

ANTHROPOMETRIC PROFILE OF ELITE MALE HANDBALL PLAYERS IN ASIA

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Abstract. Anthropometric profiles of elite athletes provide insights into the requirements for competing at top level in particular sports. Due to the comparative lack of data for contemporary handball players, the present study was conducted to describe the anthropometric characteristics of international male Asian handball players and identify any positional differences existing. Sixty three players from five different countries were measured in the 12th Asian Games in Hiroshima for height, mass, skinfold thicknesses and estimates of body fat and muscle mass. Results were compared with data for the English handball squad for reference purposes. Significant differences were evident among the Asian teams, the group from East Asia being taller and lower in adiposity than the teams from West Asia. A relative homogeneity was observed among positional roles. The more successful teams were taller and had lower body fat than the less successful teams. It is concluded that Asian handball players differ in anthropometric characteristics from European players previously studied and that specific anthropometric variables are associated with successful tournament performance at international level in Asia. *(Biol.Sport 24:3-12, 2007)*

Key words: Adiposity - Muscle mass - Asian Games

Introduction

Anthropometric measurements relevant to human movement gained formal recognition as a discipline with the inauguration of the International Society for Advancement of Kinanthropometry in 1986. Anthropometrists of all continents have participated in several major multidisciplinary studies that are being or have been conducted to assess the physical characteristics of people. Kinanthropometry

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has been defined as the quantitative interface between human structure and function [17]. This interface is examined through the measurement and analysis of age, body size, shape, proportion, composition and maturation as they relate to gross body function. Previous reports have shown that body structure and morphological characteristics are important determinants of performance in many sports and certain physical impressions such as body composition (body fat, body mass, muscle mass) and physique (somatotype) can significantly influence athletic performance [1,6].

Handball is one of the Olympic Games team sports which requires a high standard of preparation in order to complete 60 min of competitive play and to achieve success. In this game movement patterns are characterised as intermittent and change continuously in response to different offensive and defensive situations. Anthropometric factors and morphological characteristics can influence the effectiveness of such responses, as has been observed in other sports [5]. Therefore, anthropometric profiles may contribute to understanding the suitability of players for the sport of handball, particularly at a high standard of play.

Carter [2] reported that somatotype explained from 25% to 60 % of the variance in physical fitness tests. He concluded that handball players should be classified as "endomorph". Deng *et al.* [5] suggested that male Chinese handball players should be muscular, strong and tall. The Asian players participating in the 1995 World Championships in Iceland were smaller and lighter than their European counterparts [9]. French international handballers were on average 13 cm taller, 5.4 kg heavier and had 1.2 % less body fat than their national-level counterparts [14]. Handball players in Bahrain were found to be heavier than basketball and volleyball players despite being lighter than both groups [13]. Hirata [8] and Khosla [10] demonstrated that the players in medal-winning teams were taller than the others, thus suggesting how important body height and mass are to play handball successfully. Despite the game's world-wide popularity, there have been few other investigations of anthropometric and physiological characteristics of elite male handball players: most notably, recent data are lacking.

The purpose of this study was to establish anthropometric characteristics of successful handball players in the Asian handball championship for males and identify any positional variations between players from five different countries. In addition, the English handball team was used as a reference group for comparison.

Materials and Methods

Subjects: Seventy one subjects took part in this investigation. Sixty three players competing in the 12th Asian Games in Hiroshima (Japan) participated in the study from the following teams; 17 players were from the Kuwait national team (age 26.0 ± 3.0 years), 16 players from Japan (age 26.0 ± 2.0 years), 13 players from Saudi Arabia (age 25.0 ± 3.0 years), 10 players from China (age 25.0 ± 3.0 years), 7 players from South Korea (age 25.0 ± 2.0 years). Eight players from the English national squad (age 20.0 ± 2.0) formed a reference group.

Procedures: Measurements were made of height, body mass, skinfold thicknesses and limb circumferences. The height was measured by means of stadiometry to the nearest 0.5 cm and a hydraulic scale (Jonelle) was used to measure body mass to the nearest 0.1 kg. Skinfold thickness was measured by means of Harpenden skinfold calipers at five anatomical sites - the biceps, triceps, sub-scapular, suprailiac and anterior thigh.

The biceps skinfold was taken vertically from the front of the arm, at the mid-point between the shoulder and the elbow. The triceps skinfold was taken vertically from the back of the arm, at the mid-point between the acromion and olecranon processes. The subscapular skinfold was measured at an angle of 45 degrees to the vertical, running laterally and downward in the natural cleavage line of the skin at the inferior angle of the scapula. The suprailiac skinfold was obtained superior to the iliac crest on the mid-axillary line. The anterior thigh skinfold consisted of a vertical fold on the anterior aspect of the thigh, midway between the hip and knee joints. Adiposity was indicated by the sum of five sites according to the position statement of the British Olympic Association [15]. The % body fat was estimated by calculating the average of three measurements taken for each of the four sites [7].

The calculation of % body fat considered the following:

- a) the sum of the four skinfold thickness (biceps, triceps, sub-scapular, suprailiac);
- b) the age of the subject;
- c) the sex of the subjects.

The anthropometric measurements used to estimate muscle mass were skinfold thickness at the front thigh and medial calf, and the circumferences of the forearm, thigh and calf [11]. The front thigh skinfold was taken as explained before. The medial calf skinfold was taken vertically on the posterior aspect of the calf in the mid-sagittal plane 5 cm inferior to the fossa poplitea. The forearm circumference was taken at the proximal part of the forearm (within 5 cm of the elbow). The subject stood erect with arm extended in the horizontal plane. The experimenter

stood behind the subject's arm and moved the tape up and down the forearm perpendicular to the long axis until the maximum circumference of the forearm was located. The mid-thigh girth was taken at the mid-point between the trochanterion and tibiale laterale. The calf girth was taken when the tape was moved up and down the calf perpendicular to the long axis until the greater circumference was located. The estimated % muscle mass was calculated according to Martin *et al.* [11].

Statistical analyses: The statistical analyses of data were carried out using one-way analyses of variance (ANOVA). Levene's test was first carried out to examine the homogeneity of variances. When an F statistic indicated a significant difference, Tukey's HSD post hoc test was applied to determine which of the ordered means were significantly different from each other. Statistical significance was set at the $p < 0.05$ level.

Results

Table 1

Anthropometric and body composition characteristics of male handball players grouped according to their nationality (mean \pm SD) (China = 10, England = 8, Japan = 16, Korea = 7, Kuwait = 17 and Saudi Arabia = 13 players)

Teams	Age (years)	Height (m)	Body mass (kg)	Body fat (%)	Sum 5 skinfolds (mm)	Muscle mass (%)	Muscle mass (kg)
England	20.0 ± 2.0	1.742 ± 0.054	77.5 ± 11.5	13.4 ± 5.1	46.5 ± 18.5	47.8 ± 8.0	37.0 ± 6.2
China	25.0 ± 3.0	1.900 ± 0.074	85.4 ± 10.0	9.6 ± 2.8	30.9 ± 7.8	54.5 ± 8.8	46.5 ± 7.5
Japan	26.0 ± 2.0	1.854 ± 0.067	80.6 ± 3.9	9.2 ± 2.0	28.8 ± 5.3	49.0 ± 5.9	39.5 ± 4.8
Korea	25.0 ± 2.0	1.846 ± 0.053	85.4 ± 8.7	11.2 ± 2.7	37.0 ± 9.1	54.7 ± 6.8	46.7 ± 5.8
Kuwait	26.0 ± 3.0	1.816 ± 0.050	87.6 ± 10.3	12.9 ± 4.3	41.5 ± 15.4	55.3 ± 10.5	48.4 ± 9.2
Saudi	25.0 ± 3.0	1.821 ± 0.070	75.8 ± 8.1	10.3 ± 2.8	35.6 ± 9.4	46.0 ± 6.0	34.9 ± 4.5
Mean	25 \pm	1.832	82.2	11.0	36.2	51.2	42.1
\pm SD	3.1	± 0.070	± 9.6	± 3.6	± 12.7	± 9.6	± 7.9

Table 1 summarises the mean and standard deviation of anthropometric characteristics and body composition of the subjects. The results for the analyses of variance demonstrated significant differences in height ($F_{5,65}=6.44$; $p<0.001$), body mass ($F_{5,65}=3.7$; $p<0.05$), % body fat ($F_{5,65}=3.23$; $p<0.05$), adiposity ($F_{5,65}=3.72$; $p<0.001$) and muscle mass ($F_{5,65}=3.14$; $p<0.05$) between teams. There was no significant difference between Asian groups in age, but the mean of the English team was significantly lower than that of Asian groups; however, the English and Kuwaiti handball players had more adiposity as indicated by the sum of five skinfolds (46.5 ± 18.5 , 41.5 ± 15.4 mm) and a higher % body fat (13.4 ± 5.1 , 12.9 ± 4.3 mm) than the other teams.

The Chinese players were significantly taller on average than the other teams, Chinese players' heights ranging from 1.765 to 2.00 m. The Japanese and the Korean players were significantly taller than the Kuwaiti, Saudi and English players ($F_{5,65}=6.44$; $p<0.01$). The measurement of body mass showed that the Kuwaiti players had the highest body mass values. The Japanese had the lowest adiposity and estimated % body fat and along with the Chinese had a group mean of less than 10% body fat.

The Kuwaiti players had significantly more muscle mass than all the groups ($F_{5,65}=3.14$; $p<0.05$). However, the Kuwaiti, Chinese and Korean players had more muscle mass than the Saudi and English players. The Kuwaiti (55.3%), Korean (54.7%) and Chinese (54.5%) had the higher relative muscle mass values, the lower values being observed in the Japanese (49.0%) and Saudi Arabia (46.0%) players.

Table 2

Anthropometric and body composition characteristics of male Asian handball players according to the geographical location (East = 33, West = 30, Europe = 8)

Group	Age (years)	Height (m)	Body mass (kg)	Body fat (%)	Sum 5 skinfolds (mm)	Muscle mass (%)	Muscle mass (kg)
East	25.0	1.867	83.8	10.0	32.2	52.8	44.2
Asia	± 1.2	± 2.9	± 2.8	± 1.1	± 4.3	± 3.22	± 2.7
West	25.0	1.819	81.7	11.9	38.6	50.6	41
Asia	± 1.0	± 0.4	± 8.4	± 6.6	± 4.2	± 6.6	± 5.4
Europe	20.0	1.742	77.5	13.4	46.5	47.8	37.0
	± 2.3	± 5.4	± 11.5	± 5.1	± 18.5	± 8.0	± 6.2

For further analysis of the data, the teams were divided into three groups according to geographical location. These were West Asia (Kuwait and Saudi Arabia), East Asia (China, Japan and South Korea) and Europe (England). The mean age of the European (English) players was significantly lower than the East Asia and West Asia handball players ($F_{2,68}=15.3$; $p<0.001$). Also they had significantly higher % body fat values ($F_{2,68}=4.79$; $p<0.05$). Body mass and muscle mass were not significantly different, although height was significantly different between the three groups ($F_{2,68}=16.37$; $p<0.001$), where the East Asian were taller than the West Asian and European players, while West Asian players were taller than the European group (Table 2).

Table 3

Anthropometric and body composition characteristics of male Asian handball teams according to the players' position (G. Keeper = 12, Back = 15, Centre = 18, Wing = 18)

Positions	Age (years)	Height (m)	Body mass (kg)	Body fat (%)	Sum 5 skinfolds (mm)	Muscle mass (%)	Muscle mass (kg)
Goalkeeper	25.0 ± 1.9	1.865 ± 0.044	80.8 ± 7.0	10.5 ± 3.3	33.9 ± 11.4	49.8 ± 5.5	40.2 ± 4.4
Back	24.0 ± 1.5	1.858 ± 0.047	82.5 ± 5.0	10.5 ± 1.7	34.2 ± 6.9	52.2 ± 7.3	43.3 ± 6.0
Centre	26.0 ± 1.9	1.837 ± 0.024	84.7 ± 8.9	10.8 ± 3.3	41.7 ± 11.5	53.8 ± 7.7	45.6 ± 6.5
Wing	25.0 ± 0.8	1.842 ± 0.055	81.6 ± 7.4	10.4 ± 2.6	31.9 ± 5.4	51.2 ± 6.2	41.8 ± 5.0

The players from Kuwait, Japan, China, Korea and Saudi Arabia were divided according to the players' position into goal-keeper, back, centre and wing. One-way analysis of variance was used to compare the data between the five teams. There was no significant difference in age, height, body mass, % body fat, adiposity (sum of five skinfolds) and muscle mass ($F_{3,16}=1.24, 0.02, 0.27, 0.46, 0.30$; $p>0.05$), respectively. This result demonstrates that handball teams from the East and West Asian groups were relatively homogeneous in anthropometric make-up and body composition, without any unique requirements other than skills for positional roles (Table 3).

Teams were finally divided into two groups according to the results of the Asian Games (Table 4). The successful teams were those that finished first, second and third (South Korea, Japan and China) and the unsuccessful teams did not gain any medals (Kuwait and Saudi Arabia). Analysis of variance was used to re-analyse the data without the English group to determine whether the anthropometric profile and body composition differed between the successful and unsuccessful teams at an elite level of handball play. No significant difference in age, body mass and muscle mass was found between the two groups. However, the successful players were taller ($F_{1,61}=12.51$; $p<0.001$) with a lower body fat % ($F_{1,61}=6.19$; $p<0.05$) and less adiposity ($F_{1,61}=8.97$; $p<0.05$) than the unsuccessful players, confirming the results of the earlier analyses.

Table 4

Characteristics of successful (South Korea, Japan, China; $N = 33$) and unsuccessful (Kuwait, Saudi Arabia; $N = 30$) teams at the Asian Games

	Successful	Unsuccessful
Age (years)	25.0±0.8	25.0±1.0
Height (m)	1.868±0.003	1.819±0.004
Body mass (kg)	83.8±2.8	81.7±8.4
Body fat (%)	10.0±1.1	11.9±1.8 ^b
Sum 5 skinfolds (mm)	32.2±4.3	38.6±4.2 ^b
Muscle mass (%)	50.6±6.6	41.3±5.4
Muscle mass (kg)	52.8±3.2	44.2±2.7

^a indicates $p<0.001$; ^b indicates $p<0.05$

Discussion

Previous reports have shown that body structure and morphological characteristics can determine the selection of participants in many sports. Results of cross-sectional anthropometric studies have tended to suggest that certain physical factors including body composition (body fat, body mass, muscle mass) and physique (somatotype) significantly influence athletic performance [2]. A knowledge of the physical characteristics of handball players could provide insight into those individual factors which influence the players' performance in the game.

Anthropometric characteristics are very relevant for handball players because the game of handball entails physical contact in which specific physiques with a

high level of strength and power may provide an advantage. The physical characteristics of handballers are considered in the choice of players to implement the game plan. The most striking comparison of anthropometric make-up of handball players in the present study was the difference in height between the teams when grouped according to geographic location. The difference between positional roles was non-significant for height, but may have been masked by the cross-national comparisons. On average the goalkeepers were the tallest, the backs were taller than the centre and the wings, possibly because most teams use the backs to score from outside the 9-m area. The effect sizes for these positional comparisons were small, but were moderate when goalkeepers were compared to centres (0.64) and wings (0.52).

In comparison with the study of European handball players during the world championships in 1995 in Iceland [9], the average height of the European handball players was 1.907 m and the mean value of body mass was 89.3 kg. The authors reported that there were significant differences in height and body mass between the continent's players; however, Europeans were represented by a large number of teams participating, while Asia, Africa and Pan-America had very few teams. It was concluded that European players were mostly taller and heavier than Asian and African players. It seems that the excellent playing standard of Egypt and Korea was reached through high technical and tactical performance rather than body size. The results of the present study showed that the mean height (1.832 ± 0.073 m) and body mass (82.2 ± 9.6 kg) values were lower in the Asian players than are found in European handball players. This difference between races may raise further questions about the role of body size in the selection of Asian teams. Height and % body fat differed between the successful and less successful teams in this tournament. Whereas body fat is reduced by a combination of diet and training, height is unaffected by training and could therefore have implications within Asia for training.

In the present study the Japanese had the lowest sum of skinfolds (28.8 ± 5.3 mm) and along with the Chinese had a group mean of less than 10% body fat. This figure is compatible with values reported for endurance athletes [3], but higher than the $7.8 \pm 1.2\%$ recorded for 16 elite Nigerian handball players [12]. The extent to which their race or the use of Sloan and Weir's nomogram [18] affected the estimation of body fat in the Nigerian handballers cannot easily be determined. The current mean values compare favourably with observations of $12.0 \pm 0.4\%$ in 7 French international players [14] using the same approach as in the present study.

The values for muscle mass were not exceptional, being slightly below the average $58.4 \pm 5\%$ for the 48 competitive sportsmen measured by Coldwells [4] and

the $62.4 \pm 4.1\%$ reported for international Rugby Union players [16]. The more muscular make-up of the successful players would give them an advantage in contesting possession of the ball, whilst the greater fat free mass would imply greater economy in moving body mass vertically to jump for the ball and in running around the court. In this investigation the Kuwaiti players had higher muscle mass than all the groups but their ranking in the unsuccessful teams means that muscle mass did not affect the performance of Asian handball players, based at least on success in this tournament.

The limitations of this cross-sectional study are acknowledged. Firstly, different races are included among the groups being compared. Secondly, the game of handball was played at a different level of international proficiency in the various geographical locations, the English players being the poorest performers of all the teams studied. Thirdly, the estimated variables – % values for body fat and muscle mass – were derived from formulae based on specific populations. Nevertheless the inclusion of the sum of five skinfold values to indicate adiposity [15] provides data against which other groups might be compared in the future.

In conclusion, the main observations in this study were:-

- i) There was a significant difference between Asian teams in anthropometric characteristics; the East Asia group was taller and had less adiposity than the West Asia group.
- ii) With respect to the players' position, the Asian handball teams were homogenous in anthropometric characteristics.
- iii) There were no differences between successful and unsuccessful teams in body mass and muscle mass, but the successful teams were taller and had lower % body fat and less adiposity than the unsuccessful players, demonstrating that height and leanness did play a role in successful performance in the handball tournament of the Asian Games.
- iv) % body fat was compatible with observations in well-trained athletes in previous studies.
- v) Finally, height and body mass in the present study of Asian players were lower than in the European handball players studied previously.

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