Antropometric Characteristics Structure of "VC Jahorina" Pale Volleyball Players

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Abstract **Background:** Morphological dimensions represent the functioning of the growth and development of the musculoskeletal system and also play a role in specific volleyball activities. In the sphere of volleyball, it is imperative to identify the anthropometric constitution, generated by exogenous and endogenous factors. **Aim study**: The main goal of the research was to determine the factor structure of isolated latent dimensions of the population of female volleyball players of VC "Jahorina" Pale, a member of the volleyball Premier League of Bosnia and Herzegovina. **Methods:** The study involved 18 active players of the women's volleyball club Jahorina (BH=173±8.77cm; BW=66.04±9.09kg; BMI=22.03±2.19kg/m2, age=19.11±2.63 years old) members of the volleyball Premier League of Bosnia and Herzegovina. A set of 15 anthropometric variables was measured in the morphological space with the aim of determining correlations between anthropometric characteristics and identifying the latent morphological structure of volleyball players. **Result:** Statistical processing of the data was performed by Pearson correlation coefficients and Hoteling principal components analysis (PCA). The results of the correlation analysis showed statistically significant linear correlations between most anthropometric variables (p<0.05; p<0.01; p<0.001). The three-component model, which defined 81.45% of the proportion of the total common variance of the manifest anthropometric variables, was extracted by the method of analysis of the main components, with the Gutman-Kaiser criterion and Varimax rotation. **Conclusion**: It was structured by hypothetical factors with characteristic roots (Eig.>1), which were interpreted as Factor of volume and longitudinal dimensionality of the skeleton (F1=42.45%; Eig. 6.37>1), Factor of skin folds of the trunk (F2=28. 96; Eig. 4.08>1) and Subcutaneous adipose tissue factor of the lower extremities (F3=10.04; Eig.2.12>1). The correlation of the factors confirmed the inverse relationship of the factors (F1-F2=-0.85; F1-F3=-0.81). It can be concluded that the increased volume of volleyball players is not accompanied by higher values of skin folds, but is a consequence of increased muscle mass.

Keywords: *morphological dimensions, latent linearity, factor analysis, volleyball*

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1. Introduction

Success in sports, including volleyball, depends on several anthropological characteristics, among which the most important are anthropometric characteristics, motor and cognitive abilities, conative personality traits. Morphological features (anthropometric characteristics) are part of anthropological characteristics, and are defined as a trait responsible for the dynamics of growth, development and structure of morphological characteristics that include bone growth in length and width, muscle mass and subcutaneous adipose tissue [1]. According to [2], anthropometry includes precise measurement of the human body, processing, study of the obtained measures and consideration of an objective picture of the growth state of the examined person or a certain population.

Knowledge of the morphological characteristics of the respondents is one of the basic planning of the training and competition process, because different motor tasks require the appropriate morphological type to achieve good sports results, which is often significantly correlated with the sport we play. When analyzing the morphological space, one should keep in mind the fact that the development of certain latent dimensions is largely defined by individual structure, endogenous and exogenous factors. Adequate factor procedures can be transformed into latent dimensions, as such identified and defined. The obtained information on the constitution of the organism is a relevant indicator of the health status, evaluation of their growth and development rate. Often, body proportions are the starting point for planning individual training cycles of athletes and increasing the levels of certain morphological characteristics, which are determined by anthropometry [3]. Today, volleyball is one

of the most popular team sports in the world, with more than 200 volleyball nations. In recent times, it is increasingly competitive with high physical, technical and tactical performance. It is an intimate sport that requires high intensity and short-term activities interspersed with periods of low intensity [4-6]. During the game, intense activities such as jumps, steps, blocks, landings, multidirectional movements are performed, with short recovery periods such as walking and standing [7]. Successful practice of this sport requires a high level of technical and tactical performance and as such should be consistent with anthropometric characteristics [8,9]. These performances in volleyball with anthropometric characteristics and individual physical capacities are the most important factors that contribute to the success of the team in competitions [10]. As a collective sports game, volleyball requires a certain level of development of morphological characteristics due to the need for an efficient reaction of athletes in specific situations on the field. Therefore, continuous monitoring, research and application of results in the field is needed. According to [11, 12] morphological parameters are an essential part of the assessment and selection of athletes from different sports and along with physical status, anthropometric characteristics play a vital role in determining volleyball success. Knowing the morphological structure of the body specifically for different sports disciplines facilitates the pre-selection process, and in the case of team games can be an important factor determining the position of players on the field [13,14]. Anthropometric research on female volleyball players is often associated with different levels of women's skills and assessment of physical status [15,16,17]. It was found that pre-selection in volleyball is based on previously established basic somatic criteria, such as body height and weight. Such morphological selection results in significantly higher body height of volleyball players compared to non-exercising peers and women engaged in other sports, which indicates a certain diversification of volleyball players' physique depending on the playing position on the field [18,19]. It is an indisputable fact that the anthropometric characteristics of volleyball players represent the functioning of the growth and development of the skeletal-muscular system, and they also play a role in specific volleyball activities, influencing various sports results. In this regard, in the sphere of volleyball, it is imperative to identify the anthropometric constitution, generated by exogenous and endogenous factors. In this way, better management and direction of training processes is enabled, as well as the selection of players, which is confirmed by previous research [20,21,22]. Research on the latent structure of morphological dimensions in the volleyball population and the identification of existing factors have been the subject of a number of researchers [3,21,23-32].

In most of these studies, a three-dimensional, theoretical model was interpreted as: longitudinal dimensionality of the skeleton, voluminosity and body mass, and subcutaneous adipose tissue. Assessing the relationship between anthropometric characteristics and the latent morphological structure of volleyball players is one of the important tasks that researchers in sports face on a daily basis, both in practice and in the theoretical framework of research. However, compared to other sports, empirical findings on possible transformations, relations of anthropometric characteristics and their multidimensional structure are less present in volleyball. This especially refers to the lack of information in the research on the population of volleyball players of the senior rank of the B&H Premier League competition, on the basis of which the goal of this research is defined.

The main goal of the current non-experimental transferal research was to analyze the correlation of defined manifest morphological variables and determine their factor structure in the volleyball population of VC "Jahorina" Pale. In accordance with the results of previous research, as well as the defined goal, correlations between most manifest morphological variables and extraction of a certain latent model (factor) can be assumed, on the basis of which the hierarchical factor structure of volleyball players will be defined.

2. Method

2.1. The Sample of Participants

The sample of participants consist 18 female volleyball players, the members of the Volleyball Club "Jahorina" from Pale, City East Sarajevo (Body height = 173 ± 8.77 cm; Body weight = 66.04 ± 9.09 kg; BMI = 22.03 ± 2.19 kg / m², decimal age 19.11 ± 2, 63 years old) who competes in the Premier League of Bosnia and Herzegovina. All the participants were healthy and physically fit with no history of injury in the past six months. The participants were informed in detail about the nature of the study and investigational procedures, and all the participants have voluntarily given their consent to be the part of this study.

2.2. The Sample of Variables

The total of 15 variables were variables of anthropometric space which primarily referred to longitudinal, circular and body mass dimensions and skin folds dimensions.
  1. Body Height - 0,1cm;
  2. Body weight - 0,1kg;
  3. Arm range - 0,1cm;
  4. Upper arm perimeter - 0,1cm;
  5. Forearm perimeter - 0,1cm;
  6. Abdomen perimeter - 0,1cm;
  7. Upper leg perimeter - 0,1cm;
  8. Lower leg perimeter - 0,1cm;
  9. Triceps skinfold - 0,1cm
  10. Biceps skinfold - 0,1cm
  11. Subscapular skinfold -0,1mm
  12. Suprailiac skinfold - 0,1mm
  13. Abdomen skinfold - 0,1mm
  14. Front thigh skinfold - 0,1mm
  15. Rear thigh skinfold - 0,1 mm

2.3. Research Design

Anthropometric measurements were performed according to the methodology of the International Society for the Advancment of Kinanthropometry - ISAK standard procedures [33] The standard metric instruments were

applied: Stadiometer - used for measuring body height, digital scale for for measuring body weight (Beurer, GmbH, Typ BG 35, Germany), flexible tape used for measuring the body perimeter and its segments, and the Caliper for measuring skin folds (GIMA-model Plicometro, Italy). During the measurement of skin folds, the caliper was set so that the pressure on the limb tops that are touching the surface of the skin fold was 10g/mm2, with the measuring accuracy of 0.2 mm. The value was read within a 2 second time frame. The subjects voluntarily participated in this research. Subjects were wearing light clothes, without footwear, and were marked on previously relevant anthropometric points and levels necessary for measurement. All measuring the body segments, they were conducted on the right side of the body. All morphological characteristics were measured by the same examiners once, except skin folds, which were, after three successive measurements, presented as an arithmetic mean. Anthropometric measurements were conducted during regular training at february 2021. They were conducted by the author of this study. During the testing, the air temperature was between 18°-22°C. All of the measurements were according to the procedures in the Helsinki declaration.

2.4. Data Analysis

The descriptive statistics were calculated. For determining the direction and intensity of correlation between variables, Pearson's coefficient of correlation was used, while for identifying the latent structures of morphological characteristics, the Principal Component Analysis (PCA) was applied, with the application of Varimax rotation of the main axes, as well as the Kaiser-Guttman's normalization procedure. The statistical package STATISTICA, version 10.0 (STA999k347150-W) was used for data processing.

3. Results

Table 1 contains the basic statistical parameters of the examined sample of volleyball players. Most of the analyzed variables are within the normal distribution, except for some related to skin folds. The consequence of

increased heterogeneity of skin fold variables is a larger range of chronological age of 16-23), which is closely related to the postpubertal phase of some respondents, which relate to anthropometric characteristics, playing positions on the field and adequate (pre) selection of volleyball players.

The results of the analysis of Pearson's correlation coefficient on the existence of the direction and intensity of the relationship between anthropometric variables are contained in Table 2. Insight into the integrated intercorrelation matrix shows a larger number of positive intercorrelation coefficients. Of the total number of correlations, 36 variables (34%) were statistically significant for the defined level (p<0.05-12 correlations; p<0.01-13 correlations; p<0.001-11 correlations). High positive correlations in the segment of the same dimensionality are evident, i.e. negative correlations between longitudinality and skin folds. The conclusion is that more volleyball players had lower values of skin folds, that is, that the increase in height is not accompanied by an increase in adipose tissue. Statistically significant positive correlations of extremely high intensity were manifested in the longitudinal dimension of body height with variables: arm span (0.94; p<0.001), medium intensity with body weight (0.67; p<0.001) and negative correlations with all skin folds, among which there is a statistically significant relationship with the subscapular fold (-0.45; p<0.05).

Relevant and positive intercorrelation coefficients were shown by the dimensions for the assessment of volume and body weight, while the dimensions within the skin folds were evident low and medium correlation. This is explained by the fact that the skin folds of the subjects are of the topographic type, which means that the increased values of the folds of the cranial extremities do not cause directly proportional values of the folds on the caudal limbs or trunk.

In order to identify the morphological structure of volleyball players, the Principle of Component Analysis was performed, which reduced the set of 15 linearly related manifest variables with factor rotation (Varimax normalized rotation) to a smaller number of latent factors. By applying the Guttmann-Kaiser criterion, those variables with the maximum degree of explained variance were retained (Table 3).

Table 1. Descriptive statistic volleyball players

	Mean	Min	Max	SD	CV%	Skew	Kurt
Body Height	173.00	150.50	187.00	8.74	5.05	-.100	1.42
Body weight	66.04	49.90	79.60	8.13	12.31	-0.12	-0.78
Arm range	174.00	147.50	189.50	10.01	5.75	-1.10	2.19
Upper arm perimeter	26.08	23.00	30.00	2.04	7.81	0.50	-0.52
Fore arm perimeter	23.31	21.00	27.00	1.42	6.07	0.76	1.51
Abdomen perimeter	69.36	63.00	77.00	4.34	6.25	0.08	-1.14
Upper leg perimeter	54.58	48.00	61.00	3.80	6.96	-0.21	-0.56
Lower leg perimeter	35.36	32.00	39.50	2.09	5.92	0.06	-0.52
Triceps skinfold	14.63	11.20	25.00	3.30	22.59	1.93	4.92
Biceps skinfold	4.46	2.30	9.90	1.66	37.12	2.24	6.67
Subscapular skinfold	10.68	6.80	16.30	3.09	28.97	0.50	-1.13
Suprailiac skinfold	9.46	5.40	20.60	4.06	42.91	1.52	2.52
Abdomen skinfold	12.97	7.00	25.40	5.27	40.66	1.28	0.89
Front thig skinfold	21.31	13.40	31.90	5.66	26.56	0.30	-0.81
Rear thig skinfold	29.96	20.00	42.00	5.77	19.26	0.52	-0.19

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Table 2. Pearson product moment correlation

	Body height	Body weight	Arm range	Upper arm perimeter	Fore arm Perimeter	Abdomen perimeter	Upper leg perimeter	Lower leg Perimeter	Triceps skinfold	Biceps skinfold	Subscapular skinfold	Suprailiac skinfold	Abdomen skinfold	Front thig skinfold	Rear thig skinfold
Body Height	-														
Body weight	.67**	-													
Arm range	.94***	.73**	-												
Upper arm perimeter	.38	.83***	.43	-											
Fore arm Perimeter	.51*	.83***	.54*	.83***	-										
Abdomen perimeter	.36	.84***	.51*	.83***	.72**	-									
Upper leg perimeter	.22	.74**	.33	.81***	.65**	.72**	-								
Lower leg Perimeter	.31	.79***	.38	.77***	.66**	.66**	.83***	-							
Triceps skinfold	-.15	.13	-.14	.38	.22	.22	.35	.28	-						
Biceps skinfold	.02	.58*	.04	.49*	.46*	.44	.52*	.52*	.19	-					
Subscapular skinfold	-.45*	.05	-.38	.33	.02	.43	.22	.19	.50*	.2695	-				
Suprailiac skinfold	-.31	-.03	-.39	.35	.04	.25	.21	.08	.32	.10	.61**	-			
Abdomen skinfold	-.29	-.03	-.36	.27	-.09	.24	.11	.12	.47*	.08	.67**	.81***	-		
Front thig skinfold	-.26	.26	-.18	.43	.19	.29	.41	.30	.29	.36	.33	.41	.30	-	
Rear thig skinfold	-.31	.34	-.18	.49*	.39	.48*	.55**	.33	.28	.68**	.35	.3722	.19	.67**	-

Note: *p<.05; **p<0.01; ***p<0.001.

Table 3. Eigenvalues, Extraction: Principal Component Analysis (PCA)

Factors	Eigenvalue	% Total variance	Cumulative – Eigenvalue	Cumulative varianse - %
Factor 1	6.37	42.45	6.37	42.45
Factor 2	4.08	28.96	10.45	71.41
Factor 3	2.12	10.04	12.57	81.45

Table 4. Factor Loadings (Varimax normalized), Extraction: P C A (Factor Loadings > 0 ,70)

Variables	Factors			Comm.	Correlation between factor
	F1	F2	F3		
Body height	0.76	-0.35	-0.45	0.91	
Body weight	0.95	-0.04	0.22	0.96	
Arm range	0.81	-0.38	-0.34	0.92	F1 - F2 = -0.85
Upper arm perimeter	0.84	0.35	0.29	0.91	
Fore arm perimeter	0.84	-0.03	0.25	0.77	
Abdomen perimeter	0.82	0.30	0.23	0.82	
Upper leg perimeter	0.72	0.18	0.47	0.77	
Lower leg	0.77	0.14	0.32	0.73	F1 - F3 = -0.81
Triceps skinfold	0.17	-0.69	0.16	0.43	
Biceps skinfold	0.38	0.01	-0.75	0.68	
Subscapular skinfold	0.00	-0.82	0.26	0.74	
Suprailiac skinfold	-0.01	-0.85	0.16	0.74	
Abdomen skinfold	-0.02	-0.93	-0.01	0.86	F2 - F3 = 0.73
Front thig skinfold 1	0.10	0.32	-0.68	0.57	
Rear thig skinfold 2	0.18	0.21	-0.90	0.84	

Table 3 contains descriptive parameters during factor extraction, and the given characteristic values of roots (Eig.>1) were singled out and defined in further analysis as new latent dimensions. By calculating the characteristic equation in the matrix of intercorrelations of the applied anthropometric variables, three characteristic roots were singled out, which were extracted and rotated as latent dimensions by their strong vector saturations. The obtained sums of squared saturations after Varimax normalized rotation in the space of manifest anthropometric variables, cumulatively explain 81.45% of the total variance of the system. The remaining 18.55% of the proportion of isolated variability represents a smaller loss of information, which are factors that are not statistically relevant. The individual contribution in the interpretation of the isolated linear combination of the first main component is maximal with 42.45%, the second 28.96% and the third an additional 10.04% of the proportion of the explained variations. This can be understood as a satisfactory criterion for the reproduction of information contained in the whole set of anthropometric variables, which is in line with research.

Based on the principal components method and the results of the analysis, it was found that the manifest variables are transformed, i.e., rotated into three new latent linearly independent principal components (factors) that have maximum dispersion (Table 4). Examination of the matrix shows that in the structure of the first main component the maximum rotated loads of the positive direction have as many as 8 variables where the leading projection of body weight (-0.95), followed by upper arm circumference and forearm circumference (0.84), abdomen circumference (0.82), arm span (0.81), body height (0.76), upper leg circumference (0.72) and lower leg circumference (0.77). These variables in the largest percentage participate in the divergence of the studied latent dimensions, carrying the largest variability. Based on most of the interpreted total variance, utility size and statistically significant intercorrelation coefficients of variables, the content of the first principal component (F1), which represents the eigenvectors of a quadratic symmetric correlation matrix, is interpreted at the hypothetical level as a common *factor of voluminosity and longitudinal skeletal dimensionality.*

Dominant factor loads, i.e. the highest correlation coefficients on the second latent dimension in the positive direction, in the matrix of the structure of the main components, are recorded by the vectors of skin fold variables: subscapula fold (0.82), suprailiac fold (0.85), abdominal fold (0.93) and the fold of the triceps, which by its projection (0.69) although below a given level (>0.70), contributes to the extraction of the independent factor. Given the significant linear combinations of manifest variables, the content of the reduced latent homogeneous structure of the second main component (F2), which explains the significantly lower percentage of variance, was defined as an integrated *factor of skin folds of the carcass* under the condition of orthogonality.

Further insight into the matrix of the structure of the main components shows that the largest rotated loads of the positive direction to the third latent dimension have three remaining variables: skin fold of the thigh (0.89), skin fold of the biceps (0.75) and skin fold of the thigh

with a boundary projection of (0.68) which contributes to the extraction of the third independent factor. Having in mind the significant linear combination of original anthropometric variables caused by the third main component (F3), which is orthogonal to the previous one, is hypothetically interpreted as a common *factor of subcutaneous adipose tissue of the lower extremities.*

4. Discussion

In terms of technique, volleyball defines a precisely defined structure of movement, direction and intensity of activity. In order for this movement structure to be realized in the best possible way during the game on the field, it is necessary that the playing staff has an appropriate morphological structure that is specific to volleyball. In terms of players, a precisely defined morphological structure is dominant, so we often notice players of pronounced longitudinality on the courts in the presence of voluminosity accompanied by appropriate body weight. However, the position in the game (e.g. libero) requires differences in terms of these parameters, which relate to reduced longitudinal but also to the expression of certain latent motor capacities. The main goal of the research was to determine the factor structure of isolated latent dimensions of the population of female volleyball players of VC "Jahorina" Pale, a member of the volleyball Premier League of Bosnia and Herzegovina. The obtained results of research of anthropometric parameters (average, minimum and maximum values) confirmed that there is a certain diversification of anthropometric variables of volleyball players, which depend on the playing position on the field, which is in line with research results [18,19,29,34,35], so their distribution was a prerequisite for the formation of the existing structural model of morphological space. Based on the total number of defined manifest variables in the matrix of the main components structure, three latent dimensions with mutual correlations were extracted which significantly explain 81.45% of the total system variance, which suggests the validity of the applied sample of variables and measurement objectivity, with a minimum loss of 18.55% information. The vector set of the first linear combination of variables, which includes the maximum part of the information in the initial system (42.45%), was interpreted as a factor of volume and longitudinality with dominance of body mass with high vector projection and accompanying volumes of the entire musculature. Thes grouped profile of the first integrated common factor, includes volleyball players with pronounced measures of voluminousness and partial longitudinality, elongated physique, i.e. the dominant range of the upper extremities and body height. This arrangement indicates the classification of the meso-ectomorphic type of constitution. It can be observed that longitudinality is to some extent accompanied by increased voluminosity, which can be explained by a training process dominated by strength exercises that increase muscle mass. Additionally, longitudinality as an indicator of physical growth is in the completed stage of formation with respect to the average age of volleyball players, which is contrary to research [36] which indicates

that isolated longitudinal skeleton is characterized by faster growth than muscle masses, enabling the movement of the extremities and the efficient execution of specific volleyball motor structures. In our sample, the distribution of individual volleyball results shows that longitudinality is still in the growth phase, but that it is still saturated with a certain volume so that it could not be extracted as a separate factor. Also, the birth rate for the longitudinal dimensionality of the skeleton is around 0.98%, and it cannot be influenced by the training process, unlike the volume, which can be acted upon by a directed and accurately dosed training process in terms of its increase or decrease.

The structure of the second extracted latent morphological dimension in the common variance was explained with 28.96% with a characteristic root (Eig. 4.08>1), which enabled its independent extraction and definition as a factor of skin folds of the carcass. Obviously, the configuration of this factor is determined by variables that assess soft tissues, i.e., the skin folds of volleyball players. It is assumed that this latent quantity in the morphological space has a negative impact, since it takes part in the increase of the so-called ballast body mass. Volleyball as a sport requires speed and explosiveness of the horizontal and especially vertical type, which is characterized by a large number of jumps and various landings. Any increase in body weight at the expense of skin folds has a negative impact on the motor structure of volleyball players because it leads to motor imbalance and disruption of the technique of performing certain elements of the volleyball game. Good knowledge of the intensity of development of this latent dimension is of great importance because of its correlation with motor abilities, e.g. lean body mass has a positive effect on athletic performance, which implies greater muscle mass and thus greater potential for muscle strength, as opposed to ballast body mass [3]. What is important to point out is the fact that the inverse relationship of the variables that define the first factor with the variables that defined the second factor in the observed morphological space of volleyball players is evident (Table 4). It should also be noted that the values of skin folds can be reduced with an adequate training process, where through the reduction of this feature would be obtained on the quantity and quality of the volume of the subjects in favor of muscle mass.

The structure of the last third obtained and the least significant factor of subcutaneous adipose tissue of the lower extremities is defined by the variability of the skin folds of the front and back of the thigh, as well as the skin fold of the upper arm. This latent soft tissue content is responsible for a low 10.04% proportion of the total variance of the examined variables. It is determined by a larger amount of adipose tissue in the region of the lower extremities, where the characteristic root (Eig.2,12>1) enabled its independent extraction. At the same time, this extracted latent component is an interfering element for most of the motor skills of volleyball players.

Based on the parameters obtained in this study, previous studies of the influence of endogenous factors (training process) with about 50% can positively affect the transformation of subcutaneous adipose tissue factor that describes the endomorphic somatotype. The extracted subcutaneous fat factor of volleyball players in this study

coincided with empirical results in studies [18,28-32,34,37]. The obtained results confirm previous research that analyzes the interrelationship with the definition of a three-dimensional model of morphological space with slight differences in the defined order of extracted common factors.

5. Conclusion

This transfer study is the first research in terms of determining the structure of the morphological space of the volleyball players of VC "Jahorina", a member of the volleyball Premier League of BIH. The research was realized with the aim of analyzing the values of intercorrelation coefficients and determining their factor structure. The analysis of the obtained results confirmed the three - dimensional model of the morphological space with 81.45% of the explained common variance. Three factors defined as the dimension responsible for skeletal volume and longitudinality (F1), the dimension of skin folds of the trunk (F2) and the dimension of skin folds of the lower extremities (F3) were extracted. The results in the current study showed statistically significant linear correlations (34% $p<0.05$; 0.01; 0.001) between manifest morphological variables in the studied sample. Factor analysis of the intercorrelation matrix of a set of 15 anthropometric variables defined the three-dimensional structure with 81.45% of the proportion of the total common variance explained. The first common factor (F1) - voluminosity and body weight followed by longitudinality of volleyball players is defined by high projections of body weight, limb and torso circumference, body height and arm span, which with 42.45% participates in explaining joint variability with significant characteristic root (Eig. 6.37>1). It can be concluded that due to the heterogeneous pattern (which is a consequence of different ages and levels of training abilities of volleyball players) there was no better integration within one dimensionality.

The second extracted factor with 28.96% participates in defining the total joint variance (Eig. 4.08>1). The saturation of the second factor was determined by the skin folds of the trunk (supscapular, suprailiac, abdomen) so that it was defined as the factor responsible for the skin folds of the trunk. It can be concluded that this factor is an indicator of increased skin folds in this part of the body, so an adequate training process is recommended in order to reduce body fat in this region.

The third factor with 10.04% in the total joint variance of the system (Eig. 2.12>1) was saturated with variables for estimating the skin folds of the lower extremities (front and back lodges) of stronger vector projections and was interpreted as a factor of skin folds of the lower extremities. It can be concluded that one part of the body weight of volleyball players falls on the lower extremities due to the increased values of skin folds. It is also possible to act preventively in terms of fat reduction on this part of the body.

The correlation of factors confirmed the inverse relationship (F1-F2=-0.85; F1-F3=-0.81), which suggests that the volume of volleyball players is not accompanied by higher values of skin folds, but is a consequence of

increased muscle mass. Also, the obtained empirical findings of this study are important for researchers, coaches and volleyball players themselves in order to diagnose and condition the morphological structure in order to achieve a better sports result. The results obtained in our sample can now be compared with the results in other clubs in the B&H Premier League and the wider environment, since a unique methodology was used, so the possibility of comparisons is large and significant.

Conflict of Interest

The authors declare no conflict of interest.

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