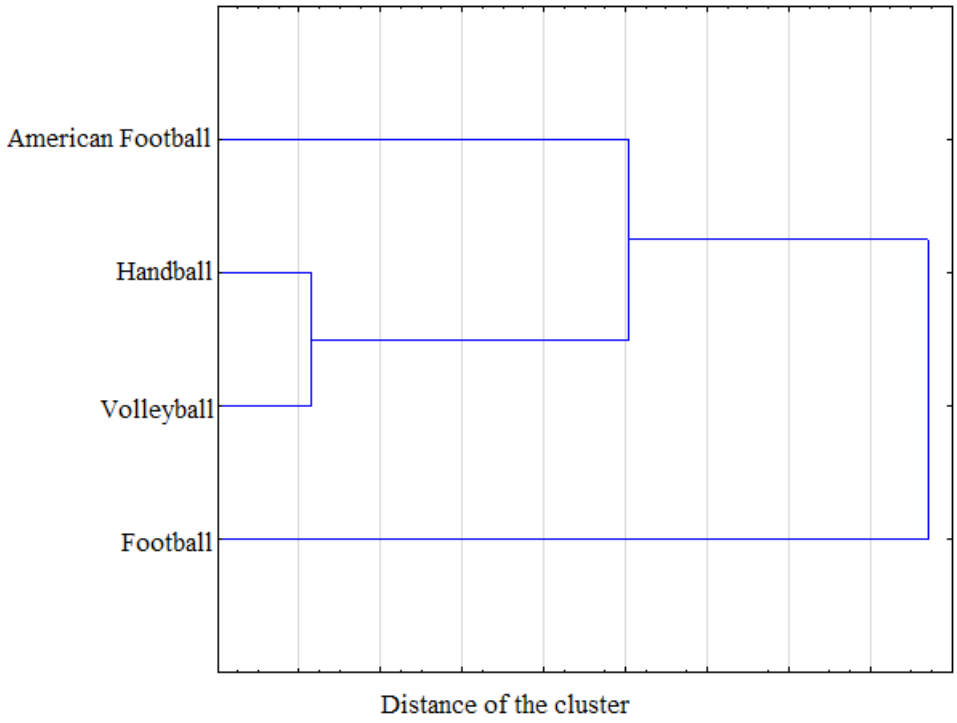

Figure 1. Dendrogram showing similarities and dissimilarities between sports disciplines based on both somatic features and BMI.

Discussion

There are many factors which influence sports success. Apart from the important factors such as talent and diligence of the player, innate physical, functional (motor) and psychological predispositions are also extremely important. Of course, the coach will also have an impact on the player's success. It is usually the coach who is the first link in the selection process for a given sport. Correct and accurate selection of players often depends on the coach's knowledge and selection skills.

Physical structure is the basic aspect of sports success in most sports disciplines. Almost every sports discipline has its morphological model of the player, which is usually the key selection criterion for the coach. Also from the competitor's perspective, the awareness of such a model makes it easier to choose the most suitable discipline. Knowledge about the morphological models preferred in various disciplines is extremely useful in case when it is necessary to change the discipline due to an injury or for other reasons. From the economic

point of view, it allows both the coach and the player to reduce costs in the event of wrong decisions and, from the social perspective, to avoid frustration.

Many studies have shown that body height is the basic criterion for choosing athletes in team games (Duncan et. al., 2006; Bozo et al. 2012). Basketball and volleyball players are considered the tallest (Sheppard et. al., 2013; Gaurav et. al., 2010). In my own studies, volleyball players were also the tallest group of players, far surpassing the others. American footbal players turned out to have the smallest body height. These athletes were also characterised by the highest relative body mass (BMI). This was expected and is in line with the observations made by other authors (Bilsborough et. al., 2015; Dengel et. al., 2013; Ghigiarelli, 2011). Some authors have observed that the high BMI of American football players is not due to high muscle tissue content, but a higher fat content, which indicates overweight and is a health risk factor (Harp & Hecht 2005; Laurson & Eisenmann 2007; Malina et al. 2007). In my future research, more attention should be paid to the body composition and other health indicators of Wrocław footballers. Football players had the smallest relative body mass. Football is an aerobic-anaerobic type of discipline. It is characterized by frequent accelerations, feints, changes in the direction of the run, jumps, but also a relatively smaller level of direct contact in comparison to the other analysed disciplines. That is why in this discipline, individuals with average height but proportionally lower weight are preferred (Bandyopadhyay, 2007).

Discussing similarities and differences from a multidimensional perspective is more difficult. Researchers embark on such analyses with the use of taxonomic methods much less often. Sporis et al. (2010) explain the greater general morphological differences and the preferrence for smaller body dimensions in footballers, as compared to the other disciplines, by the agility required in football (shorter and quicker feints, sudden and short accelerations, but lasting much longer throughout the entire game). In my research, the football players also turned out to be the most morphologically different from the other players. Handball and volleyball players were characterised by the most similar physical structure. Great homogeneity (determined by cluster analysis) of handball players, both within the discipline (positions on the pitch) and in comparison to other team disciplines, was also pointed out by Stankowic et al. (2009).

Conclusions

1. Each of the sports disciplines analysed in this paper prefers players with a completely different morphological structure. This is evidenced by the statistically significant multidimensional diversity.
2. However, the disciplines' selection criteria are not the only source of intergroup variation. The research should focus on other factors of morphological diversity, such as broadly understood living environment factors, or nutrition and supplementation in sport.
3. The preferred characteristics in particular disciplines include:
    a. American football: weight-height proportions, determined by the BMI index, higher compared to the other sports and closer to the upper limit of the norm,
    b. football: relatively low body weight in relation to body height, the lowest of all research participants,
    c. handball: the most balanced weight-height proportions which include players in the middle of the standard range,
    d. volleyball: relatively high body height, the highest of all study participants.
4. Handball and volleyball prefer players with similar morphological structures. American football players differ significantly in morphological structure from the players in the other two disciplines. Football players are the most different morphologically. The results point to the similarity of the selection criteria and similarity of the impact of handball and volleyball training on the players' morphological structure. Players in these disciplines have a different morphological profile from American football and football players.

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