THE DIFFERENCES IN MORPHOLOGICAL CHARACTERISTICS AMONG TOP HANDBALL, BASKETBALL AND FOOTBALL PLAYERS

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Abstract

The aim of the research is to apply the system of 25 variables of morphological characteristics and the differences among groups of sportsmen regarding the arithmetic mean of the variables so more objective and correct selection of sportsmen can be made during the training process and the training transformational process can be managed more efficiently; the research has been carried out on the sample of 158 top sportsmen of male gender (51 handball players, 51 basketball players and 56 footballers). The processing of data by statistical method of multivariate and univariate analysis of variance (MANOVA/ANOVA) has shown that there is a considerable difference in the arithmetic means (p= 00) among handball players, basketball players and footballers in the whole system (multivariate) of the applied morphological variables. By analyzing univariate values according to groups of latent variables, the results have shown that the basketball players have the highest values of the variables of longitudinal and transversal dimension of the skeleton; the handball players are characterized by the highest value of the mass and voluminosity of the body as well as of the panniculus adiposus, whereas the footballers show the lower values than handball and basketball players. On the basis of the obtained multivariate and univariate statistically important parameters of the differences in the arithmetic means of all applied manifested variables, it can be concluded that there are various morphological structures of the sportsmen according to the sports. The special attention during selection should be paid to the basketball players because they have increased values of morphological characteristics of longitudinal and transversal dimension of the skeleton where we can find gene limits, whereas in case of handball players and footballers there is the possibility of transformation regarding morphological characteristics.

Key words: *handball, basketball, football, morphological characteristics, MANOVA/ANOVA, differences*

Introduction

Within the training technology, it is considered that research on the morphological status of sportsmen in top sport practice as well as determining the differences of morphological characteristics among sportsmen in various sports is of high importance, observing it, on the one hand, from the perspective of selecting young people (Ifrim, 1984; Schwartz, 1984; Stanković, 2000), and on the other hand, from the aspect of their transformation (Wolansky, 1984; Stanković, 2001), because it is known that morphological characteristics are mainly under the influence of gene factors (endogen influence) and the factors of the environment (exogen influence); however, it must be taken into consideration that the influence of gene factors is not the same for all latent morphological dimensions (Wolansky, 1971; Nikitjuk, 1986). Heritability estimates (H^2), according to Holtzinger index (Holtzinger, 1929), is .98 (H^2=.98) for dimension of the skeleton, for the voluminosity of the body it is .90 (H^2=.90), and for panniculus adiposus it is .50 (H^2=.50).

Therefore, the biggest transformation under the influence of exogen factors (the process of sports training and diet) is possible in case of panniculus adiposis, then in case of the mass and voluminosity of the body; however, as far as dimension of the skeleton is concerned, that transformation is without significance (Malacko & Rađo, 2004). However, the most significant factor for the success in sport is skeleton musculature, which is considered to be the basis of motor abilities.

Examining the structure of skeleton muscles has shown that the structure of motor unit is under the strong gene influence. The information on the composition of myofibrils and enzyme muscular activities prove that the training cannot change the number of myofibrils significantly; it means that people with less myofibrils in certain types of muscles, notwithstanding the intensity of training, stay in the same (not favourable) position in comparison with the people with more myofibrils (Malacko & Doder, 2008).

The aim of the research

The aim of the research is determining statistically significant differences among top handball players, basketball players and footballers in Serbia, so more objective and correct selection of sportsmen can be made during the training process and the training transformational process can be managed more efficiently by analyzing the models of constitutive types of sportsmen, and their morphological characteristics can be diagnosed, changed and controlled, especially about those where there are no genetic limits.

Methods

The system of 25 variables of morphological characteristics was applied on the sample of 158 sportsmen of the top level of Serbia (51 handball players, 51 basketball players, and 56 footballers) of the male gender, aged between 18 and 30 years, who actively participate in the training process and competitions. For the purposes of estimating morphological characteristics the following variables have been applied: *longitudinal dimension of the skeleton*: 1. HEIGBO – the height of the body, 2. SPAARM – span of the arms, 3. LENLEG – the length of the leg, 4. LENLFO – the length of the foot 5. LENARM – the length of the arms, 6. LENHAN – the length of the hand, *transversal dimension of the skeleton*: 7. PLPAHA – planimetric parameter of the hand 8. BIABRE – biacromial breadth, 9. BICBRE – bicrystal breadth, 10. DIAELB – diameter of the elbow, 11. DIAWRI – diameter of the wrist, 12. DIAKNE – diameter of the knee, 13. DIAANK – diameter of the ankle, *circular dimension and mass of the body*: 14. MASBOD – mass of the body, 15. PECHES – perimeter of the chest, PEUPAR – perimeter of the upper arm, 16. PEUNAR – perimeter of the underarm, 17. PEUPLE – perimeter of the upper leg, 18. PESHAN – perimeter of the shank, 19. panniculus adiposus: 20. SKCRUA – skin creases of the upper arm, 21. SKCRBA – skin creases of the back, 22. SKCRBE – skin creases of the belly 23. SKCRAR – skin creases of the armpit, 24. SKCRUL – skin creases of the upper leg, 25. SKCRSH – skin creases of the shank. All above-mentioned variables are measured according to the methods of International Biological Program (IBP). For the purposes of determining the differences in arithmetic means of the applied variables among handball players, basketball players and footballers, statistical method of multivariate and univariate analysis of variance (MANOVA/ANOVA) has been applied. The multivariate test of null-hypothesis that the centroids of groups are equal to the common centroid (GENERAL MANOVA) is made by Wilks' Lambda-test and F-test, and then their statistical significance (p) is tested. The univariate statistical significance (p) between arithmetic means of the groups (Mr ↔ Mk ↔ Mf) according to variables was calculated by F-test.

*The differences in arithmetic means of variables among handball players (**M_h**), basketball players (**M_b**) and footballers (**M_f**) and their statistical significance (**p**)*

Variables	M_h	M_b	M_f	F	p
HEIGBO	1867.64^{2}	1942.70^{1}	1804.44^{3}	63.78	**.00***
SPAARM	1931.35^{2}	1990.15^{1}	1853.00^{3}	47.30	**.00***
LENLEG	1074.51^{2}	1120.15^{1}	1013.92^{3}	70.35	**.00***
LENLEFO	272.43^{2}	289.68^{1}	269.96^{3}	27.87	**.00***
LENARM	837.60^{2}	858.76^{1}	808.25^{3}	28.47	**.00***
LENHAN	202.49^{2}	206.52^{1}	197.14^{3}	10.14	**.00***
PLPAHA	232.76^{1}	230.80^{2}	218.32^{3}	22.26	**.00***
BIABRE	404.98^{2}	421.84^{1}	381.10^{3}	49.35	**.00***
BICBRE	288.47^{2}	291.70^{1}	269.98^{3}	18.18	**.00***
DIAELB	72.72^{2}	77.03^{1}	68.05^{3}	29.36	**.00***
DIAWRI	58.47^{2}	59.58^{1}	56.26^{3}	12.34	**.00***
DIAKNE	103.92^{2}	104.09^{1}	97.37^{3}	24.30	**.00***
DIAANK	75.49^{2}	75.52^{1}	72.87^{3}	4.68	**.01***
MASBOD	89.03^{1}	88.03^{2}	76.57^{3}	34.15	**.00***
PECHES	1026.09^{1}	1008.29^{2}	930.10^{3}	46.40	**.00***
PEUPAR	314.45^{1}	303.54^{2}	285.25^{3}	22.52	**.00***
PEUNAR	269.21^{1}	261.13^{2}	250.94^{3}	17.95	**.00***
PEUPLE	590.92^{1}	588.64^{2}	566.35^{3}	7.80	**.00***
PESHAN	396.50^{1}	390.92^{2}	384.37^{3}	3.98	**.02***
SKCRUA	9.54^{1}	8.58^{2}	6.57^{3}	14.37	**.00***
SKCRBA	12.86^{1}	9.43^{2}	8.83^{3}	18.96	**.00***
SKCRBE	15.60^{1}	10.45^{2}	9.42^{3}	20.59	**.00***
SKCRAR	12.13^{1}	7.19^{2}	6.76^{3}	30.60	**.00***
SKCRUL	14.41^{1}	11.15^{2}	8.39^{3}	24.68	**.00***
SKCRSH	13.52^{1}	10.96^{2}	8.46^{3}	21.18	**.00***

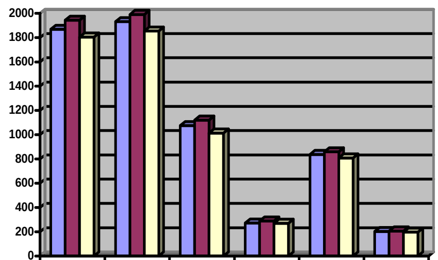
Wilks lambda = .15 **F** = 8.16 **p** = **.00***

M_h – handball players, **M_b –** basketball players, **M_f -** footballers, **F** - test, **p** –statistical significance, $^{1,\ 2,\ 3,}$ - the order of variables according to value hierarchy

Variables:
HEIGBO – the height of the body, **SPAARM** – span of the arms, **LENLEG** – the length of the leg, **LENLFO** – the length of the foot, **LENARM** – the length of the arms, **LENHAN** – the length of the hand, **PLPAHA** – planimetric parameter of the hand, **BIABRE** – biacromial breadth, **BICBRE** – bicrystal breadth, **DIAELB** – diameter of the elbow, **DIAWRI** – diameter of the wrist, **DIAKNE** – diameter of the knee, **DIAANK** – diameter of the ankle, **MASBOD** – mass of the body, **PECHES** – perimeter of the chest, **PEUPAR** – perimeter of the upper arm, **PEUNAR** – perimeter of the underarm, **PEUPLE** – perimeter of the upper leg, **PESHAN** – perimeter of the shank, **SKCRUA** – skin creases of the upper arm, **SKCRBA** – skin creases of the back, **SKCRBE** – skin creases of the belly **SKCRAR** – skin creases of the armpit, **SKCRUL** – skin creases of the upper leg, **SKCRSH** – skin creases of the shank.

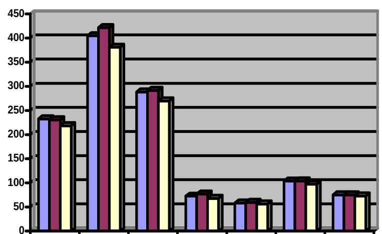
Results

The calculated statistical values given in the following numerical chart, it can be seen clearly that there is a statistically significant difference in arithmetic means (p=00) among handball players, basketball players and footballers in the whole system of (multivariate) applied 25 morphological variables. By analyzing Graph 1, where the univariate values of arithmetic means in variables of longitudinal dimension of the skeleton are shown (**HEIGBO** – the height of the body, **SPAARM** – span of the arms, **LENLEG** – the length of the leg, **LENLFO** – the length of the foot, **LENARM** – the length of the arms, **LENHAN** – the length of the hand), it can be seen that basketball players (in the table marked with [1]) have the highest values, followed by handball players (in the table marked with [2]) and footballers (in the table marked with [3]).



	HEIGBO	SPAARM	LENLEG	LENLFO	LENARM	LENHAN
handball	1867.64	1931.35	1074.51	272.43	837.6	202.49
basketball	1942.7	1990.15	1120.15	289.68	858.76	206.52
football	1804.44	1853	1013.92	269.96	808.25	197.14

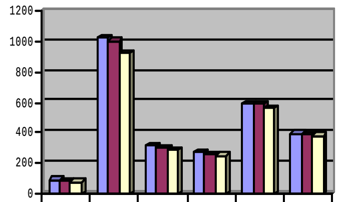
Graph 1. Longitudinal skeletal dimension



	PLPAHA	BIABRE	BICBRE	DIAELB	DIAWRI	DIAKNE	DIAANK
handball	232.8	405	288.5	72.72	58.47	103.9	75.49
basketball	230.8	421.8	291.7	77.03	59.58	104.1	75.52
football	218.3	381.1	270	68.05	56.26	97.37	72.87

Graph 2. Transversal skeletal dimension

According to Graph 2, where the univariate values of arithmetic means in variables of transversal dimension of the skeleton (**PLPAHA** – planimetric parameter of the hand, **BIABRE** – biacromial breadth, **BICBRE** – bicrystal breadth, **DIAELB** – diameter of the elbow, **DIAWRI** – diameter of the wrist, **DIAKNE** – diameter of the knee, **DIAANK** – diameter of the ankle), the basketball players, except for variables of planimetric parameter of the hand, also have higher values than handball players and footballers.

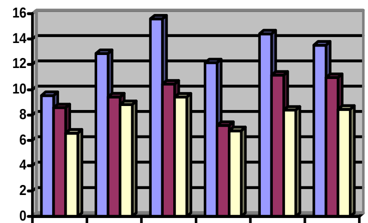


	MASBOD	PECHES	PEUPAR	PEUNAR	PEUPLE	PESHAN
handball	89.03	1026.1	314.45	269.21	590.92	396.5
basketball	88.03	1008.3	303.54	261.13	588.64	390.92
futball	76.57	930.1	285.25	250.94	566.35	384.37

Graph 3. Voluminosity and body mass

In contrast to the longitudinal and transversal dimension of the skeleton, in Graph 3, where the variables of arithmetic means and voluminosity of the body are shown (**MASBOD** – mass of the body, **PECHES** – perimeter of the chest, **PEUPAR** – perimeter of the upper arm, **PEUNAR** – perimeter of the underarm, **PEUPLE** – perimeter of the upper leg, **PESHAN** – perimeter of the shank,), it can be seen that the handball players have the highest values, followed by basketball players and footballers.

As far as variables of the panniculus adiposus is concerned (**SKCRUA** – skin creases of the upper arm, **SKCRBA** – skin creases of the back, **SKCRBE** – skin creases of the belly **SKCRAR** – skin creases of the armpit, **SKCRUL** – skin creases of the upper leg, **SKCRSH** – skin creases of the shank), the handball players have higher values than basketball players and footballers (Graph 4).



	SKCRUA	SKCRBA	SKCRBE	SKCRAR	SKCRUL	SKCRSH
handball	9.54	12.86	15.6	12.13	14.41	13.52
basketball	8.58	9.43	10.45	7.19	11.15	10.96
football	6.57	8.83	9.42	6.76	8.39	8.46

Graph 4. Panniculus adiposus

Discussion and conclusion

The main objective of the research has been determining statistically significant differences in arithmetic means of particular morphological variables among top handball players, basketball players and footballers so more objective and correct selection of sportsmen can be made during the training process and the training transformational process can be managed more efficiently presuming that the whole system of applied morphological variables equally contributes to making differences among groups since most morphological variables is under genetic control. The obtained results have confirmed these expectations because there is a statistically significant differences between arithmetic means (p=.00) among handball players, basketball players and footballers in the whole system of 25 (multivariate) applied morphological variables. It has been confirmed that basketball players have dominant values regarding longitudinal and transversal dimension of the skeleton, that is to say, hard tissue even at the initial selection of children special attention should be paid during the training process to this morphological composition, and, bearing in mind genetically limited morphological characteristics, more attention should be paid to as optimal transformation of soft tissue (voluminosity of the body and panniculus adiposus) as possible.

Here, it is important to emphasize that voluminosity also means larger muscular mass because it influences motoric and functional efficiency, whereas the sportsmen who have more panniculus adiposus suffer from problems with motor manifestations of any type. The basketball players have dominant hard tissue manifested by summing longitudinal and transversal dimension into unique dimension of the skeleton; on the other hand, the handball players have increased values of soft tissue defined by muscular mass and panniculus adiposus.

Regarding this, it is known in professional and scientific bibliography that the volume of muscles has direct influence on the ability of making muscles stronger so more or less efficient movement, overcoming resistance or obstacles is defined. Although panniculus adiposus in motor manifestation of sportsmen represents balanced mass, it is very important not to neglect the need for optimal amount of panniculus adiposus since it consists of fat acids necessary in human organism for functioning of various chemical processes, and for creating some tissue and energy production. In contrast to handball and basketball players, for footballers there is an expected reduced value in all morphological dimensions of skeleton, mass and volume of the body and panniculus adiposus since the sport requires more harmonious morphological composition and interactive manifestations with motor and functional abilities. Within training procedures of transforming soft tissue (increasing muscular mass and reduction of panniculus adiposus), it is strictly necessary to pay attention to developing active muscular mass by continuous use of muscular cells and adequate diet due to the fact that large muscular mass has a large energy consumption.

Then it must be emphasized that fat acids, as part of panniculus tissue, may be used by lower working intensity because they can be ‘burned’ only in aerobic conditions of training pressure if it lasts long enough. It means that during process it is needed to optimize the muscular system for working, and thus the total motor efficiency will increase.

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RAZLIKE U MORFOLOŠKIM ZNAČAJKAMA MEĐU VRHUNSKIM RUKOMETAŠIMA, KOŠARKAŠIMA I NOGOMETAŠIMA

Sažetak

Cilj istraživanja je da se na uzorku 158 vrhunskih sportaša muškog spola (51 rukometaš, 51 košarkaš, 56 nogometaša), uzrasta od 18 do 30 godina, primjeni sustav od 25 varijabli morfoloških značajki i utvrde razlike između grupa sportaša u aritmetičkih sredinama varijabli, kako bi se tijekom trenažnog procesa na pravovaljaniji i objektivniji način mogla vršiti selekcija sportaša i učinkovitije upravljati trenažnim transformacijskim procesima. Obradom podataka pomoću statističke metode multivarijantne i univarijantne analize varijance (MANOVA/ANOVA), rezultati su pokazali da između rukometaša, košarkaša i nogometaša u cijelom sustavu (multivarijantno) primjenjenih morfoloških varijabli postoji statistički značajna razlika aritmetičkih sredina (p= 00). Analizom univarijantnih vrijednosti po grupama dobiveni rezultati su pokazali da košarkaši posjeduju najveće vrijednosti u varijablama longitudinalne i transverzalne dimenzionalnosti skeleta, rukometaši u masi i voluminoznosti tijela i potkožnom masnom tkivu, dok nogometaši pokazuju niže vrijednosti i od rukometaša i od košarkaša. Na temelju dobivenih multivarijantnih i univarijantnih statistički značajnih parametara razlika u aritmetičkim sredinama svih primjenjenih varijabli može se zaključiti da se radi o različitim morfološkim strukturama sportaša po sportovima. Najveću pozornost pri selekciji potrebno je obratiti kod košarkaša, jer oni posjeduju povećane vrijednosti u morfološkim osobinama longitudinalne i trasverzalne dimenzionalnosti skeleta kod kojih postoje genetska ograničenja, dok kod rukometaša i nogometaša u morfološkim značajkama postoji mogućnost vršenja određenih transformacija.

Ključne reči: *rukometaši, košarkaši, nogometaši, morfološke značajke, MANOVA/ANOVA, razlike*

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