

## DISCRIMINATIVE ANALYSIS OF MORPHOLOGICAL VARIABLES BETWEEN TWO BASKETBALL CATEGORIES (CADETS AND SENIORS)

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### Abstract

Main goal of the empiric research is to identify significant differences between the two groups of examinees in morphologic space. At the representative sample of  $N=75$  examinees of basketball players and subspecimen of junior players aged 15 to 16 and seniors older than 21 we have measured 16 anthropometric variables according to the standards of International Biologic program. The data were processed by multivariate method of discriminative canonic analysis which differentiated statistically significant quantitative differences between the categories of players. ( $W\lambda = .824$ ;  $p < .05$ ;  $\chi^2 = 148.87 > df = 13.277$ ). Obtained values of the coefficient of canonic correlation as well as 64.53% of the proportion of mutual variance of the system of analyzed variables define quantitative inequalities between the groups. Variables with highest orthogonal projection at bipolar structure of extracted discriminative function that mostly contributed to the differentiation of examined groups are: upper arm skinfold, forearm skinfold and chest skinfold. According to the univariant values of important canonic pressures of component variables, extracted discriminative factor is hypothetically interpreted as subcutaneous fat. Manifest distance between the centroids of the groups at discriminative function, i.e. their projection in space limited with the vectors of analyzed variables, showed that juniors have positive relation with isolated anthropometric discriminative, whereas seniors have negative relation with it, i.e. that seniors have less percent of fat in comparison to the values of the skinfold of juniors.

**Key words:** discriminative canonic analysis, centroids, morphological variables, juniors, seniors

### Introduction

Various cyclic and acyclic movements and extremely explosive and fast actions are primary characteristics of basketball game and as such they require high level of player's morphological functional and intellectual skills. Complexity of a game, from a basketball player requires readiness and ability to successfully complete motor tasks in an optimum time and intensity. The main criterion for successful realization of such requirements is adequate player's constitution, which, influenced by different factors, can be aimed in a positive and negative direction. It is familiar that most of anthropometric dimensions are more or less hereditary. However, it is also well known that systematic and professionally organized training processes have relevant impact on some latent morphological dimensions of sportsmen.

Therefore, anthropometric basketball player's characteristics present biomechanical basics of movement realization which determines the speed with and without the ball, body movement in space and maintaining default body position. Morphological dimensions are the basics for active and intensive training, successful programming and training process prediction of basketball players. Previous kinesiology research determined that morphological space arrangement of basketball players is complex and it was not resolved appropriately.

Moreover, there are only a few empiric researches and theories about anthropometric variable quantity differences between different basketball categories. According available literature in previous research it was concluded there are statistically significant differences in anthropometric variables between different groups of sportsmen, in other words they vary in morphological dimensions (Kurelić, Momirović, Stojanović, Šturm, Radojević & Viskiće-Štalec, 1975; Ružić, 2004; Sertić, Đapić & Baić, 2004; Mikulić, Sporiš, Tomić & Ujević, 2004; Vučetić, Matković & Oreb, 2005; Ivanović, 2009).

Therefore, it is necessary to identify significant coefficients of canonical correlation and common variance in the system of anthropometric characteristics between the categories of basketball players of different age. That is a basis for defining the quantitative difference between competing selections. Unfortunately, the anthropometric measuring of basketball players was not conducted nor we formed scientific data base of its results in our country. According to the main issue of the research and literature review, the primary goal in this research was determined and directed toward determining of statistical significance and quantity differences in a cluster of 16 anthropometric variables between analyzed groups of basketball players (cadets and seniors).

According to the problem, goal and methodological approach in this work we started with null hypotheses ( $H_0$ ) regarding which there is no statistically significant quantitative difference in anthropometric variable discriminative function between the two basketball player categories: cadets and seniors.

## Methods

### Sample of examinees

The sample in this quantitative research makes  $N=75$  male examinees as follows: 56 basketball players (cadets), age 15 to 16 and 19 basketball players (senior), age above 21. Examinees were basketball players from club "Metalac" in Valjevo "Svislajon" league. The selection of representative sample was made in January 2009. All measured respondents were clinically healthy with no physical deviation from typical and no damage to the musculoskeletal system.

### Sample of anthropometric variables

According to International biological program (IBP), sample of anthropometric measures in this work was cluster of 16 measures: 1. body mass – TELMAS (kg), 2. body height – TELVIS (mm), 3. upper arm skinfold (*m. triceps*) – NABNAD (mm), 4. forearm skinfold – NABPOD (mm), 5. chest skinfold – NABGRU (mm), 6. abdominal skinfold (*suprailiac crystal skinfold*) – NABTRB (mm), 7. upper leg skinfold – NABNAT (mm), 8. lower leg skinfold – NABPOT (mm), 9. upper arm circumference – OBINAD (mm), 10. forearm circumference – OBIPOD (mm), 11. upper leg circumference – OBINAT (mm), 12. lower leg circumference – OBIPOT (mm), 13. elbow diameter (*biconylar upper arm width*) – DIJLAK (mm), 14. arm diameter – DIJRUC (mm), 15. knee diameter (*bicondylar diameter*) – DIJKOL (mm), 16. ankle diameter – DIJSZG (mm). Protocol of anthropometric measuring was conducted by the same examiner at the same time of the day with the same instruments (anthropometer, altimeter, medical scale, centimeter strip, sliding caliper and caliper).

### Statistical data processing

Determining significant quantity differences in anthropometric space between two respondent groups and gaining reliable information about morphological characteristics and their relations was realized by classical multivariate method canonical discriminative analysis (statistical package, SPSS, 6.0). First, applying Bartlett's Hi-quadrant test ( $\chi^2$ ) and Wilks lambda test ( $W\lambda$ ), we determined significance of discriminative function, calculated canonic correlation coefficient value and estimated variance percentage of analyzed system of variables. After that, we calculated linear correlations of individual manifest variables with extracted discriminative factor.

Finally, for each group of respondents we determined centroid (common arithmetic mean) at isolated discriminative function in the domain of applied variables. During testing of null hypothesis ( $H_0$ ) we apply critical value  $p$ , which presents the risk of statistical conclusion. If the beginning of significance is  $p < 0,5m$  then there is more evidence against this assumption. In other words a null hypothesis is being rejected with reliability of 95% and the differences between the groups are considered statistically significant on the level of second order error.

## Results and discussion

In order to distinguish the groups of respondents, according to anthropometric variables, we applied canonic discriminative analysis. The main goal of this multivariate method is to extract significant discriminative function, which totally enables maximal differentiation of respondent groups. The results in this empiric research are presented in words and in table. Applying multivariate technique in morphological domain of variables based on the sample of two respondents clusters, in table 1 we isolated discriminative function which statistically treats two separate groups of respondents in anthropometric variable domain (canonic correlation .79, Wilks's lambda test .594, Bartlett's Hi quadrant test of significance 68.145,  $p=.05$ ).

Table 1: Characteristic values, canonical correlations and significance testing of discriminative function

root	$\lambda$	$\lambda \%$	$W\lambda$	R	Hi-2	df	p
1	25.83	64.53	.82	.79	68.15	4	.05

$\lambda$  – characteristic root or value,  $\lambda \%$  – percentage of described inner group variance  $W\lambda$  – Wilks's lambda test, R – canonic correlation coefficient,  $\chi^2$  – Bartlett's Hi-Quadrant test, df – level of difference between groups in degrees and p value – level of statistical significance (proportion of possible error in statistical conclusion while accepting null hypothesis about nonexistence of quantity differences between the groups).

Value of characteristic root or value ( $\lambda = 25.834$ ) and canonic correlation coefficient was determined through Bartlett's Hi-quadrant significance test. Examining the table, we noted there is one statistically significant discriminative function on the level of statistical estimation  $p=.05$ , with high positive canonic correlation coefficient value ( $R=.79$ ), with proportion of first order error possibility 5% for differences in groups of respondents. This isolated discriminative factor takes 64, 53% proportion of analyzed anthropometric variable common variance system what is the biggest defining factor of quantitative group differences.

Examining the table of limit  $\chi^2$  values distribution, we noted high level of Bartlett's Hi-Quadrant value calculated is bigger than limit value, with 4 degrees of option ( $\chi^2=148.87>df=13.277$ ). With above mentioned, we can conclude that null hypothesis (H0), about existence of significant differences in anthropometric variable domain in this work was rejected, which justifies performance of adequate discriminative functions. Discriminative strength of the variables, or its canonical loading, are presented according to the values of Wilks's lambda significance test that indicates maximal differences between respondent groups (cadets and seniors) can be described with one rooted discriminative function ( $W\lambda = .824$ ).

Table 2: Standard correlation structure coefficients of discriminative function

Variables	S
Body mass	-.18
Body height	.33
Upper arm skinfold	-.42
Forearm skinfold	-.32
Chest skinfold	-.35
Abdominal skinfold	-.09
Upper leg skinfold	-.15
Lower leg skinfold	-.18
Upper arm circumference	-.14
Forearm circumference	-.24
Upper leg circumference	-.11
Lower leg circumference	-.15
Elbow diameter	.08
Arm diameter	-.14
Knee diameter	.16
Ankle diameter	.18

S = structure of discriminative function

In table 3 we presented summary structure abstract of applied anthropometric variables in forming significant discriminative function. According to system of 16 variables in morphological domain and obtained parameters of statistical significance, in matrix we isolated one statistically significant bipolar structure of discriminative function (DF) which draws attention toward contribution of some anthropometric measures in defining isolated discriminative factor.

Obtained values of standard correlation coefficients, similar to partial regression coefficients, emphasize the relative importance of orthogonal projection of each component variable at rooted discriminative function. Observing structure matrix it is visible that ratio of standard coefficients rates from .07 to .41. It is also obvious that out of 16 morphological measures, only 3 have statistically significant correlations, in other words represent significant predictors with favorable effective discriminative power.

Statistically significant partial contribution to analyzed groups differentiation is conditioned only with negative sign of 3 component variables as follows: upper arm skinfold (*m. triceps*, NABNAD=-.41), forearm skinfold (NABPOD=.31) and chest skinfold (NABGRU=.35). Therefore, calculated high univariant standardized values of these discriminative ponders, in other words their relevant canonical saturation have dominant strength in discriminative function. They are also the basics in describing quantity differences between the groups of respondents and as such make reliable discriminator of latent morphological space between these two groups of basketball players. According to component variables of skinfold on negative pole in structure matrix, the rooted discriminative function can hypothetically be interpreted as SUBCUTANEOUS FATT TISSUE. According to Malacko (2000), configuration of this anthropometric discriminate is defined with total amount of subcutaneous body fat that has relatively minimal genetic condition ( $H^2=.50$ ). It is also important to say that extra fat tissue in cadets have negative impact on basketball results since its slowing their movement. On the other hand, regarding criteria for defining canonical discriminative function, values and standard correlation coefficients of other anthropometric component variables (on negative and positive pole) they have minimal orthogonal projections in defining isolated discriminative factor, in other words they have no significant statistical impact on maximal differentiation of anthropometric characteristics in analyzed respondent groups. Therefore, the distribution of average results in most of anthropometric characteristics of basketball players suggests discriminative generator of morphological space, which is not too significant.

Table 3: Centroids and percentile group of discriminative factor

GROUP	CENTROIDS
cadets	2.719
seniors	-3.084

percent (total) = 66.18

During further discriminative analysis, we presented group centroid values in statistically significant discriminative function, in other words maximal distance between these two respondent groups, based on arithmetic mean vector of anthropometric measures results (table 3). Obtained data about relative size and position of centroids (mean) in discriminative domain rates from 2.719 to -3.084. The difference value of rooted discriminative factor of centroid emphasize that the two analyzed clusters (cadets and senior) are significantly separated (move away) on positive and negative pole of discriminative function which was reversely scaled.

According to the cadets group results where positive pole (sign) of centroids is away from the origin in .2.719 of standard units and directed toward bigger values of orthogonal projection, we can conclude that cadets have tendency toward bigger values in latent dimension of subcutaneous fat tissue, while seniors, with sign minus are  $-3.084$  of standard units directed toward lower values of orthogonal projection or in other words have tendency toward lower values in latent dimension of subcutaneous fat tissue on isolated anthropometric discriminate.

Insight in centroid projections, in a domain limited with anthropometric variable vectors, clearly confirms that the best defined discriminative factor is structured of component skinfold variables. So cadets have bigger and seniors have smaller values of subcutaneous fat tissue. Success of discrimination between analyzed groups presents calculated percentile of the groups that presents their middle values as z-values and actually emphasize the distance between respondents in analyzed domain of anthropometric variables (table 3).

Calculated parameter indicates that the distribution of quantity differences between the groups equals 71 percentile, or that the interpretation of the uneven results of measurements realized with the probability of accuracy of 66.18%. This means according to included variables and discriminative analysis with 2/3 of basketball players it is possible to predict the discriminate of certain applied variables in morphological domain.

### Conclusion

The sample of 75 male respondents was divided in two subspecimens: cadets (N=56) and seniors (N=19) where we applied system of 16 anthropometric variables. Adding obtained results of discriminative canonical analysis in this empiric research the following conclusions were established: 1. Obtained findings indicate there are statistically significant quantitative differences in anthropometric variable cluster between analyzed groups of basketball player's cadets and seniors;

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2. Significant and high value of canonical correlation coefficient is approximately 2/3 of described common variance proportion and indicates important proportion incompatibility between analyzed anthropometric variables of analyzed respondent groups; 3. Statistically significant partial contribution of cadets and seniors group differentiation result with standard correlation coefficient i.e. relevant canonical saturation of 3 applied variables as follows: upper arm skinfold (*m. triceps*), forearm skinfold and chest skinfold. Their orthogonal projections enabled for a latent dimension to be described (hypothetically) as discriminative function – subcutaneous fat tissue. Distribution of remained anthropometric component variables average results with their small or irrelevant orthogonal projections does not present representative discriminative generator in morphological domain; 4. Obtained values of visible distance between centroids of opposite ends of analyzed groups on statistically discriminative function indicate that cadets are in positive and seniors are in negative relations with isolated anthropometric discriminate. This means, according to projections of centroids in domain bounded with anthropometric variable vectors, with senior we have manifestation of minimal ectomorphic component because of a small amount of subcutaneous fat tissue, comparing with cadets who have bigger percentage of skinfold.

According to obtained results in this work, null hypothesis (H0) is rejected with allowed error possibility ( $p < .05$ ), about nonexistence of statistically significant quantitative differences in discriminative function of anthropometric variables between the two basketball player's category. Obtained results in this research influence optimal development of basketball player's morphological characteristics. However, regarding the fact that quantity differences problem in morphological domain is not completely identified, we have to conduct similar longitude kinesiology research to determine criteria according which we can constantly evaluate obtained findings as well as successfully program development and transformation of basketball player's anthropometric dimensions.

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## DISKRIMINATIVNA ANALIZA MORFOLOŠKIH VARIJABLI DVIJU KATEGORIJA KOŠARKAŠA (KADETA I SENIORI)

### Sažetak

Cilj ovog empirijskog istraživanja jeste identifikacija značajnih razlika u morfološkom prostoru između dvije grupe ispitanika. Na reprezentativnom uzorku iz populacije košarkaša ( $N=75$ ), subuzorcima kadeta uzrasta 15–16 godina i seniora uzrasta iznad 21 godine, izmjereno je 16 morfoloških varijabli prema standardima Internacionalnog biološkog programa. Podaci su obrađeni multivarijantnom metodom diskriminativne kanoničke analize, koja je diferencirala statistički značajne kvantitativne razlike između kategorija igrača ( $W\lambda = .824$ ;  $p < .05$ ;  $\chi^2 = 148.87 > df = 13.277$ ). Dobivena visoka vrijednost koeficijenta kanoničke korelacije, kao i 64,53% proporcije zajedničke varijance sustava analiziranih varijabli, definiraju kvantitativne nejednakosti između grupa. Primjenjene varijable koje su imale najveću projekciju na bipolarnu strukturu ekstrahirane diskriminativne funkcije, a samim tim i najviše doprinosile diferencijaciji ispitivanih grupa su: kožni nabor nadlaktice, kožni nabor podlaktice i kožni nabor grudí. Na temelju univarijantnih vrijednosti znatnih kanoničkih opterećenja komponentnih varijabli, izolirani diskriminativni faktor hipotetički je interpretiran kao potkožno masno tkivo. Manifestna udaljenost centroida grupa na diskriminativnoj funkciji, tj. njihove projekcije u prostoru omeđenom vektorima analiziranih varijabli, ukazala je na to da su kadeti u pozitivnoj, a seniori u negativnoj relaciji sa izoliranom antropometrijskom diskriminantom, odnosno da seniori imaju manji postotak masnog tkiva u odnosu na vrijednosti kožnih nabora kadeta.

**Ključne riječi:** diskriminativna kanonička analiza, centroidi, morfološke varijable, kadeti, seniori

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