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LOCATION OF BODY FAT BY DUAL-ENERGY X-RAY ABSORPTIOMETRY IN PROFESSIONAL MALE FIELD HOCKEY PLAYERS IN RELATION TO THEIR FIELD POSITION

Key words: field hockey, fat distribution, DXA.

ABSTRACT

Assessment of the body composition and regional distribution of body fat can have implications for performance and is important in achieving real improvements in training quality. The aim of this study was to determine body fat distribution by DXA in professional male field hockey players, in relation to their field position. The research was performed on 21 male players subdivided according to their field position into forwards, mid-fielders, defenders and goalkeepers, respectively. Body height and weight were measured using standard procedures. Whole body fat and fat distribution were measured with the use of DXA. The biggest morphological differences were observed between goalkeepers and midfielders and between goalkeepers and forwards. The differences between the other players were confidentially smaller, which could have been due to the game's character and players' mixed functions during a field hockey match.

INTRODUCTION

The success in team games depends on various external and internal factors, among which the player's anthropological characteristics play a significant role [13, 16]. It is important to get an insight into those factors which influence the development of a successful sports career, to assist young athletes in reaching the elite level and elite athletes to constantly improve their skills [8]. One of the success factors in field hockey is the player's body composition. The present study aimed at assessment of body fat and its distribution in athletes.

A field hockey team consists of eleven players. Depending on a particular team it can include four forwards, three defenders and three midfielders. One player may be designated the goalkeeper. We can suppose that different playing positions in field hockey impose different demands on the players. For example, forwards and midfielders are significantly more engaged in situations were they are required to hit the ball with great force; defenders tend to make more tackles; whereas goalkeepers must have quick reflexes and an ability to communicate defensive strategies to the team. Such findings suggest certain heterogeneity in the players' physical parameters that can be important for success in particular positions in field hockey. It is similar in other team games, for example, in soccer or football [17].

Still little has been known about the relationship between sport and morphological parameters (herein tissue distribution[(1]), so the

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first purpose of this study was to describe morphological differences, and the second one – to analyze body fat and its distribution in Polish elite professional field hockey players according to their playing position on the field.

METHODS

The study was carried out on male field hockey players from the Polish national team. The study sample consisted of 21 male players of mean age 27.3, s = 4.16 years (Tab. 1) subdivided into forwards (4), mid-fielders (7), defenders (7) and goalkeepers (3), respectively. The data were collected in 2007. The research procedures were in accordance with the standards of the medical ethics committee.

Each subject's standing mass (kg) and body height (cm) were measured with a calibrated balance and a stadiometer. The players' age and playing position were also noted down. After the anthropometric data were collected, each subject underwent DXA analysis to assess regional values for body fat distribution [11]. The DXA was recommended for body composition studies by the European Society for Clinical Nutrition and Metabolism [10]. The DXA instrument was a Lunar Prodigy Advance (GE Healthcare). The instrument was calibrated before the examination. DXA is based on the differential attenuation of radiation at two energies as it passes through bone and soft tissues. The feedback then provides information about body fat mass, lean mass, total bone mineral content, percent fat, percent lean, and regional values of the android/gynoid region, arms, legs and trunk. The arm region included the hand, forearm and arm; and the leg region included the foot and lower and upper leg [5]. Each subject was barefoot and wore no metallic objects during the measurements. The subjects lied on their backs on a bed, with the forearms fixed at the maximal pronated position. The DXA of total body composition was performed.

Mean $\bar{x}$, standard deviation (s), minimum (min) and maximum (max) values were calculated for each variable of interest. The level of statistical significance was set at 0.05 and 0.01. The differences were calculated using the Mann-Whitney U test.

RESULTS

Table 1 presents the morphological characteristics of field hockey players including stature, body mass, body mass index (BMI), segmental body fat and fat mass ratios.

Anthropometric characteristic

According to Table 1, the mean body stature for the entire team was 177.2, s = 5.71 cm and ranged between 165 and 187 cm. Body mass was 77.3, s = 8.84 kg (59 – 95). Body mass index was calculated reflecting body height and body mass. The average value of this index was 24.6 kg/m^2, s = 2.2 kg/m^2 (21.7 – 30.1).

Table 1. Morphological characteristics of field hockey players

Characteristic	$\bar{x}$	s	min.	max	V %
Stature	177.2	5.71	165	187	3.2
Body mass	77.3	8.84	59	95	11.4
BMI	24.6	2.2	21.7	30.1	8.9
Body fat (%)					
Total	16.3	5.9	7.9	31.5	36.2
Arms	12.7	5.7	5.4	28.3	44.9
Legs	15.5	5.3	7.8	26.1	34.2
Trunk	18.8	7.3	8.7	37.1	38.8
Android	21.1	7.9	10.5	44.2	37.4
Gynoid	19.5	6.0	8.3	33.6	30.8
Fat mass ratios (%)					
Arms/Total	9.17	1.23	6.33	11.64	0.1
Legs/Total	32.73	4.34	27.13	42.66	13.3
Trunk/Total	54.19	4.57	44.92	62.49	8.4
Arms+legs/total	41.90	4.41	33.59	51.21	10.5
Arms/legs	28.49	5.53	20.04	38.71	19.4
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Ganoid	19.5	6.0	8.3	33.6	30.8
Fat mass ratios (%)					
Arms/Total	9.17	1.23	6.33	11.64	0.1
Legs/Total	32.73	4.34	27.13	42.66	13.3
Trunk/Total	54.19	4.57	44.92	62.49	8.4
Arms+legs/total	41.90	4.41	33.59	51.21	10.5
Arms/legs	28.49	5.53	20.04	38.71	19.4

Distribution of body fat

The mean body fat for all the team was 16.3%, *s* = 5.9% (Tab. 2). The largest amount of body fat was noted on the trunk, then on the legs and then on the arms (trunk>legs>arms). The percent body fat was 12.7%, s = 5.7% for the arms, 15.5%, *s* = 5.3% for the legs and 18.8%, *s* = 7.3% for the trunk, in all athletes, regardless of their playing position. A broad range of body fat was noted: 5.4 to 28.3 for the arms, 7.8 to 26.1 for the legs and 8.7 to 37.1 for the trunk.

Also upper and lower fat distribution was analyzed. It showed that field hockey players featured the android type of adiposity ($\bar{x}$ = 21.1, *s* = 7.9) as opposed to the gynoid type ($\bar{x}$ = 19.5, *s* = 6.0).

Subjects' anthropometric characteristics depending on the field position

In terms of stature (Tab. 2), the goalkeepers and defenders were taller than the midfielders and forwards, but there were no significant differences between each pair of positions, except for the defenders and forwards (p<0.05). Next feature was body mass which ranged between 72.7 (midfielders) to 84.7 (goalkeepers). The difference was significant only in the case of goalkeepers and forwards (p<0.01). The goalkeepers' BMI was greater than of all other positions, but significant only in comparison to the midfielders (p<0.01) and the forwards (p<0.05). It is important to remember that a high BMI could lead to an incorrect interpretation of the amount of fat in athletes with excessive muscle mass [14]. Besides there is a limitation of BMI for individuals who are very tall or very short, or who have very long or short limbs in relation to the trunk [19].

Table 2. Mean values and U test for morphological characteristics in field hockey players, according to their field position

Characteristics	Mean values				Significant differences					
	G	D	M	F	G-D	G-M	G-F	D-M	D-F	M-F
Stature	178.8	179.7	176.1	173.5					*	
Body mass	84.7	80.7	72.7	73.8			**			
BMI	26.47	25.01	23.34	24.58		**	*			
Body fat (%)										
Total	23.73	16.70	13.47	14.78			*	*		
Arms	19.83	13.10	9.53	12.20			*			
Legs	22.57	15.61	12.67	14.80	*	**				
Trunk	26.50	19.14	15.53	18.03						
Android	29.90	21.24	17.67	20.00						
Gynoid	28.13	19.91	16.89	17.05			*			
Fat mass ratios (%)										
Arms/Total	9.86	9.47	8.49	9.31		**				
Legs/Total	33.92	33.33	32.21	31.70						
Trunk/Total	53.20	53.36	55.01	54.95						
Arms+legs/total	43.78	42.8	40.70	41.00						
Arms/legs	29.87	29.41	26.31	29.69						

* p<0.05, **p<0.01, G – goalkeepers; D – defenders; M – midfielders; F – forwards

Fat mass ratios

Five fat mass ratios were studied. The value of body fat on the arms, the legs and the trunk in proportion to total body fat; arms and legs together to total body fat index which demonstrated that the extremities constitute almost a half of body fat (41.9%); and arms to legs body fat proportions. The mean value of the last ratio was 28.49% and ranged from 20.04% to 38.71%.

Distribution of body fat by the field position

It seems that not only total body fat plays an important role but also its distribution. There was a significant correlation between the player's position and the amount of body fat. The goalkeepers had the greatest amount of body fat (23.73%) in comparison to the players in other positions, but the only significant (p<0.05) difference was in comparison to the forwards and midfielders (Fig. 1). Body fat on the arms also varied, especially between the goalkeepers and midfielders (p<0.05). There were also differences in the amount of fat on the legs between different playing positions (between goalkeepers and defenders p<0.05; and between goalkeepers and midfielders p<0.01). Studies have shown that excess fat in the legs can increase inertia in athletes [1]. There was only one significant difference in the android type of fat distribution among athletes from various field positions (goalkeepers to forwards p<0.05) (Fig. 2). The gynoid fat distribution was significantly higher in the goalkeepers in comparison with the forwards (p<0.05). Also a large contrast of this type of adiposity appeared in comparison to the midfielders (16.89%).

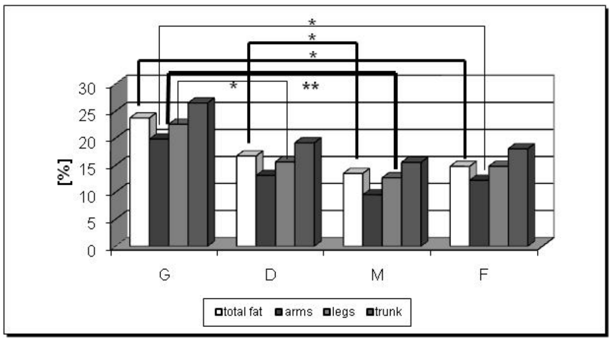

Figure 1. Mean values and U test for body fat in field hockey players, according to playing position

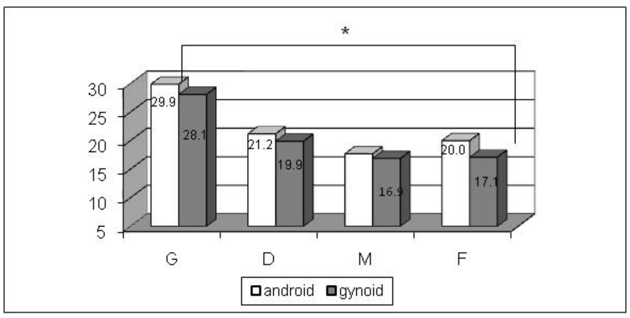

Figure 2. Mean values and U test for body android and ganoid fat distribution in field hockey players, according to their playing position.

Fat mass ratios by the field position

There was a significant difference in the arms/total ratio between players in different field positions (goalkeepers and midfielders (p<0.01). It means that the proportions of body fat distribution in all hockey players were very similar (Fig. 3).

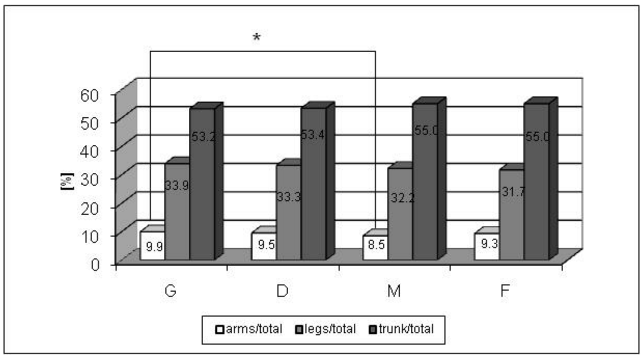

Figure 3. Mean values and U test for body fat indexes in field hockey players, according to their playing position

DISCUSSION

Among many different factors the player's body size is crucial in field hockey. There are some body elements which are characteristic for field hockey players, for example, long trunk, narrow shoulders, wide pelvis, average body stoutness [6]. In this study we concentrated on body fat and fat distribution. The players who have less body fat have an advantage over those who do not. Two distinct groups can be distinguished in our study in terms of their morphological parameters: the goalkeepers and the others. The goalkeepers were superior in height and weight as compared to the field players. Also the amount of fat mass was substantially greater in the each body segment of goalkeepers as compared to the field players. Additionally, they were the heaviest and had the largest body mass index. In field hockey the goalkeeper plays a very special role because the game regulations allow him to hit the ball with every part of the body within the shot area. He must feature great hand-eye coordination and outstanding reflex. He makes or breaks the entire team's success, so his role in the team is crucial. The goalkeeper's technique is therefore quite different from the other players'. This can have an impact on his body build. Being tall, for example, can make one more suitable for this position and, in fact, it appears to be a prerequisite to become a professional goalkeeper [2]. Some studies suggest that too short goalkeepers will not be successful at the highest performance level [18].

It was also revealed that the percent of body fat was positively influenced by the player's position on the field. Extra body fat mass may serve as desirable protection in contact situations. Besides, the bigger the goalie, the larger chance to defend the goal. However, it may come as a disadvantage in sprint runs [12, 7]. The goalkeepers in our study were heavier than the other players. Similar findings were noted in soccer players by other authors [2, 3]. This concerns the majority of team sport players who often come in direct contact with their opponents. If they are large, they have an advantage over those who are not. But it is also important to know that the size should be connected mainly with muscle mass and not fat mass, because less muscle leads to less power.

The defenders' aim is to defend their goal so they play mainly in the defence area. It means that they move a little less than the midfielders and forwards. This could be a reason why they have more body fat than the other players (with the exception of the goalkeepers). By contrast the midfielders are the most engaged players during the game, which could have an impact on their lower amount of body fat. Total adiposity changes can be caused by physical activity, but not by fat patterning [4]. The majority of field hockey players represented the android type of body fat distribution.

The differences between the goalkeepers and midfielders were the largest and were manifested by the body mass index, body fat on the legs and by the arms/total ratio. Also significant differences were found in body mass, body mass index, total body fat, body fat on the arms and in android/gynoid distribution of body fat between the goalkeepers and forwards.

The present study shows that the most different morphological parameters can be found among field hockey goalkeepers. All the morphological differences between the defenders, midfielders and forwards are in most cases rather small. This could result from the game fluctuation (field hockey players perform exhausting short distances which are frequently repeated during the match). This fluctuation causes mixing of the individual players' roles. Nevertheless there was some body build diversification according to the player's field position, which could be quite important during competition.

In conclusion, it is essential to consider positional requirements when interpreting various morphological factors. The coaches should impart differential conditioning to different players in accordance with their field positions, requirements of the type of activity and workload of each player separately [15]. It could help to understand some characteristics better and facilitate their application in training, performance or talent identification [1, 9].

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