Original Article

Morphological motor status of top quality sitting volleyball players in Bosnia and Herzegovina

VESNA BRATOVČIĆ¹, BRANIMIR MIKIĆ², SENAD MEHMEDINOVIĆ¹, EDINA ŠARIĆ¹, ŽARKO KOSTOVSKI³

¹Faculty of Education and Rehabilitation, University of Tuzla, BOSNIA AND HERZEGOVINA

² Faculty of Education, University of Travnik, BOSNIA AND HERZEGOVINA

³ Ss. Cyril and Methodius University, Faculty of Physical Education, Sport and Health, Skopje, MACEDONIA

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Abstract:

The aim of the research was to examine the morphological-motor status of top quality sitting volleyball players. The research includes appropriate sample of 63 sitting volleyball players from Bosnia and Herzegovina. The sample includes players from the first league clubs from the area of Tuzla Canton and the competitors of the national team of Bosnia and Herzegovina in sitting volleyball so that the sample of examinees is comprised of two sub-samples as follows: 22 competitors of national team of Bosnia and Herzegovina in sitting volleyball, 41 competitor from five first league teams in sitting volleyball. The players of sitting volleyball included in this research are persons with physical disabilities most often caused by warfare. For the aim of research of anthropological space, 26 controlled variables were used and which are: 11 variables for assessment of motor characteristics and 15 variables for assessment of morphological characteristics of examinees. Anthropometric measurements were executed by standard instruments per methodology which International Biological Program recommends. For the aim of ascertaining connection between the sets of morphological and basic-motor variables, a canonical correlation analysis was done. For the aim of ascertaining differences between the examined groups, as well as for ascertaining the importance of significance of contribution of applied variables in their classification, a method of multi-variance analysis was applied. On basis of achieved research results, it can be concluded that morphological-motor relation of sitting volleyball players corresponds to morphological-motor relation to standing up volleyball.

Key words: motor skills, anthropometric measurements, volleyball players, physical disabilities..

Introduction

Sitting volleyball is sports activity which gives evident positive effects during rehabilitation and general resocialization of persons with physical disabilities. Motorical abilities (handiness, agility, flexibility, endurance, strength, speed and similar are developed through this game) (Mahmutović & Turković, 1999). Sitting volleyball is extremely dynamic game in which all persons with physical disability give maximum of its possibilities thereby achieving positive transformations from any aspect (physiological, psychological, sociological, motor etc) (Mahmutović & Turković, 1999). The movements of the body in sitting volleyball are specific, unnatural and learned, and differ significantly from natural forms of movement. The movements in sitting volleyball have sports purposes and they are most commonly used for activities on the ball (Mahmutović & Turković, 1999). Specificity of the game is such that players “must” sit on the ground during the game or in the course of playing of game elements their gluteal part must be in contact with the ground (Mahmutović & Turković, 1999).

Sitting volleyball is a game that involves rally of two teams made up of a maximum of twelve, and at least six members in each. Twelve players participate in game, six in each team. The game is played in three won sets on principle of tie-breaks up to 25 points with a difference of two points in first four sets, and in the fifth set, tie-break is played up to 15 points with a difference of two points. Three balls whose colour, shape and weight is determined per rules of the World Organisation Volleyball for Disabled (WOVD) is used during the game.

The rules of the sitting volleyball are structured in a way so that they enable the players to show the best of their abilities, spirit, creativity and aesthetics during the competition. With a few exceptions, sitting volleyball enables all players to play on attack (game on the net) and in defence (in background) and to serve.

Like other games with net, it has certain elements such as: service, rotation, attack, defence, but it is exceptional in that the ball must constantly remain in the air and in that it allows certain degree of internal switching of the ball among the players of one team.

The introduction of specialized defence player (sweeper) into sitting volleyball allowed for the game to additionally gain on dynamics. Today, there are twenty registered teams in sitting volleyball in Bosnia and Herzegovina which compete in two leagues and which are: First Federal league and Second Federal league. Each

league has ten teams. Sitting volleyball is a sport in Bosnia and Herzegovina with most trophies. National team of sitting volleyball has on international level in period from 2001-2013 won 11 gold and two silver medals on international competitions, out of which 7 gold medals were from European Championships, two gold medals and one silver medal on World Championships and two gold and one silver medal on Paralympic Games. Optimal physique is apparently an advantage to volleyball performance. Only when a volleyball team is collectively equipped with all the ideal anthropometric characteristics can the team win the dominance in a game (Chen, 2005). However, as opposed to standing up volleyball, the players in sitting volleyball are recruited from population of persons with disabilities, regardless of morphological and motor predispositions usually preferred with volleyball players, such as longitudinal dimensionality of skeleton, explosive strength, coordination and above all agility. Characteristic which has negative impact on the success of the game is subcutaneous adipose tissue (Cabral, B., Cabral, S., Miranda, Dantas & Reis, 2011; Dopsaj, Nešić & Čopić, 2010; Marelić, Đurković & Rešetar, 2007). Sitting volleyball can be played by male and female players with damaged movement system which includes classification of International Organisation of Sports for the Disabled (IOSD) for persons with amputations and classifications for other damages of musculoskeletal system (les autres), such as: cerebral palsy, damage to the spinal column, dwarfism, dysmelia, hip and knee arthroplasty with permanent disabilities and similar.

There are nine classification categories in sitting volleyball for persons with physical disability. Each player of sitting volleyball must have personal classification card with level of disability (Mahmutović & Turković, 1999). Thus, the question which is raised is how much do sitting volleyball players fit to anthropological model of standing up volleyball players. Therefore, the aim of this research was to examine morphological-motor status of the top quality sitting volleyball players.

Methods

Participants

The research includes appropriate sample of 63 sitting volleyball players from Bosnia and Herzegovina. The sample includes players from the first league clubs from the area of Tuzla Canton and the competitors of the national team of Bosnia and Herzegovina in sitting volleyball so that the sample of examinees is comprised of two sub-samples as follows: 22 competitors of national team of Bosnia and Herzegovina in sitting volleyball, 41 competitor from five first league teams in sitting volleyball. The players of sitting volleyball included in this research are persons with physical disabilities most often caused by warfare.

Procedures

For the aim of research of anthropological space, 26 controlled variables were used and which are: 11 variables for assessment of motor characteristics and 15 variables for assessment of morphological characteristics of examinees. Anthropometric measurements were executed by standard instruments per methodology which International Biological Program (IBP) recommends. Measuring of motor abilities was executed with help of objectivised test which is usually applied in research of motor abilities (Mikić, 1999). Abbreviations for motor skills represent international nomenclature which is used in all kinesiology researches.

Statistical analyses

Research data were processed by method of parametric statistics. A canonical correlation analysis was executed for the aim of determining connection between the sets of morphological and basic-motor variables. For determining of significance of differences among the examined groups, as well as for determining significance of contribution of applied variables in their classification, a method of Multivariate Analysis of Variance - MANOVA was applied. Research data were processed in statistical package SPSS 16. for Windows.

Results

For the aim of determining connection between the sets of different groups of variables, canonical correlation analysis was performed. The connection between the examined psychosocial variables is determined by Pearson's Correlation Coefficient. As per recommendation of Tebachnik and Fidell (2001), only those correlations between the variables and variances with value higher than 0,23 are taken into account in all correlation analysis. Such value of correlations fits the level of statistical significance of 0,05 (Tabachnik & Fidell, 2001). Through analysis of results achieved in matrix of cross correlations (Table 1) it can be seen that statistically significant and multiple relations between morphological and basic-motor sets of variables on this sample of examinees are achieved.

Table 1. Matrix of cross correlation of motor and morphological variables

Var.	MBFT D	MBF TL	MFL PR	MFL IS	MRC ZG	MRCS K	MRC 30	MFEB M	MFED D	MFE DL	JAP TES
ASJEV	0,03	-0,05	0,31	-0,17	0,06	0,27	0,17	0,24	0,38	0,21	-0,22
ADUZ	0,00	-0,03	-0,09	0,07	-0,10	-0,11	-0,04	0,04	0,30	0,12	0,15
R											
ARAS	0,00	0,05	0,07	-0,10	0,15	0,26	0,17	0,27	0,20	0,21	-0,17
R											
ASIRR	-0,01	0,01	0,14	-0,10	-0,14	-0,06	-0,10	0,03	0,26	0,20	0,12
ASIRK	-0,05	-0,04	-0,04	0,07	-0,03	0,01	0,11	0,24	0,21	0,15	-0,02
ADIJL	-0,10	-0,10	0,03	0,06	-0,09	0,00	0,14	0,24	0,06	0,07	0,10
ADIJR	0,03	0,02	0,06	-0,07	0,00	0,12	0,08	0,12	0,14	0,03	0,06
ATJE	-0,26	-0,31	-0,16	0,23	-0,37	-0,28	-0,26	0,15	0,45	0,21	0,24
M											
AOBG	-0,22	-0,20	-0,04	0,05	-0,34	-0,11	-0,09	0,30	0,40	0,26	0,18
R											
AOBN	-0,06	0,02	-0,07	-0,22	0,06	0,27	0,18	0,54	0,22	0,09	-0,22
A											
AOBP	-0,11	-0,07	-0,06	-0,19	0,02	0,18	0,16	0,43	0,34	0,25	-0,22
O											
AOBT	-0,21	-0,25	-0,15	0,20	-0,35	-0,27	-0,23	0,14	0,22	0,02	0,24
R											
AKNN	-0,16	-0,28	-0,09	0,16	-0,26	-0,39	-0,39	-0,25	0,11	-0,04	0,32
A											
AKNT	-0,22	-0,34	-0,12	0,23	-0,39	-0,53	-0,44	-0,16	0,21	0,09	0,40
R											
AKNL	-0,17	-0,28	-0,01	0,11	-0,29	-0,40	-0,24	-0,05	0,26	0,09	0,22
E											

Key: Sitting height – ASJEV; Arm length – ADUZR; Arm range: ARASR; Shoulder width – ASIRR; Pelvis width-ASIRK; Elbow diameter-ADIJL; Wrist diameter- ADIJR; Body weight -ATJEM; Breast scope-AOBGR; Upper arm scope-AOBNA; Forearm scope-AOBPO; Stomach scope-AOBTR; Forearm skin fold-AKNNA; Stomach skin fold-AKNTR; Back skin fold-AKNLE; Right hand taping-MBFTD; Left hand taping -MBFTL; Bend on box- MFLPR; Flex with bat-MFLIS; Knuckle in height-MRCZG; Pushups on a loom-MRCSK; Body lifting in 30 seconds-MRC30; Throwing of 1.5 kg medicine ball from lying position-MFEBM; Dynamometer of right hand-MFEDD; Dynamometer of left hand-MFEDL; JAPAN test-JAPTES.

Canonical correlation analysis has isolated two pairs of statistically significantly related canonical factors (Table 2). The first canonical correlation amounts to 0,82 and explains 72% of common variance of results. The first pair has achieved statistical significance on level of $p < 0,01$, and the second pair statistically significant on level of $p > 0,05$. Data on pairs of canonical variants can be seen in table 2.

Table 2. Isolated pairs of statistically significantly related canonical factors

Factor	R	R ²	Hi-square	df	p
0	0,85	0,72	236,53	165,00	0,00
1	0,82	0,68	175,14	140,00	0,02

Table 3 shows correlations between variables and canonical variants, explanations of variants and redundancies. The first canonical variant has extracted 11% of variants from morphological space and 20% of variance from motor space. The second canonical variant has extracted 10% of variants from morphological space and 23% of variants from motor space. These two canonical variants together, explain 31% of variance of variables of morphological space and 33% of variance of variables of motor space.

The first canonical dimension in space of anthropometric variables is defined by negative projections, before all by measures of longitudinal dimensionality of skeleton (ASJEV, ADUZR), measures of body weight (ATJEM), scope and measures of subcutaneous adipose tissue (AKNNA, AKNTR, AKNLE). Positive pole of correspondent canonical dimension, isolated in space of motor tests, is mostly saturated by measures of repetitive body power (MRC30) and upper extremities and shoulder area (MRCZG, MRCSK) as well as the speed of movement of left hand (MBFTL), and negative one by measures of statistical right hand strength (MFEDD) (Table 3). Second canonical dimension in space of anthropometric variables is defined by negative projections of measures of subcutaneous adipose tissue (AKNNA, AKNTRB, AKNLE), and variable of stomach scope (AOBTR) and body weight (ATJEM). Positive pole of second canonical dimension is defined by measures of

longitudinal dimensionality of skeleton (ASJEV, ARASR) and upper arm scope (AOBNA) as measure of body scope.

Second motor canonical factor is defined by positive projection of evaluation test of repetitive strength (MRCZG, MRCSK, MRC30), explosive strength (MFEBM), left hand movement speed (MBFTL) and flexibility of body and lower extremities (MFLPR), and negative one by projection of test evaluation of agility (JAPTES) and upper extremities flexibility (MFLIS) (Table 3).

Table 3. Canonical coefficients, proportions of explained variances and redundancies of canonical variants for sets of variables of motor abilities and morphological characteristics

FACTOR STRUCTURE OF LEFT SET			FACTOR STRUCTURE OF RIGHT SET		
ASJEV	-0,40	0,39	MBFTD	0,15	0,17
ADUZR	-0,25	-0,21	MBFTL	0,31	0,31
ARASR	0,01	0,30	MFLPR	0,01	0,31
ASIRR	-0,24	-0,04	MFLIS	0,02	-0,59
ASIRK	0,03	-0,09	MRCZG	0,31	0,54
ADIJL	0,27	-0,22	MRCSK	0,30	0,82
ADIJR	-0,09	0,04	MRC30	0,48	0,49
ATJEM	-0,45	-0,30	MFEBM	0,24	0,40
AOBGR	-0,20	-0,17	MFEDD	-0,60	0,08
AOBNA	-0,03	0,25	MFEDL	-0,21	0,20
AOBPO	-0,16	0,23	JAPTES	-0,17	-0,73
AOBTR	-0,23	-0,37			
AKNNA	-0,42	-0,41			
AKNTR	-0,37	-0,63			
AKNLE	-0,35	-0,48			
Explained variance	0,11	0,10	Explained variance	0,20	0,23
Total variance		75,95	Total variance		100,00
Redundant variance	0,08	0,07	Redundant variance	0,13	0,15
Total redundant variance		29,50	Total redundant variance		37,17

Key: Sitting height – ASJEV; Arm length – ADUZR; Arm range: ARASR; Shoulder width – ASIRR; Pelvis width-ASIRK; Elbow diameter-ADIJL; Wrist diameter- ADIJR; Body weight -ATJEM; Breast scope-AOBGR; Upper arm scope-AOBNA; Forearm scope-AOBPO; Stomach scope-AOBTR; Forearm skin fold-AKNNA; Stomach skin fold-AKNTR; Back skin fold-AKNLE; Right hand taping-MBFTD; Left hand taping -MBFTL; Bend on box- MFLPR; Flex with bat-MFLIS; Knuckle in height-MRCZG; Pushups on a loom-MRCSK; Body lifting in 30 seconds-MRC30; Throwing of 1.5 kg medicine ball from lying position-MFEBM; Dynamometer of right hand-MFEDD; Dynamometer of left hand-MFEDL; JAPAN test-JAPTES.

Multivariate analysis of variance (MANOVA) was applied for determining the difference between the set of competitors of national team of Bosnia and Herzegovina in sitting volleyball and set of competitors from five first league teams in sitting volleyball. The results have shown that there is statistically significant difference $p=0,00$ between the examined sets (Table 4) in whole space of variables.

Table 4. Multivariate analysis of variance between the set of competitors of national team of Bosnia and Herzegovina in sitting volleyball and set of competitors from five first league teams in sitting volleyball

Wilks' Lambda	Rao's R	df1	df2	p	Pillai-Bartlett Trace	V (45,17)
0,03	11,42	45	17	0.00	1,00	17,93

It can be concluded from MANOVA results that the national team have had higher results in variables ASJEV, ARASR, AOBNA in the area of morphological characteristics which measure longitudinal and transversal dimensionality of skeleton, while the examinees from the first league group have measured higher values in variables AKNNA, AKNTR and AKNLE through which measures of subcutaneous adipose tissue are expressed. In the area of motor abilities, the examinees from the national team group have had better results in all motor tests, except in tests whereby the dynamometer of hand and right hand movement speed is measured and on which no statistically significant difference between the examined groups was found (Table 5).

Table 5. Multivariate significance of differences between the group of examinees of set of competitors of national team of Bosnia and Herzegovina in sitting volleyball and set of competitors from five first league teams in sitting volleyball

Var.	X ₁ NATIONAL TEAM COMPETITORS	X ₂ FIRST LEAGUE COMPETITORS	F (df 1,2) 1,61	p
ASJEV	975,82	939,68	10,56	0,00
ARASR	1877,68	1831,12	5,80	0,02
AOBNA	338,95	318,17	8,97	0,00
AKNNA	7,38	11,68	16,65	0,00
AKNTR	7,52	14,72	24,70	0,00
AKNLE	6,70	11,07	13,19	0,00
MBFTL	35,09	30,37	9,07	0,00
MFLPR	31,36	26,88	7,25	0,01
MFLIS	78,41	100,53	26,26	0,00
MRCZG	9,77	6,24	21,95	0,00
MRCSK	15,00	5,78	132,79	0,00
MRC30	30,95	21,61	47,29	0,00
MFEBM	1116,36	813,66	44,79	0,00
JAPTE	22,45	19,10	68,34	0,00

Key: Sitting height- ASJEV; Arm scope-ARASR; Upper arm scope-AOBNA; Forearm skin fold-AKNNA; Stomach skin fold-AKNTR; Back skin fold-AKNLE; Left hand tapping -MBFTAL; Bend on box- MFLPR; Flex with bat-MFLISK; Knuckle in height-MSAVIS; Pushup on a loom-MSASKL; Body lifting in 30 seconds-MRCD30; Throwing of 1.5 kg medicine ball from lying position-MFEBML; JAPANtest-JAPTES.

Discussion and conclusions

Since the number of research related to motor-morphological status of sitting volleyball players is reduced, the discussion related to achieved results of this research relates to comparing with the results of research of motor-morphological status of standard volleyball players. Also, having in mind that these are the results of top quality sportsmen from this sports discipline, it seems appropriate to correlate anthropological statuses of mentioned population of sportsmen.

Numerous researches of anthropological status of male and female volleyball players show that positive relation of longitudinal and transversal dimensionality of skeleton, repetitive and explosive strength of upper extremities and shoulder area, agility and negative relation of the same with the body weight and amount of subcutaneous adipose tissue dominates in their morphological-motor relation (Tomić & Šoš, 1984; Cardinal, 1993; Janković & Marelić, 1995; Janković, V., Janković, G & Đurković, 2003; Alić-Partić & Đug, 2005).

The relation between canonical factors from the system of morphological variables basic-motor variables show that the examinees who have had lower values in variables which measured sitting body height and arm length, body weight, as well as amount of subcutaneous adipose tissue have achieved better results on tests which measured repetitive arm strength shoulder and body area, and lower results on tests which measured statistical power of hand muscle. It was earlier reported that handgrip strength had strong correlations with various anthropometric characteristics (Bamaç, B., Colak, T., Özbek, A., Yenigün, N., Çolak, S., & Bamaç, Y, 2003; Koley, Singh & Kaur, 2010; Koley & Kaur, 2011).

Also, the examinees with higher values in variables which measure sitting height, arm scope and upper arm scope and lower values of variables which measured stomach scope have had better values on tests which measured explosive upper extremities strength and shoulder area and agility. Volleyball players require well-developed speed, agility, upper-body and lower body muscular power, and maximal aerobic power. Several studies have examined the relationships between anthropometric and physiological characteristics of volleyball players (Gabbet & Georgieff, 2007; Marques, M.C., van den Tillaar, R., Gabbett, T.J., Reis, V.M., & González-Badillo, J.J., 2009; Marques, M.C., Silva, A.J., Conceição, A.T., Aranha, A., Costa, A.M., & Marinho, D.A., 2010; Duncan, Woodfield & al-Nakeeb, 2006). On basis of achieved research results, it can be concluded that morphological-motor relation of sitting volleyball players suits morphological-motor relation of standing up volleyball players.

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