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DIFFERENCES ANTHROPOMETRICAL CHARACTERISTICS AND EXPLOSIVE POWER OF UPPER & LOWER LIMBS GREECE AND SERBIAN HIGH LEVEL HANDBALL PLAYERS

RAZLIKE U ANTROPOLOŠKIM KARAKTERISTIKAMA I EKSPLOZIVNOJ SNAZI GORNJIH I DONJIH EKSTREMITETA KOD PORFESIONALNIH RUKOMETAŠA SRBIJE I GRČKE

Summary: The differences between the anthropometrical characteristics and motor skill (explosive power), of the upper & lower limbs, between high level handball players of Greece and Serbian are examined in this study. The sample consisted of 21 Greek players aged 20±5 who had been training for 6±2 years and 20 Serbian players aged 19±4 years who had been training for 7±8 years. The anthropometrical characteristics were body height, body weight, extended arm distance, acromial distance and hand length (palm diameter). The motor skills are explosive power (upper & lower limbs). The analysis of the results ascertained that the Serbians had a significant statistical advantage over the Greeks in five the anthropometrical characteristics (p<0.05) as well as in the motor skill: power (explosiveness limbs). An important issue which was noted in the research is the fact that the Serbians, unlike the Greeks, apply strict anthropometrical criteria when choosing young players as well as place emphasis during training on the development of specific motor skills for game situations.
Key words: anthropometrical characteristics, handball, explosive power

Sažetak: razlike izmedju antropometrijskih karakteristika i motoričkih sposobnosti (eksplozivne snage) gornjih i donjih ekstremiteta, između porfesionalnih rukometaša Grčke i Srbije su ispitane u ovom radu. Uzorak se sastojao iz 21 grčkog igrača od 15 do 25 godina koji su trenirali 4 do 8 godina i 20 sprskih igraca od 15 do 23 godine koji su trenirali 7 do 8 godina. Antropološke karakteristike su visina težina, dužina raspona ruku, akromijalna dužina i dužina šake. Motoričke sposobnosti su eksplozivna snaga gornjih i donjih ekstremiteta. Analiza rezultata je dokazala da su sprski igrači statistički napredniji od grčkih u pet antropoloških karakteristika (p<0.05) kao i u motoričkim sposobnostima: snaga tj eksplozivnist. Važan problem koji je primećen u istraživanju je činjenica da Srbi za razliku od Grka koriste striktne antropometrijske kriterijume kada biraju mlade igrače kao i istaknutost mesta u toku treninga radi razvoja specifičnih motoričkih sposobnosti u situacionoj igri.
Ključne reči: antropološke karakteristike, rukomet, eksplozivna snaga.

INTRODUCTION

One of the most dynamic team sports which is distinguished for its highly developed level of motor skills such as speed, reaction speed, high jumps, endurance, strength, as well as coordination abilities is team handball (Wolf, Tittel, Doscher, Luck, Hierse, Kiess, Lippold, Tetzlaff, Kohler & Schaetz, 1974). The sport was first introduced in

Greece in 1977. The Greek team achieved sixth place in 2004 Olympic Games in Athens and 2005 World Championship Tunisia. Taking into consicleration the data of the Greek Handball Federation. Today, the sport has progressed, there are 60.000 members, 25.500 active players and 190 clubs. These growing numbers are proof of the rapid progress the sport has been making in Greece. The development of a sport depends on many factors and Greek team handball can be helped by studying and designing a model based on the experiences of many internationally successful countries. One of these countries is Serbia which has a long tradition in this sport. Not only geographical proximity, but also the fact that Serbia has a Balkan outlook to life and temperament, means that Serbia is a model country for the development of team handball in Greece.

To a large extent, the success of any sport depends on the level of its players' morphological characteristics and motor skills (Bota, 1984; Hošek & Pavlin, 1983). Ignatijeva (1986), stated that team handball players should, besides other characteristics, have a high level of competitive intelligence. Thirty years ago, Matson (1966), pointed out that a successful modern team handball player must be us fast as a sprinter jump us high as a high jumper, be as strong as a javelin thrower, and the have endurance of a middle-distance runner. Besides Bolek (1982), showed that a player's morphological characteristics significantly affect performance. More over, Stawiarski (1989), found that there was a significant correlation between the variables. Body weight, height and level of performance Oxyzoglou et al. (2004) found that body morphological characteristics contribute to the height and level of performance. Analyzing the motor skills of team handball players, Šimens & Pavlin (1983), showed that success depends on the level of their skills, which in turn influences the level of game performance. Pokrajac (1983), compared the body characteristics and the motor skills of team handball players of different levels and found significant statistical differences in relation to the competitive level of the game. In a similar study done in Greece, Bajios (1991) found the same differences in the competitive level of Greek players. Further more when he, compared the results of his study with those of Pokrajac, he found a statistical difference in the Serbian team's favour. Similar results found and Oxyzoglou (2001), Hatzimanouile & Oxyzoglou (2004). These results obviously show the discrepency of the competitive level of performance between the two countries.

Considering that there is limited bibliography on this topic in Greece and that Serbia has an excellent team handball school, we attempt to record and evaluate the differences of certain morphological characteristics and specific basic motor skills between these two countries.

METHODOLOGY
Subjects
The sample consisted of 41 team handball players of the National junior category. The sample was divided into two groups. The first group consisted of Greek team handball players (N=21) and the second of Serbian team handball players (N=20).
Procedure
Both the chronological age and training age of players were recorded. In addition, the protocol for the measurements included the following anthropometrical characteristics: body height in (cm); body weight in (kg); acromial distance in (cm); the extended arm distance in (cm); and hand length (palm diametre) in (cm). Measurements were made for

three motor indexes based on the 6 variables explained below. The evaluation of strength was measured according to the hand's strength and bench press in (kg). Power was measured by long jump in (cm); vertical jump in (cm); triple jump in (cm). Speed was measured in sprint in seconds (secs); The measurements were conducted according to the International Biological Program and standard measures were taken during the morning and afternoon hours before training and after warm ups. The conditions of measurements were strictly adhered to and the best of two attempts was recorded.

Statistical Analysis

The principle of descriptive and parametric statistics were used. In the analysis of the data, the mean, the standard deviation, the frequency of the values and their percentage were taken. For comparative statistics, factors analysis was used in order to compare the two sub-groups with the help of (student T-test) for small, independent samples. The level of significance was determined at .05.

RESULTS

From the analysis of the research findings, a statistically significant difference was observed which favored the Serbian players were 1.7 years younger when they stated training. The Serbians first started the sport when they were 11.6 years old, whereas the Greeks at 14.3 years of age. Yet another important statistical difference in favor of the Serbians was in all the anthropometric indexes. More specifically, the height of the Serbian players was on average 192.5 cm as compared to the Greeks whose average was 186.6 cm. In body weight the Serbians weighted 93.8 kg on average whereas the Greeks weighted 81.5 kg. In the acromional distance, the Serbians had on average 44.4 cm while the Greeks had 40.5 cm. In extended arm distance the former had 196.5 cm as opposed to the later who had 185.4 cm. Furthermore, in extended arm distance a big difference was observed with 24.6 cm and 21.8 cm respectively (Table 1).

A significant difference in explosive power exists between the two sample groups, as can be seen in Table 2. The Serbians with 52.6 kg outdid the Greeks in palm strength who had only 48.8 kg in palm strength. Also in bench pressure, the Serbians had 84.4 kg in comparison to the Greeks who had 74.2 kg. In the results of explosive power a significant difference was discerned in all of the variables in the Serbians' favor. More specifically, there was no significant difference between the two teams, in the long jump (210.1 cm to 196.5 cm), the vertical jump (59.2 cm to 54.571 cm), as well as in the triple jump (8.023 cm to 7.339 cm) there were significant statistical differences which clearly showed the Serbians to be better.

In the speed variables, the Serbians in the 10m sprint (1.752 sec versus 1.962 sec) achieved much better scores which were statistically significant.

DISCUSSION

From the results of the present study, it is clear that the two teams (Serbia and Greece) differed in practically all the variables of the morphological characteristics. The variables, such as body height and, acromial distance, extended arm distance, and hand length (palm diameter) are all very important in team handball. The higher values that the Serbian players had are perhaps related to the strict criteria for choosing players at an early age. According to Hošek & Pavlin's research (1983), as well as Bota's (1984), in

order to achieve a high rate of success it is a precondition that the players have the above mentioned morphological characteristics. Overall, the Serbian players reach these values whereas the Greek players do not. Bolek (1982), demonstrated the relationship between high achievement and anthropometrical characteristics where the national junior Czeck handball team had an average height of 189.06 cm and average weight of 83 kg. The Serbian players in our study actually surpassed these measurements. Roman Seco (1989), shows that there is a growing trend that the average height of team handball players is constantly increasing. This was also obvious from the data analysis of the Olympic Games in Seoul, Korea (1988) as well as in the World Championship in Switzerland in 1988, where the average height of players in seven out of the twelve teams in the finals was from 191.5 m up to 2 m.

Concerning extended arm distance, an acceptable measurement for high performance players, is close to 1.05-1.06 (index) of body height (Ghermanescu 1989; Focseneanu & Parasschiv 1986). In our study only the Serbian players came close to these values. Fulkozi (1994), by analysing the measurements he made on players of both the World Championship and the Olympic Games from 1970 to 1988, found that the average measurement for extended arm distance was 197.9 cm while for height it was 190.2 cm. Correlating these two variables, he came to the conclusion that the ideal value is 1.04. The Serbians with 1.025 come close to meeting this ideal, whereas the Greeks had only 0.99. The ideal average value for acromial distance is between 42-43 cm. (Germanescu 1989). The Serbian players in our sample do not simply come close to these measurements but they actually surpass them with 44.4 cm as opposed to the Greeks who had 40.548 cm. The ideal measurement for hand length is 24-25 cm (Germanescu 1989). Our results showed that the Serbians with 24.6 cm have the ideal average, the Greeks however, (21.8 cm) fall short in this area.

Comparatively speaking, it can be said that, as in Diaczuk's (1982) research who studied the importance of high performance and found that this was dependent on height, length of upper and lower limbs, as well as hand length, the Serbian team handball players, reach and at times even surpass, the ideal measurements in contrast to the Greeks who in many of these values fall short of the ideal average.

In Table 2 it can be seen that the Serbians in two variables which contribute to winning were statistically superior to the Greeks. In Bolek's (1982) research, which was based on measuring strength of the hand and the extended muscles of the elbow and knee, it was ascertained that the size of these particular muscle groups contributed to the high performance of both defense and attack moves.

In Table 3, the superiority of the Serbians in relation to the Greeks is obvious in all three variables of power of the lower limbs. This is the result of the high quality of training, whose aim is to improve these agility skills (strengthening the lower limbs). The Serbian teams trainers place a lot of emphasis in this area which directly help in improving a player's performance.

The results of the speed indexes the Serbian players were better in the 10m sprint. A major characteristic of contemporary team handball is both speed and reaction speed. This is most likely due to the high pressure of the defense resulting in the game having a fast pace which obviously only the faster players can keep up with (Germanescu 1983). In addition, high performance team handball players should be in a position to cover a distance equivalent to 2 km in a game. The relationship between running and defense

moves is 4:1 in other words 2000:4=500 m. This means that 500 m are covered in the form of defense moves which do not have greater distances than 1-4 m in length. From the total number of moves in one game, 60% are made with high intensity and distances which are no greater than 25 m. Out of these the first 8-10 m are the most important, since a high reaction speed is advantageous for counterattacks and a better overall speed (Kovač, Kovač, Jovanović & Durić, 1983; Kovač & Dukić 1980; Kovač 1977). Both Pokrajac (1983), and Greicel (1989), have referred to the importance of speed, emphasizing the contribution it makes to the percentage of goal scoring after a surprise attack. Furthermore, the same authors highlighted the fact that in contemporary team handball these types of goals are constantly on the increase. In our results it was shown that the Serbians were faster at the 10m sprint which is more important in team handball.

Thus, the Serbian team handball players appear to place more emphasis on a particular type of training, which includes the moves more often used in game situations rather than the more stereotypical, simpler moves of running in straight lines backwards and forwards.

On the index for coordination skills, the Greek players achieved better results and had a statistically significant difference in two of the four measurements. From our findings it appears that Serbian and Greek trainers use different types of training methods. The former enforce the type of training which is geared towards a game situation. More specifically, they apply exercises which require fast and precise execution in a small space. On the contrary, the Greeks seem to emphasize simpler forms of training, applying exercises of basic rectilinear running (basic forms of surprise attack), where the degree of difficulty from the point of view of technique and tactical skills is small.

In conclusion, the final results showed a statistically significant difference in the variables of all the morphological characteristics and the majority of agility indexes in favor of the Yugoslav players. We believe that to a large extent, useful comparisons can be obtained on the high level of team handball players' performance, which is dependent on the above mentioned morphological characteristics and specific motor skills. We propose that a model be adopted in Greece which borrows training strategies from the Serbian school followed in the future by further research which will compare the progress made by Greek Handball teams.

Table 1. Mean and levels of statistical significance of the morphological characteristics of the national handball teams of Serbian and Greece.

Variables	Serbia	Greek	Difference	p
Body height (cm)	192.525	186.571	5.954	0.006
Weight (kg)	93.825	81.571	12.254	0.0001
Acr. distance (cm)	44.4	40.541	3.852	0.0001
Ext. arm dist.(cm)	196.5	185.4	11.1	0.0004
Hand length (cm)	24.6	21.8	2.8	0.5403

Table 2. Mean and levels of statistical significance of strength between Serbian and Greek team handball players.

Variables	Serbia	Greek	Difference	p
Strength of the hand (kg)	52.6	48.833	3.767	0.078
Bench pressure (kg)	84.45	74.238	10.212	0.0002

Table 3. Results of statistical significance and mean scores of power between Serbian and Greek team handball players.

Variables	Serbia	Greek	Difference	p
Long jump (cm)	210.1	196.524	2.942	0.0055
Triple jump (cm)	8.023	7.399	3.339	0.019
Vertical jump (cm)	59.2	54.571	2.395	0.0215

Table 4. Comparison of speed indexes between Serbia and Greek team handball players.

Variables	Serbian	Greek	t	p
10m sprint (sec)	1.752	1.962	-4.143	0.0002

REFERENCES

Bajios, J. (1991). Analiza telesnog statusa i motoričkih sposobnosti rukometaša Grčke na tri takmičarska nivoa. Magistarski rad. F. F. V. Beograd.

Bolek, E. (1982). Prilog metodologij dinamometrijiskog ispitivanja snage rukometaša. Rukomet, 6: 62-70.

Bota, I. (1984). Handball modele de joc si pregatire. Editura sportturism, Bucuresti.

Cherwinski. J. (2000). Statistical analysis and remarks on the game character based on the European championship in Croatia 2000. (1): 5-10, *EHF* Periodical

Diaczuk, J. (1982). Karakteristika somatske građe rukometašica. Rukomet, 6: 80-84.

Fosceneanu, A. & Paraschiv, V. (1986). Criterii, probe si norme pentru selectia in handball. Editura *C.N.R.E.F.S.,* Bucuresti.

Fulkozi, K. (1994). Rukomet- Selekcija talenata. Sportski savez Beograda.

Gabrijelic, M. (1977). Manifestne i latentne dimenzije vrhunskih sportista nekih momčadskih sportskih igara u motoričkom-konativnom prostoru. Doktorska disertacija,   F.F.K. Zagreb.

Germanescu, I. (1989). Determing factors for the further devolment of Handball. Proceedings of internatioal Symposium of *I.H.F.,* Portugal, pp. 152-180.

Ghermanescu, K. (1984). Modelirane na idividualnata podgotofka na handbalistite. Mezd. seminar. Timisoara.

Germanescu, I. (1983). Teoria si metodica handbalului. Editura didactica si pedagogica, Bucuresti.

Greicel, W. (1989). The development of Handball during the 80ies and Results of the olympic games 1980. Proceedings of international symposium of *I.H.F.,* Portugal pp. 8-47.

Hatzimanouil, D. & Oxizoglou, N. (2004). Evaluation of the Morphological Characteristics and Motor Skills in the National Junior Handball teams of Greece and Yugoslavia, *Journal of Human Movement Studies, 46:125-140*

Hošek, A. & Pavlin, K. (1983). Povezanost između morfoloških dimenzija i efikasnosti u rukometu. Kineziologija,15 (2): 145-151, Zagreb.

Ignatijeva, V. (1986). Bazele stiintifice ale antrenamentului. Vol. XIL. Editura C.N.R.E.F.S., Bucuresti.

Klusov N.P. (1982). Rukomet 6, pp. 7-16,

Kovač, J. (1977). Korelacije nekih parametara koji karakterišu brzinu kod rukoetašica. Fizička kultura, 3: 180-183, Beograd.

Kovač, J., Kovač , M., Jovanović, V. & Durić, D. (1983). Faktorska struktura takmičarske aktivnosti rukometaša. F. F. K., Novi Sad.

Kovač, J. & Đukić, M. (1980). Kvantitativna analiza kretnih karakteristika rukometaša u takmičarskim uslovima. Sportska praksa, Novi Sad, 1: 6-10.

Cardinale, M. (2004). Handball Performance: Physiological Considerations & Practical Approach for Training Metabolic Aspects. Retrieved from World Wide Web at February 27, 2004.

Matson, R. (1966). Igramo rukomet. Sportska knjiga, Beograd.

Mocsai, L. (2002). Analysing and evaluating the 5th men's European Handball Championship. *EHF Periodical, (1):* 3-12.

Oksizoglou, N. (2001). Struktura motorickog prostora Grckih i Jugoslovenskih Juniorskih reprezentativaca u rukometu. *Masters Thesis*, F.F.V. Belgrade.

Οξύζογλου, Ν., Χατζημανουήλ, Δ., Ρίζος Α., Ρίζου, Ε. (2004). Διαφορές στη Βιολογική κατανομή επίλεκτων Ελλήνων-Γιουγκοσλάβων χειροσφαιριστών ηλικίας 19-21 ετών. *Φυσική αγωγή αθλητισμός και υγεία,* 16-17, 121-127.

Pokrajac, B. (1983). Telesni i motorički status rukometaša u odnosu na takmičarski nivo i komparativna analiza sa sportistima drugih sportskih igara. Doktorska disertacija. F.F.V. Beograd.

Seco, R. (1989). Modern ideas for Handball development. Proceedings of international symposium of *I.H.F.,* Portugal p.p. 192-222.

Stawiarski, W. (1989). Wynik a cenchy morfologiczne I wiek pilkarzy reczych. Sport wyczynowy, 27 b: 37-41.
Šimens, Z. & Pavlin, K. (1983). Relacije situacionomotoričkih faktora i ocena uspešnosti igranja rukometa. Kineziologija, 15 (2): 137-144, Zagreb.

Taborsky, F. (2001) Game performance in handball, (2), 23-26, *EHF, Periodical.*

Wolf, G., Tittel, K., Doscher, I., Luck, P., Hierse, B., Kiess, Chr., Lippold, G., Tetzlaff, B., Kohler, E. and Scaetz, P. (1974). Statistische Analyse uber Ursachen, Lokalisationen und Arten haufiger bei Training und Wettkampf aufgetretener Verletzungen und   Fehlbelastungsschaden im Hallenhandball. Medicine und Sport, 3:77-80.

Zimmerman, K. (1981). Koordinativne sposobnosti u igri. Rukomet, 5: 12-14, Beograd.