2nd International conference "Management in Sport", University in Belgrade 11-12 May 2006, 420-433

DETERMINING - LEVEL HANDBALL PLAYERS' MORPHOLOGICAL CHARACTERISTICS AND MOTOR ABILITIES, i.e. STRENGTH, AGILITY AND FLEXIBILITY, BY PLAYING POSITION.

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*Summary***:** High performance in team sports is to a great extent dependent on the level of the players' morphological characteristics and motor abilities according to their playing position. The aim of this research is to evaluate and determine the players' morphological characteristics and motor abilities, i.e. strength, agility and flexibility, according to their playing position. The sample used consisted of 46 handball players, aged 18-21, from the national teams of Greece and Yugoslavia. Further on, the sample was divided in four experimental subgroups corresponding to four playing positions. More specifically, the subgroups consisted of goalkeepers (n=8), wingers (n=14), backcourt players (n=16) and pivot players (n=8). The above athletes were biologically distributed on the basis of five morphological characteristics on the one hand and three motor indices on the other. The morphological characteristics chosen for evaluation were height, weight, bioacromial distance, palm diameter and extended arms distance. The determination of motor abilities was performed on the basis of strength, agility and flexibility indices. Comparative measurements among the four subgroups were carried out by means of the Kruskal –Wallis method, whereas the Maun-Whithney U method was used to compare small independent samples. The level of significance was defined at 0.05. In terms of height, weight and palm diameter variables, the research results showed a great difference between goalkeepers, backcourt players and pivot players on the one hand and wingers on the other, with the latter presenting significantly lower values. As regards explosive strength, there was no significant difference among different playing positions. In terms of agility, values were greater for wingers and backcourt players as compared to goalkeepers and pivot players. Furthermore, wingers displayed significantly higher wrist joint flexibility compared to pivot players, whereas goalkeepers displayed higher hip joint flexibility in relation to any other playing positions. Therefore, we were drawn to the conclusion that morphological characteristics such as high height, ideal weight, appropriate bioacromial distance, required extended arms distance, palm diameter and motor abilities such as high-level strength, agility and flexibility are represented with different values for each one of the playing position respectively.

Key Words: competing position, morphological characteristics, strength, agility, flexibility

INTRODUCTION

Both morphological characteristics and motor abilities of athletes play a significant role and contribute greatly to high performances in the majority of team sports (Bolek, 1982; Hošek & Pavlin 1983; Stawiarski, 1989). In team sports, athletes' body type and morphological characteristics are related to both the type of sport and the athlete's playing position (Bakler, 2000). With regard to morphological characteristics in handball, having carried out anthropometric analyses on handball players who participated in the 1980 Olympics, Jeschke (1981) established that average height displayed an increasing trend in relation to the 1976 Olympics. More specifically, body height, length of upper and lower

limbs and body weight should be related to corresponding playing positions (Ackland, Mazza & Carter, 1994; Ramadan & Byrd 1987; Roche, Heymsfield & Lohman, 1996). Based on an analysis of men's average height in World Championships and Olympics Games between 1970 and 1988 Creissel (1989) established an increase from 184.6cm to 190.1cm. According to Seco (1998) average height and weight in the Men's Youth European Championship amounted to 188.99cm and 87.36kg respectively, i.e. compared to the former European championship values increased by 6-7%. Having analyzed former Yugoslavia's men's national team between 1970 and 1986 Fulkozi (1994) demonstrated that average height increased from 183.4cm to 190.2cm and average weight from 82.4kg to 86.1kg, whereas in terms of extended arms distance there was an increase from 191.5cm to 197.9cm. The increasing trend of all of the above values may have caused a corresponding change of indices values in playing positions. Having analyzed the men's European Championship Seco (2001) ascertained that central backcourts' average height was 193.6cm, whereas central backs' average height amounted to 187.1cm. According to the same researcher (1998), based on height comparisons by playing position, goalkeepers were 186.25cm tall and 87.66kg heavy, whereas wingers were 181.8cm tall and 78.1kg heavy respectively. Central backcourt players were 189.25cm tall and 87kg heavy, side backcourt players 194.5cm tall and 90kg heavy and pivot players 191.8cm tall and 93.2kg heavy. According to Mocsai's analysis (2002) of the results of men's 5th European Championship average height and weight were 191cm and 91kg respectively.

As far as motor abilities are concerned, Izaak's study (1975), in which players' defending and attacking roles are examined separately, analyzed the distances covered in relation to playing position and found that -with the exception of central backcourt players- there were no significant statistical differences. The latter established that wingers and pivot players presented the highest values in terms of relative torso strength in relation to all other playing positions. In a similar research, pivot players presented greater relative strength in upper and lower limbs, whereas wingers presented greater muscular endurance in both torso (abdominal muscles) and feet extension (Bolek, 1982b). More specifically, with regard to lower limbs strength in standing triple jump, the ideal value for high-level handball players should range between 9 and 9.50m (Jeftusenko, 1981; Khosla 1983; Tumanian & Martirosov 1976). Based on specific measurements Fulkozi (1994) observed that vertical jump increased from 59.1cm to 68.8 cm and horizontal jump from 258.1cm to 269.7cm. The latter mentions that the increasing trend of all of the above parameters possibly also depends on playing positions.

Agility is a prerequisite motor ability, primarily for the defenders, since they have to move frequently creating openings within an area of 3-4meters (Fekete & Kovacs 1983, Zarek & Stawiarski 1978). Moreover, front, central and side backcourt attackers perform back and front movements (within an area of 5 - 6meters) thereby covering approximately 1000meters during a game (Slovik, Horvat & Zafkova, 1989). The ratio of running and defense movements is 4:1, i.e. 2000/4=500 m, i.e. out of 1000meters 500 are covered by defense movements performed within an distance of 1-4meters at the most (Kovac, Kovac, Jovanovic, & Djuric 1983; Kovac, Djukic 1980; Kovac 1977). The analysis of the results of men's 5th European championship by Mocsai (2002) showed that agility is related to weight rather than to height.

Flexibility is considered to be a primary motor ability for all handball athletes indiscriminately, as it allows greater width joint movements and in many occasions is determinant of successful performance (Anderson, 1989; Zaciorski, 1981). Handball is a dynamic team sport requiring among other motor abilities flexibility (Wolf, Tittel, Doscher, Luck, Hierse, Kiess, Lippold, Tetzlaff, Kohler & Schaetz, 1974).

On the basis of the above, the conclusion is drawn that top-rank handball players regardless of their playing positions should possess outstanding morphological characteristics and motor abilities which probably contribute to the overall team performance.
The majority of available research studies related to morphological characteristics in handball are primarily concerned with handball athletes in general rather than with handball players by playing positions. Moreover, those referring to motor abilities by playing positions are very few and in addition they do not take into consideration variables that are included in our study. This fact dictated the need for the present study the aim of which was to determine and evaluate specific morphological characteristics, i.e. height, weight, extended arms distance, bioacromial distance and palm diameter and specific motor abilities, i.e. strength, agility and flexibility by playing position, as well as to provide comparative results.

METHOD

Subjects

Our sample consisted of 46 handball players, aged 18-21, from the national teams of Greece and Yugoslavia. Further on, the sample was divided in four experimental subgroups. More specifically, the subgroups consisted of goalkeepers (n=8), wingers (n=14), backcourt players (n=16) and pivot players (n=8).

Procedure

The morphological characteristics chosen for evaluation were height, weight, bioacromial distance, palm diameter and extended arms distance. The determination of motor abilities was performed on the basis of strength, agility and flexibility indices. Strength evaluation was carried out based on the following measurements: a) standing horizontal jump (cm), b) triple jump (cm) and c) vertical jump (Abalakov test, cm). Agility was evaluated on the basis of the following measurements: a) the best time achieved in 10x5 m (sec) backward running, b) the best time achieved in 6x5 m (sec) front-to-back running and c) the best time achieved in running around a square (envelop) with dimensions 5mx3 m (sec). Flexibility was evaluated by measuring a) wrist joint flexion – extension width (^{0}), b) wrist joint flexion width (^{0}), c) wrist joint extension width (^{0}) and d) width of hip joint with Spaggat (index).

Following the directions of Clarke, 1976; Johnson & Nelson, 1979; Pokrajac, 1983, measurements were carried out in the morning and evening prior to training and after warm-up, according to the measures provided by the International Biological Program. Measurement conditions were strictly adhered to, while the measurement kept was the optimal one between two efforts.

Statistical analysis

For the purposes of the study, the principles of descriptive and non-parametric statistic were used to carry out quantitative measurements. Fur the purposes of descriptive statistics measurements, the sample average (- M) and standard deviation (- SD) were used. The Kruskal-Wallis and Mann-Whitney U analysis were used to compare subgroups. The significance level was .05.

RESULTS

Based on the Kruskal-Wallis analysis, statistically significant differences were found among playing positions in terms of height, body weight, palm diameter ($H=9.13$, $p<.02$), running around a square 5x3m ($H=9.18$, $p<.05$), wrist joint width and spaggat ($H=13.08$, $p<.001$), (Table 1).

Table1: *Average values, Standard Deviations and average of morphological characteristics and motor abilities by playing position.*

	Goalkeepers	Wingers	Backcourt Players	Pivot Players

		$Rang_M$		$Rang_M$		$Rang_M$		$Rang_M$
	M		*M*		*M*		*M*	
Body height	189.18±4.22	20.88	183.62±6.94	11.44	191.81±6.40	24.83	190.57±8.69	22.21
Weight	87.25±8.17	20.69	80.18±8.00	11.88	91.08±9.65	24.44	88.71±10.68	20.93
Acromional distance	42.50±2.28	21.50	41.18±3.26	16.56	42.77±2.69	22.25	42.71±2.44	22.29
Palm distance	23.12±1.95	18.38	22.31±.84	10.94	24.17±1.86	24.39	24.78±1.165	26.79
Hand extention	190.37±5.35	14.63	190.87±8.23	15.94	196.19±6.28	25.22	194.97±7.99	22.21
Long jump	206.62±16.23	24.63	208.00±22.44	19.19	201.21±11.79	19.81	202.42±20.14	22.00
Triple jump	769.12±53.92	20.56	779.12±109.32	21.19	778.05±58.63	22.22	759.14±26.90	18.14
Vertical jump	57.50±6.09	23.31	58.62±9.88	20.88	56.44±5.50	21.08	55.71±4.82	19.43
Running 10x5m	14.06±.50	28.44	13.64±.54	20.75	13.50±0.63	19.19	13.49±0.59	17.43
Running 6x5m	8.76±.38	24.88	8.37±.46	16.06	8.56±0.45	20.33	8.68±0.26	23.93
Running around a square 5x3m	11.82±.70	29.38	10.91±.33	13.50	11.16±0.60	19.17	11.46±0.57	24.71
Width of wrist joint	145.62±16.54	22.44	150.12±13.01	25.50	145.38±18.03	20.19	140.28±13.23	16.29
Wrist flexion	72.25±9.45	20.50	77.00±6.41	24.81	74.44±9.10	21.31	70.85±11.20	16.43
Wrist extension	70.37±11.66	21.06	73.12±7.66	23.31	71.16±12.93	21.44	68.00±7.93	17.14
Spaggat	0.11±4.23	8.44	0.17±3.74	21.38	0.17±3.19	22.53	0.20±3.55	31.00

Based on the Mann-Whitney analysis, statistically significant differences were observed in terms of height (Backcourt players and Goalkeepers > Wingers) and body weight (Backcourt players > Wingers), palm distance (Wingers < Backcourt players and Pivot players), arms extension (Goalkeepers > Backcourt players**)**, 5x3m running (Wingers > Goalkeepers and Pivot players, Backcourt players > Goalkeepers), width of wrist joint (Wingers > Pivot players), spaggat (Goalkeepers > Wingers, Backcourt players and Pivot players). There were no statistically significant difference by playing position in terms of bioacromial distance, arms extension, jumps and wrist flexion - extension. (Table 2)

Table 2: *Rank comparison among position team handball players.*

	Goalkeepers vs Wingers		Goalkeepers vs Backcourts		Goalkeepers vs Pivot Players		Wingers vs Backcourts		Wingers vs Pivot Players		Backcourts vs Pivot Players	
	Mann-Whitney *U*	*p*	Mann-Whitney *U*	*p*	Mann-Whitney *U*	*p*	Mann-Whitney *U*	*p*	Mann-Whitney *U*	*p*	Mann-Whitney *U*	*p*
Body height	15.00	.07	57.00	ns	25.00	ns	25.00	.00	15.50	ns	56.00	ns
Weight	18.50	ns	62.00	ns	22.00	ns	25.50	.01	15.00	ns	57.00	ns
Acromional distance	25.00	ns	70.50	ns	26.50	ns	51.50	ns	20.00	ns	62.50	ns
Palm distance	20.50	ns	50.50	ns	17.00	ns	27.50	.01	3.50	.00	58.00	ns
Hand extention	31.50	ns	32.50	.02	16.00	ns	41.50	ns	18.50	ns	57.00	ns
Long jump	24.00	ns	54.00	ns	25.00	ns	66.50	ns	27.00	ns	54.00	ns
Triple jump	30.00	ns	66.50	ns	24.50	ns	69.50	ns	26.00	ns	49.00	ns
Vertical jump	31.00	ns	68.00	ns	22.50	ns	71.50	ns	27.50	ns	58.00	ns
Running 10x5m	19.00	ns	39.50	.07	14.00	ns	66.50	ns	23.00	ns	57.00	ns
Running 6x5m	17.50	ns	56.50	ns	27.00	ns	58.50	ns	16.50	ns	53.00	ns
Running around a square 5x3m	7.00	.00	36.50	.05	21.50	ns	53.50	ns	12.00	.06	46.50	ns
Width of wrist joint	31.00	ns	67.00	ns	20.50	ns	52.50	ns	12.50	.07	53.00	ns
Wrist flexion	25.00	ns	69.50	ns	22.50	ns	59.50	ns	17.00	ns	47.00	ns
Wrist extension	30.50	ns	68.50	ns	22.50	ns	65.50	ns	17.50	ns	52.00	ns
Spaggat	10.00	.02	19.50	.00	2.00	.00	66.50	ns	14.50	ns	32.50	.06

DISCUSSION

Great success in sports is to a great extent dependent on the level of morphological characteristics (Hošek & Pavlin 1983). Morphological characteristics that are specifically required for handball, i.e. high height, great upper and lower limbs length, as well as ideal body weight, should be examined in relation to different playing positions (Roche, Heymsfield, Lohman, 1996). Taborsky (2001), mentions that with regard to handball biokinetics, high height, ideal weight, long upper limbs and fingers constitute great

advantages. The latter also suggests that the aforementioned parameters play a determining role in both defense and attack. Tall players have an advantage over shorter ones when it comes to man-to-man operations, ball possession and ball control, in throws, ball transfers and block shots. Players' height in top-quality teams ranges between 188 and 192 cm. Cherwinski's analysis (2000) of the results of the pan-European championship ascertained that the poor performance of the Portuguese team could be attributed to low-level morphological characteristics.

Goalkeepers

The results of our study showed that goalkeepers present high height values. More specifically, height average in our sample was 189.18±4.22 cm. Our results agree with those of Fulkozi (1994) who concludes that goalkeepers' height average is 191.250 cm. Similar results are presented by Taborsky (2001) who maintains that goalkeepers are ranked among the tallest players of a team their height approximating 192 cm. Average weight of goalkeepers was 87.25±8.17 kg. Our results agree with those of Bayios (1999b) presenting similar values ranging between 80 and 88 kg. Seco (1993) gives a similar value (89.2 kg) as well. According to our results bioacromial distance amounted to 42.50±2.28 cm, while palm diameter was 23,12±1.95 cm. Our results agree with those of who mentions that ideal values of the above variables regardless of playing position amount to 42-44 cm and 24-25 cm correspondingly Ghermanescu (1983). In our study, extended arms distance average was 190.37±5.35 cm. Also Ghermanescu (1983) presents a 200 cm extended arms distance average and maintains that extended arms distance value should reach 106/100 of height value. With regard to standard horizontal jump, triple jump and vertical jump, goalkeepers' extended arms distance amounted to 206.62±16.23 cm, 769.12±53.92 cm and 57.50±6.09 cm correspondingly. Fulkozi (1994) observed that horizontal jump increased from 258.1 cm to 269.7 cm and vertical jump from 59.1 cm to 68.8 cm. Extended arms distance value is lower in our study, possibly due to the different composition of the samples used (seniors – juniors).

According to Arslanagic (1997) agility is one of the most important motor abilities of a goalkeeper. Furthermore, a goalkeeper should be distinguished for his outstanding balance, movement precision with or without the ball and good orientation in relation to time and space (Zaciorski, 1981).

As far as wrist joint flexibility is concerned, goalkeepers' total movement width was 145.62±16.54^{o}, whereas wrist flexion and extension amounted to 72.25±9.45^{o} and 70.37±11.66^{o} correspondingly. According to Burton et al. (1992), palm flexibility plays an important role in ball landing and ball control. These are essential in order for the goalkeeper to be able to transfer the ball quickly and precisely, especially in case of feints. The value of hip joint flexibility in our study amounted to 0.11±4.23 (index). According to Arslanagic (1997), flexibility, especially hip joint flexibility, should be highly developed, since it is prerequisite to successful kicks when the lower limbs are used.

Wingers

Wingers' average height and weight values according to our study were 183.62±6.94 cm and 80.18±8.00 kg correspondingly. Our results partially agree with those of Fulkozi's (1994) study, in which it is shown that wingers' average height was 187.5 cm. However, our sample consisted of juniors, not seniors. An older opinion according to which wingers are short is now considered played out. As a result, due to the fact that height in handball teams is characterized by an increasing trend, wingers are often assigned tackling of taller players. Therefore, wingers' height and body mass should be approximately 185 cm and 80 kilos respectively. According to Ghermanescu (1983), height and body weight index should approximate the value of 1.06. Our results approximate this value (83.62/80.18=1.043). Oxizoglou & Hatzimanouil (2003), establish that average height and weight of top-rank

handball players is 189.548 cm and 87.698 kg correspondingly. According to our results, bioacromial distance and palm diameter were 41.18±3.26cm and 22.31±0.8 cm correspondingly. Ghermanescu (1989) concluded that bioacromial distance's ideal average ranges between 42 and 44 cm, whereas ideal palm diameter average ranges between 24 and 25 cm. Oxyzoglou, Hatzimanouil, Rizos & Rizou (2004) research established that elite Yugoslavian handball players' average bioacromial distance value regardless of position was 44.4 cm, whereas in terms of this variable the corresponding value for Greek handball players amounted to 40.541 cm. Vujovic (2004) mentions that in a top-rank handball players' sample aged 16-18 the greatest recorded difference in palm diameter mean value was between goalkeepers and wingers. More specifically, with regard to palm diameter goalkeepers surpass wingers. According to our research results extended arms distance average was 190.87±8.23 cm equaling the average (190.95 cm) recorded by Oxyzoglou, Hatzimanouil, Rizos & Rizou (2004) for elite handball players, both Greek and Yugoslavian.

Wingers' horizontal and triple jump values are according to our results 208.00±22.44 cm and 779.12±109.32 cm correspondingly. According to Bayios (1999), wingers perform 46% of total team efforts, out of which 65% are successful. Since in most cases their efforts are in the form of feints, wingers should possess outstanding strength. Vertical jump value for wingers is 58.62±9.88 cm. Based on Fulkozi's (1994) analysis of Yugoslavia's men's national team between 1970 and 1986, vertical jump increased from 59.1 cm to 68.8 cm. The ability to perform high horizontal and vertical jumps lends players a significant advantage during the game and as a result increases the possibilities for better performance (Klizning, 1991).

Concerning agility, our results showed high values, primarily in relation to the variable of running (5X3m), in which movements towards all possible directions are required (10.91±.33 sec). Most athletes, but primarily wingers in front defense and side defense position, have to perform front, back and lateral movements within an area of 5-6 meters thereby covering approximately 1000 during a game (Slovik et al. 1989).

Concerning wrist joint flexibility, wingers' total movement width was 150.12±13.01^{o}, whereas flexion width was 77.00±6.41^{o} and wrist extension width 73.12±7.66^{o}. Moreover, wingers' hip joint flexibility amounted to 0.17±3.74 index. Bolek (1982a) points out that in this position highly developed wrist joint flexibility is an important factor that determines successful ball transfer and ball throw.

Backcourt players

The results of our study showed that backcourt players are the tallest of our sample. Their average height and weight amounted to 191.81±6.40 cm and 91.086±9.65 kg correspondingly. Our results agree with those of Fulkozi's (1994) study, according to which backcourt players are taller than 190 cm. Backcourt players are divided in central backs and side backs. Taborsky (2001) mentions that apart from goalkeepers the tallest players (over 192 cm) of a team are the side backcourts. Based on an analysis of central backcourt players' height in the men's Youth pan-European Championship Seco (1998) found that average height of central backcourt players increased in relation to previous years height values. This increase is attributed to the participations of Balkan teams for which strictly tall players are selected for backcourt positions. Although central backcourts are shorter in relation to their opponents, i.e. central defenders, they are able to perform well in team attacks, since they have the chance to execute many different types of throws during the game, such as extended arm overhead throws and shoulder height throws (Seco, 2001). According to the same study, bioacromial distance and palm distance values were 42.9 cm and 24.7 cm correspondingly. The above values appear to have improved in relation to the Hatzimanouil & Oxyzoglou

(2004) study, in which bioacromial distance and palm distance values were 42.4 cm and 23.2 cm respectively. This is possibly owed to the fact that each study used samples of different composition (seniors– juniors). As regards extended arms distance, our results showed a 196.19±6.28 cm average. Our results agree with those of Fulkozi (1994), who on the basis of analyses and comparative measurements carried out on participants in world championships and Olympics Games between 1970 and 1988 found that extended arms distance average regardless of position was 197.9 cm.

According to tour results, standing horizontal jumps, triple jump and vertical jumps values for backcourt players were 201.21±11.79 cm, 778.05±58.63 cm and 56.44±5.50 cm respectively. In a similar research carried out by Vujovic (2004) concerning the explosive strength of teenage handball players' (16-18 years old) lower limbs, it was ascertained that the greatest divergence recorded was between goalkeepers and backcourt players. On the other hand, the smallest divergence was between wingers and central backcourt players. A great number of goal shoots with jump (24%) are executed from the circumference of the court and more specifically from the center (Zahalka et al. 1997). Consequently, correct technical execution of this type of throws requires high-level explosive strength, mainly in the lower limbs. An ideal top-rank handball player should be able to perform high standing triple jumps (Jeftusenko,1981; Khosla 1983; Tumanian & Martirosov 1976). In our study, the values in question were lower than the ones mentioned by Jeftusenko, Khosla, Tumanian & Martirosov, possibly due to the fact that different age samples were used (juniors – seniors).

As already mentioned, agility in handball is an essential motor ability, primarily in defense, regardless of playing positions, since all players have to move frequently thereby creating openings within a distance of approximately 3-4 meters (Bayios 1999; Fekete & Kovacs 1983; Zarek & Stawiarski 1978). Furthermore, side backcourt players in attack perform front and back movements (within an area of 5-6 meters) thereby covering approximately 1000 meters during a game (Slovik et al. 1989).

Regarding wrist joint flexibility, backcourt players' wrist movement width was 145.38±18,03^{o}. More specifically, wrist width flexion was 74.44±9.10^{o}, while wrist width extension was 71.16±12.93^{o}. Pappas, Morgan, Schulz & Diana (1995) suggest that effectiveness is related to wrist movement width maintaining that wrist joint flexion and extension influence the ball's direction. In terms of the spaggat measurement (0.17 index) the greatest divergence recorded was between backcourt players and goalkeepers.

Pivot players

Pivot players' height and weight average in our study amounted to 190.57±8.69 cm and 88.71±10.68 kg respectively. These results are different from those of Taborsky (2001), according to whom players in this playing position are usually taller than 192 cm. However, our sample consisted of juniors not seniors. According to Fulkozi (1994) pivot players were 190-195 cm tall and heavier than players in any other playing positions. The latter points out that pivot players usually play in the position of central defender as blockers. Klusov (1982) suggests that pivot is a highly specific position in handball due to the fact that pivot players stand on the 6 m line and as a result are isolated from the rest of the team. Due to the fact that defenders play very hard, pivot players should possess especially developed morphological characteristics. More specifically, due to central defenders' outstandingly high height which usually ranges between 1.95 and 2.00 m (Jeftusenko, 1981; Khosla, 1983; Tumanian & Martirosov, 1976), pivot players should possess high-level physical characteristics, so as to be able to perform effectively. As concerns pivot players, Seco (1998) observes that an increasing trend in both height and weight has been recorded in relation to previous years data. According to our results, pivot players' average bioacromial distance, palm diameter

and extended arms' distance were 42.71±2.44 cm, 24.78±1.16 cm and 194.97±7.99 cm correspondingly. The study of Hatzimanouil & Oxyzoglou (2004) showed that average bioacromial distance, palm diameter and extended arms' distance regardless of playing positions were 42.4 cm, 23.2 cm and 190.9 cm respectively. Pokrajac (1983), points out that training influences greatly handle and ball control. Both handle and ball controls depend on palm diameter. Diaczuk (1982) explored the importance of the above parameters (upper and lower limbs length – palm length) and concluded that they are interrelated with top performance in handball. Moreover, on the basis of the present study's results it was demonstrated that in terms of the abovementioned variables pivot players' values approximate and at times identify with the ideal average values recorded by Ghermanescu (1989).

Pivot players' standing horizontal jump values, triple jump values and vertical jump values amounted to 202.42±20.14cm, 759.14±26.90 cm and 55.71±4.82 cm. The same variables for athletes in other playing positions were higher but statistically negligible. This is possibly due to the pivot players' optimal strength Bolek (1982a).

Agility is an essential motor ability for pivot players, especially in defense, since they have to move frequently creating openings within an area of 3-4 meters (Bayios 1999; Fekete & Kovacs 1983; Zarek & Stawiarski 1978). In addition, they often undertake the role of central defenders and as a result they have to tackle opponents with high-level mobility and explosiveness. Considering this, agility is deemed extremely essential for pivot players

Pivot players' wrist joint and hip joint flexibility amounted to 70.85±11.20 cm and 0.20±3.55 (index) correspondingly. These were the lowest recorded values in relation to any other playing positions. As concerns certain variables such as spaggat the difference between pivot players and the rest of playing positions was significant. A possible explanation for this is that pivot players most of the times execute high-angle goal shoots from the centre of the goal area. As a result, they rarely have to execute throws requiring high-level wrist joint flexibility, as opposed to wingers who have to execute highly effective throws from a small angle (Taborsky, 2001).

CONCLUSIONS

Based on the results of the above study the following conclusions were drawn:

1. Goalkeepers are characterized by high height, ideal weight, bioacromial distance and palm diameter. In addition, compared to players in other playing positions, they are distinguished for their highly developed flexibility, especially of the hip joint.
2. Wingers are characterized by relatively small height and palm diameter compared to backcourt and pivot players, while their weight and extended arms distance are normal. They are also distinguished for their highly developed agility compared to goalkeepers and pivot players, as well as for their greater wrist joint movement width compared to pivot players.
3. Backcourt players are taller than players in any other playing position. More specifically, they surpass wingers in height, weight and palm diameter thereby presenting the greatest value difference recorded in our study. In addition, they surpass goalkeepers in agility and pivot players in flexibility.
4. Finally, pivot players are characterized by high height, large weight, long extended arms distance and the longest palm diameter in comparison with players in any other playing position. The greatest recorded difference was between pivot players and wingers. As regards motor abilities, i.e. wrist agility and flexibility, pivot players presented the lowest values thereby marking the greatest downward difference.

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