

# Morphological Differences of Elite Croatian Soccer Players According to the Team Position

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## ABSTRACT

*Team position is of extreme importance in interpretation of morphological data because there are specific demands for a specific play position. The aim of the study was the analysis of morphological characteristics and body composition of elite Croatian soccer players with respect to their team position. The measurements were performed on 57 soccer players, members of the First Croatian National League. The anthropometrical measurement encompassed 13 variables. Descriptive statistics, t-test and MANOVA were used in data processing. The goalkeepers were the tallest and the heaviest ( $182.9 \pm 4.3$  cm;  $80.1 \pm 5.1$  kg), and had significantly higher amounts of body fat (20.2% goalkeepers vs. 13–15% others;  $p < 0.05$ ), whereas the forwards and the midfield players were on the average about 3 cm shorter. The goalkeepers had longer legs and arms ( $p < 0.05$ ), and the largest biacromial diameter ( $43.2 \pm 1.9$  cm). The forwards were the shortest on the average ( $179.2 \pm 6.3$  cm). The lowest values of fat tissue were found in defenders (13.9%) and midfield players (14.4%). In conclusion, the differences in morphological characteristics according to the team position were noticed only in goalkeepers, especially regarding their height, weight and the percentage of fat tissue.*

**Key words:** soccer, morphological characteristics, anthropometry, body composition, body height.

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## Introduction

Morphological characteristics of athletes determine the success in particular sports events in various ways. The knowl-

edge of these characteristics is necessary to establish their importance for the success in competitive sport. The research on

the influence of these characteristics in sporting games (soccer, handball, basketball, volleyball) is of particular complexity, because the success in the game depends, among other things, on how the individual characteristics of some players fit into the whole, thus creating a coherent team. Team position is of extreme importance in interpretation of morphological data because the different demands for a specific play<sup>1</sup>. For example, midfield players cover a large area of a football field. It is estimated that they cover approximately 10 km per game, including walking, moving backwards, jogging, running and sprinting, similarly the outside defenders, whereas the forwards and center-halves cover shorter distances<sup>2,3</sup>. Expressed in percentages with regard to the total distance covered, the players in attack sprint the most, whereas the midfield players run the most.

Throughout the last several decades an interest in the analysis of body composition for the purpose of investigating and treating obesity and osteoporosis rose increasingly, particularly in sports medicine. The data on body mass, body height and skin fold thickness proved to be insufficient indicators of the congruity of the morphological status and body composition for the success in a particular sport. Soccer belongs to an aerobic-anaerobic (stop-go) type of sport with alternate phases of high load as sprints, fast zig-zag running, jumps, sudden stops, etc. Practically in all activities a player carries his mass, moves it against the force of gravity so that each excess of body fat represents an overload which additionally burdens the energy mechanisms and makes the execution of a whole series of activities, especially the jumps and sprints, more difficult.

As interposition specialization starts at the early age, the understanding of morphological characteristics of each team position is of high importance for coaches

as well as for sports medicine specialists. The objective of this paper was determination of the body composition and morphological characteristics in soccer players who play in the first league clubs in Croatia and determination of possible differences in the monitored characteristics related to the position on which the player plays in the game.

## Materials and Methods

The sample was comprised of soccer players who were members of some first league clubs in Croatia ( $n=57$ ) and who were tested throughout the competition season 1997/98. There were seven goalkeepers, 21 midfield players, 12 forwards and 17 defenders, of the average age  $23.2 \pm 3.5$  years with an average playing experience of  $12.1 \pm 3.6$  years.

Body composition in soccer players was determined by means of bioelectrical impedance (Body analyzer by Danninger, USA). The percentages of body fat (% FAT) and lean body mass (LBM) were analyzed. According to the instructions of the International Biological Program<sup>4</sup>, the following anthropometric variables were measured: body height, body mass, length of the leg, length of the arm, biacromial and bicristal diameters, knee and elbow diameters, upper arm girth, forearm girth, thigh girth and calf girth.

The obtained results were processed by means of standard statistical procedures for determining the basic descriptive statistical parameters – mean ( $X$ ) and standard deviation (SD). Both the minimal and the maximal values measured were recorded (Min., Max.). The differences between the groups were analyzed by means of the MANOVA<sup>5</sup>. Data processing was done by the statistical package STATISTICA for Windows.

**Results**

The average age of the soccer players was 23.2 years and the average playing experience was 12.9 years, ranging from

**TABLE 1**  
AVERAGE AGE AND PLAYING EXPERIENCE OF SOCCER PLAYERS

	X	SD	Min.	Max.
Age (years)	23.2	3.4	17.0	35.0
Playing experience (years)	12.9	3.2	7.0	24.0

7 to 24 years of age, which points to the well-known fact that the age of children who participate in the sports training decreases all the time.

The goalkeepers were the oldest and with the longest playing experience, while the forwards were the youngest, which was understandable because of the higher physiological demands (Table 2).

The basic descriptive parameters of morphological characteristics of the whole group are presented in Table 3, whereas Table 4 contains arithmetic means expressed for the goalkeepers, midfield players, forwards and defenders.

Goalkeepers and defenders were the tallest players with similar average mass values, but of all other players, goalkeepers had significantly higher amounts of body. The goalkeepers have longer legs (statistically significant) and arms, and their biacromial diameter is the largest.

**TABLE 2**  
AVERAGE AGE AND PLAYING EXPERIENCE ACCORDING TO THE POSITION IN THE PLAY

	Goalkeeper	Forward	Midfield	Defender
Age (years)	25.2	22.7	23.4	23.3
Playing experience (years)	14.9	13.8	12.1	13.1

**TABLE 3**  
BASIC STATISTICAL PARAMETERS OF MORPHOLOGICAL CHARACTERISTICS OF SOCCER PLAYERS

	X	s	Min.	Max.
Body mass (kg)	77.6	5.7	63.5	93.0
Body height (cm)	180.6	5.7	164.5	190.5
Fat tissue (%)	14.9	3.5	7.1	5.5
Lean body mass (kg)	66.3	5.4	56.2	78.8
Length of the leg (cm)	102.1	3.9	94.6	109.5
Length of the arm (cm)	78.2	3.0	73.0	83.3
Biacromial diameter (cm)	42.2	1.7	37.6	44.8
Bicristal diameter (cm)	28.7	1.4	26.6	31.7
Elbow diameter (cm)	7.2	0.4	6.5	8.5
Knee diameter (cm)	10.0	0.4	9.3	11.0
Upper arm girth (cm)	29.2	1.8	26.5	33.8
Forearm girth (cm)	26.4	1.2	23.3	28.4
Thigh girth (cm)	57.7	2.2	52.5	61.7
Calf girth (cm)	38.9	2.2	33.5	44.1

**TABLE 4**  
AVERAGE VALUES OF MORPHOLOGICAL CHARACTERISTICS IN SOCCER PLAYERS  
ACCORDING TO THEIR POSITION IN THE GAME

	Goalkeeper	Forward	Midfield	Defender
Body mass (kg)	80.1	76.8	76.1	79.1
Body height (cm)	182.1	179.2	179.6	182.2
Fat tissue (%)	20.2	15.0	14.4	13.9
Lean body mass (kg)	64.0	66.9	65.4	68.3
Length of the leg (cm)	104.3	100.4	101.4	102.7
Length of the arm (cm)	79.2	77.6	77.7	78.6
Biacromial diameter (cm)	43.2	41.5	41.8	42.6
Bicristal diameter (cm)	28.5	28.3	28.9	28.9
Elbow diameter (cm)	7.2	6.9	7.2	7.3
Knee diameter (cm)	9.9	9.8	10.1	10.0
Upper arm girth (cm)	30.0	29.9	28.9	29.0
Forearm girth(cm)	26.9	26.6	26.2	26.4
Thigh girth (cm)	57.7	58.9	57.3	57.6
Calf girth (cm)	38.4	39.0	38.7	39.2

The other anthropometric characteristics were similar in all players.

**TABLE 5**  
RESULTS OF MULTIVARIATE ANALYSIS  
OF VARIANCE

	F	p
Body mass	0.6008	0.6189
Body height	0.4477	0.7205
Fat tissue	5.1292	0.0049
Lean body mass	0.9531	0.4259
Length of the leg	1.0841	0.3689
Length of the arm	0.3929	0.7588
Biacromial diameter	1.2903	0.2934
Bicristal diameter	0.2517	0.8595
Elbow diameter	1.0109	0.3998
Knee diameter	0.9099	0.4464
Upper arm girth	0.7525	0.5285
Forearm girth	0.5987	0.6202
Thigh girth	0.6640	0.5799
Calf girth	0.2341	0.8719
Wilks' $\Lambda=0.2667$	Rao R=0.8425	p=0.7199

Multivariate analysis of variance showed no statistically significant differences in any of the selected parameters in soccer players who play at different field positions (Table 5).

## Discussion

The average age of soccer players was in congruence both with the average values recorded in other European first league teams<sup>6</sup>, and with the generally accepted claim that the best results in sporting games were achieved at the age of 24 to 27 years.

Taking into account the average age and the position played by the player, it can be concluded that the first league goalkeepers were, on the average, older than the players in the field, who, on the other hand, did not significantly differ from each other in this characteristic. The goalkeepers apparently had longer playing careers and therefore it was not unusual that some goalkeepers who were in their late 30s appeared at interna-

tional competitions. For example, the first goalkeeper of the Scottish National Team at the 1998 World Cup in France was 40 years. This phenomenon can be connected with a relatively smaller incidence of chronic injuries in goalkeeper<sup>7</sup>.

Body height did not significantly deviate from the average population of men of the same age in Croatia. However, body mass values to a lesser and body fat values to a larger extent are lower, which was naturally to be expected taking into account the participation in the physical activity<sup>8</sup>. Compared to the results obtained in athletes from other countries it can be concluded that there is a certain point of similarity<sup>9,2</sup>, but in comparison with some older data<sup>10–13</sup>, it seems that in soccer there is also a tendency of an increase in body height, which was to some extent confirmed by Jankovic and associates<sup>14</sup>. They found that body height had a discriminative role in the selection of young soccer players, in favor of those who were taller. This, however, is not in congruence with a still existing opinion<sup>6</sup>, established by Medved<sup>9</sup> quite a long time ago after analyzing a large sample of soccer players, which claims that more successful players are shorter and weigh less than the ones who are not so successful. The found range of body height was wide. It is highly probable that the height itself does not guarantee the success in the game. Still, it is also likely that a particular body height at a younger age has an important role in the selection of players as for determining their position in play even before entering the senior competition level and accordingly the adaptation of training. Additionally, when dealing with body height, the fact that it is connected with the ethnic component should be taken into consideration. For instance, the Asian teams are on the average significantly shorter than their peers from Europe or America are.

The comparison of body height of players playing on various positions in the game showed that goalkeepers were the tallest, whereas the forwards and the midfield players were on the average about 3 cm shorter. The body height values were accompanied by the size of mass, thus leading to the conclusion that goalkeepers and defenders were, at the same time, the ones who weighted the most, whereas midfield players weighted the least. Body height is favorable for defenders in actions in which the ball is received or fought for by the head, on the jump or standing on the ground. Body height is, therefore, definitely important when directing a player towards specific position-related or tactical roles in the game. Similar results were recorded in English college players<sup>15</sup>. The goalkeepers were the tallest (180 cm on the average), whereas the midfield players proved to be the shortest (173 cm). Such a trend was also recorded in professional players in England several years later<sup>16</sup>, in national teams participating in the World Cup in France in 1998<sup>8</sup> and in Portuguese first league players. Portuguese goalkeepers were 186 cm, center-halves 185.3 cm, and midfield players 176.8 cm and forwards 174.6 cm high<sup>17</sup>. Interestingly, the forwards were the shortest on the average, although it could have been expected that they would be more similar to the defenders, taking into account direct duels on the jump in front of the goal. Identically, body height is also favorable for the goalkeepers when defending the goal. Still, the analysis of other morphological characteristics in goalkeepers showed that significantly longer legs and arms accompanied a taller body height. Naturally, such a body type contributes to self-confidence of a goalkeeper when trying to cover the broad area between the goalposts.

The average values of both the elbow and the knee diameters, as well as the

values regarding the bicristal range, responded to the average values recorded in normal population, whereas the soccer players proved to have somewhat broader shoulders<sup>4</sup>. Circumferences were also larger in soccer players, which were especially expressed in circumferences measured on the legs. That was the consequence of a bigger muscle mass in comparison with a significantly smaller amount of fat. Muscle mass is very well developed in soccer players, especially in the upper leg<sup>5,18</sup>, which is very likely the result of a specific strength training<sup>3</sup>. This is also evident in research dealing with the body type of this specific population. The somatotype values indeed indicate a moderate to mesomorph component – for example, top Hungarian players (2.1/5.1/2.3)<sup>19</sup> or English players (3/5/2.5)<sup>11</sup>.

Body composition in soccer players is also an important factor in determining the success in this sport. On the average, the amount of fat in young healthy men who underwent no organized type of physical training is within 18–20% of the total body mass, whereas the amount of fat in athletes is generally smaller<sup>8,20,21</sup>. The lowest values are found in long distance runners and range between 4 and 7%<sup>8</sup>. With regard to the requirements of a soccer game it could be expected that the soccer players had relatively small amounts of fat. However, the results varied significantly, in so far that even a very high body fat percentage of 19.3 was recorded in top English soccer players<sup>2</sup>, which could be connected with the time point of the measurement which coincided with the beginning of the preparation period. This points to the fact that the soccer players accumulate a certain amount of body fat outside the playing season. The fat then disappears during strenuous training in both the preparation and the competition period. The average value of 14.9% of body fat found in

Croatian soccer players corresponds to the value found in English college players (14.7%) or to the value found in the Scottish club Aberdeen (14.9%). It is, however, significantly higher than in Brazilian first league players (10.9%), Portuguese players (10.5%) or English players (12.4%) according to Dunbar and Power<sup>22</sup>. Arithmetic means of overall body fat values were significantly increased because of the contribution of the average body fat percentage in goalkeepers (20.2%), which was statistically significantly higher than in all other players. That was surprising, particularly if compared to a very low value recorded in Portuguese goalkeepers (10.0%) and taking into account the fact that the measurements were carried out during the competition season itself<sup>17</sup>. The explanation could probably be found in the age of the goalkeepers on the one hand, and in the lower intensity of play to which the goalkeepers were exposed on the other. Still, taking into account the requirement set before the goalkeepers in their attempts to defend the goal – jumps sudden throws, etc. – it can be assumed that a smaller body fat amount would contribute to a more efficient play.

The lowest values of body fat percentage were found in defenders and midfield players, which was not surprising taking into account their tasks in the play and the requirement for an extremely high dexterity. These players could not achieve the required high intensity of the play if they had larger amounts of body fat, which was expected if we consider physiological demands<sup>23</sup>.

## Conclusions

Soccer players do not significantly differ from the normal population as for their morphological characteristics (body height and body mass), but they do have significantly lower amounts of fat and bigger circumferences of the body. This is,

of course, the consequence of bigger muscle mass, which is the result of a specific training process. Still, in comparison with somewhat older results there is a tendency of increase in body height. This is particularly the case in goalkeepers and defenders, because of the character of their tasks in the play. Interposition dif-

ferences were noticed in height, weight and percentage of fat tissue. The acquaintance of noticed differences could improve the training process as well as the selection at the early age.

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## RAZLIKE U MORFOLOŠKIM KARAKTERISTIKAMA NOGOMETAŠA KOJI IGRAJU NA RAZLIČITIM POLOŽAJIMA

### SAŽETAK

pozicija unutar ekipe je od iznimne važnosti za interpretaciju morfoloških podataka sportaša jer se energetske zahtjevi pojedinih položaja razlikuju. Ovo istraživanje je bilo provedeno u svrhu utvrđivanja morfoloških razlika vrhunskih hrvatskih nogometaša

koji igraju na različitim položajima. Uzorak su činila 52 vrhunski nogometaša (5 vratara, 17 obrambenih igrača, 21 vezni i 9 napadača) Prve hrvatske nogometne lige. Izmjeren je 13 morfoloških karakteristika. Podaci su obrađeni metodama deskriptivne statistike, t-testom i višestrukom analizom varijance. Vratari su bili najviši i najteži ( $182.9 \pm 4.3$  cm;  $80.1 \pm 5.1$  kg), i imali su značajno veći postotak tjelesne masti (20.2% vratari vs. 13–15% ostali;  $p < 0.05$ ), dok su napadači i vezni igrači bili u prosjeku 3 cm niži. Vratari su imali duže ruke i noge ( $p < 0.05$ ), i najveći biakromijalni raspon ( $43.2 \pm 1.9$  cm). Najniži od svih su bili napadači ( $179.2 \pm 6.3$  cm), a najniže vrijednosti masnog tkiva su utvrđene kod obrambenih igrača (13.9%) i veznih igrača (14.4%). U zaključku, značajne razlike u morfološkim karakteristikama između nogometaša koji igraju na različitim položajima unutar ekipe su utvrđene za vratare, i to posebno razlike u visini, težini i postotku masnog tkiva.