Position-specific and Team-ranking-related Morphological Characteristics in German Amateur Soccer Players - a Descriptive Study
- Anthropometry in Amateur Soccer Players -

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Abstract

The purpose of this study was to describe the morphological characteristics in German amateur soccer players based upon their ranking in the championship table and the position of the players. Seventy-two male Fifth Division soccer players from four clubs volunteered for this study. The examination of the teams was conducted within 10 days of the preparation period for the second half of the season when teams A through D were ranked 6th, 5th, 2nd and 11th in the Division. Anthropometric measurements included body weight and height, skinfold thickness (biceps, triceps, subscapular, suprailiac, calf), biepicondylar humerus and femur breadths, upper arm (flexed and tensed), thigh and calf girths. Somatotypes were calculated using the Heath-Carter equations.No differences were found between the means of the different anthropometric variables of the four teams (p <.05). In all groups, the somatotype means of the soccer players were mesomorph-endomorph. Compared to field players, goalkeepers showed higher values for body height, body weight and arm girth (p <.05).This study showed that there were no anthropometric and somatotype differences between the soccer teams of different club ranking. Compared to field players, goalkeepers showed higher body height and weight, higher biepicondylar femur and humerus breadths, hig8her arm, thigh and calf girths, and higher mesomorphy. Discriminant function analyses were unable to separate the players' position on the basis of body composition or somatotype. No differences were found between the means of the different anthropometric variables of the four teams (p < .05).

Key Words: Anthropometry, Body composition, Somatotopy, Soccer

Introduction

Success in sports has been associated with specific anthropometric characteristics, body composition and somatotype (Carter & Heath, 1990; Duquet & Carter, 2001). During a soccer match (90 minutes), the player's movements are characterized by high intensity, short-term actions and pauses of varying length. To be successful in such a team sport, soccer players need an optimal combination of technical, tactical, physical characteristics (e.g. somatotype), and mental motivation (Bangsbo, 1994), among other sports characteristics. Hence, for soccer coaches, managers, sports physiotherapists, and scientists, an in-depth understanding of the determinants of success, such as the specific anthropometric characteristics of players may be important. Some studies showed evidence for position-specific anthropometric characteristics in soccer players (Bale, 1986; Ramadan & Byrd, 1987; Rienzi et al., 2000; Gil et al., 2007). Goalkeepers are taller than central position players, such as defensive and central offensive players (Reilly et al., 2000; Tahara et al., 2006; Gil et al., 2007). Similar studies on position-specific anthropometric profiles have been reported for Australian football (Young et al., 2005; Pyne et al., 2006), Gaelic soccer (McIntyre, 2005; McIntyre & Hall, 2005), rugby (Bale, 1986; Duthie Gabbett, 2000; Pyne & Hooper, 2003) and American football (Bale, 1986; McGee & Burkett, 2003; Garstecki et al., 2004).

Based on a selection of anthropometric variables, a somatotype can be calculated (Carter & Heath, 1990; Carter, 2003). A somatotype can be defined in terms of its three components: endomorphy, mesomorphy and ectomorphy (Carter & Heath, 1990). The combination of these three physical parameters allows the classification of athletes into different somatotypes. The most predominant somatotype of professional soccer players is within the mesomorphic sector on the somatochart, with means close to 2.5 – 5 – 2.5 (Carter & Heath, 1990; Rienzi et al., 2000). Hence, anthropometric characteristics predispose athletes to position-specific roles within soccer. However, to the best of our knowledge, research examining the possible relationship between a team's success (i.e. team ranking in its respective soccer league) and the anthropometric characteristics of its athletes is still lacking.

The aim of the present study was (i) to describe the morphological characteristics of amateur soccer players playing in the four Fifth Division soccer teams in Germany, and (ii) to search for position-specific and (iii) ranking-related anthropometric characteristics.

Methods

Subjects

In total seventy-two male Fifth Division soccer players from four different teams, A (n=17), B (n=19), C (n=17) and D (n=19), volunteered in this study. The players had been playing soccer for more than 10 yr. In addition to one match during the weekend, all players attended training sessions at least three times a week.

Anthropometric measures

Twelve anthropometric variables were gathered: body height and weight, biceps, triceps, subscapular, supraspinal and calf skinfold, biepicondylar humerus and femur breadth, arm (flexed and tensed), calf and thigh girths. The examinations were conducted according to the guidelines of the International Society for the Advancement of Kinanthropometry (ISAK) (Ross & Marfell-Jones, 1991). The Technical Error of Measurement (Ulijaszek & Kerr, 1999) was lower than 5% for skinfolds and 2% for the other measurements.

Technical devices used for the examinations included electric scales (Soehnle: Personenwaage Pharo, Nassau, Germany), a Harpenden skinfold caliper (Baty: Harpenden Skinfold Caliper, West Sussex, UK), a bone caliper (Rosscraft Innovation: Campbell 10 Caliper Tommy 3, Surrey, Canada), and a tape for the girth (Rosscraft Innovation: Fiberglass Anthropometric Tape, Surrey, Canada) as well as a stadiometer (Wellington: GPM, SibnerHegner, Zurich, Switzerland).

Body mass index (BMI) was calculated as body mass over body height squared. In addition, the sum of four skinfolds ($\sum 4SKFS$ = biceps + triceps + suprailiac + calf) was also computed as a proxy for body fat. Body density (BD) was assessed based on $\sum 4SKFS$ corrected for chronological age (Durnin & Womersley, 1974). Relative body fat (%BF) was then calculated using Siri's equation (Siri, 1956).

Procedure

All examinations were conducted at the training facilities of each team within 10

days of the preparatory phase for the second leg of the season. At this point of the season, team A was ranked 6th, team B was ranked 5th, team C was ranked 2nd, while team D was ranked 11th. The players wore minimal clothing (slips only). Written informed consent was given by the athletes.

Statistical analyses

Data were tested on normality. Parametric statistics (means and standard deviations) were used for the descriptive analysis of all the variables under investigation.

To analyze differences between German soccer players and soccer players from other studies, an independent t-test was performed for all variables.

Univariate analysis of variance (Anova) was used to observe differences between the means of the different variables of the four teams and to detect differences between the means of the groups of the different positions (goalkeeper, defender, midfielder, striker). If significant differences were found, a Bonferroni adjusted post hoc test was used to compare pairs of teams or pairs of positions. The significance was set at the p<.05 level of probability.

Discriminant function analyses were used between the body composition and the somatotype components to determine which variables could best correctly classify the players by position. The criteria employed for evaluating the discriminant function analyses included a small overall Wilks' lambda, a significant level (p <.05) and a high percentage of players correctly classified by position.

Analysis was carried out with SPSS 13.0 (SPSS Inc., Chicago, Illinois, USA) while Somatotype - Calculation and Analysis (Sweat Technologies, Adelaide, South Australia, Australia) was used to calculate average somatotypes and to analyze somatotype differences between the teams and the groups.

Results

Mean age, body height and weight of the total sample (N=72) were mean value 23.8, SD= 3.8 years, mean value 179.2, SD = 5.9 cm and mean value 77.5, SD = 9.5 kg, respectively.

Comparison of the player positions

<Table 1> shows the means of the variables under investigation for the different positions.

Body height, weight, and arm girth were higher in goalkeepers than in field players (p <.05). The biepicondylar humerus breadth was larger in goalkeepers than in the defenders and midfielders, while the biepicondylar femur breadth, thigh and calf girths, and mesomorphy were higher in goalkeepers than in midfielders (p <.05).

Table 1. *Characteristics of player positions with meansand standard deviations of age, anthropometry and somatotypes*.

	Goalkeeper	Defender	Midfielder	Striker
Age	24.7 ± 5.3	24.4 ± 4.0	23.5 ± 3.8	22.9 ± 2.6
Body height (cm)	187 ± 6.1†	179.1 ± 4.4	178.7 ± 5.9	177.5 ± 6.8
Body weight (kg)	93 ± 6.1†	77.5 ± 7.6	74.7 ± 7.6	77.6 ± 11.3
BMI (kg/m²)	26.6 ± 3.0	24.2 ± 2.1	23.41 ± 2.3	24.6 ± 2.6
Relative Body fat (%)	16.5 ± 5.4	15.6 ± 3.6	15.4 ± 4.1	16.1 ± 2.8
Σ4SKFS(mm)	41.2 ± 19.9	36.9 ± 10.7	36.7 ± 12.8	37.8 ± 9.5
Biepicondylar humerus breadth	7.7 ± 0.9††	7.2 ± 0.3	7.1 ± 0.3	7.2 ± 0.5
Biepicondylar femur breadth	10.5 ± 0.8†††	10 ± 0.5	9.9 ± 0.4	9.9 ± 0.4
Arm girth (cm)	36.3 ± 3.1†	32.0 ± 1.9	31.5 ± 1.8	32.3 ± 2.4
Calf girth (cm)	40.7 ± 1.3†††	37.9 ± 2.0	37.3 ± 2.6	38.5 ± 2.7
Thigh girth (cm)	63.8 ± 2.9	59.4 ± 4.1	58.1 ± 3.6	60.5 ± 3.0
Endomorphy	3.2 ± 1.6	3.2 ± 1.0	3.1 ± 1.2	3.2 ± 0.7
Mesomorphy	6.1 ± 1.6†††	5.0 ± 0.9	4.7 ± 1.1	5.3 ± 0.9
Ectomorphy	1.9 ± 1.2	2.3 ± 0.9	2.6 ± 1.1	2.1 ± 0.9

* Values are means ± SD.
When compared by ANOVA (with Bonferroni Post-Hoc).
† significant difference between goalkeeper and defender/midfielder/striker (p < .05).
†† significant difference between goalkeeper and defender/midfielder (p < .05).
††† significant difference between goalkeeper and midfielder (p < .05).

The discriminant function analysis used the body composition measurements and the three somatotype components, endomorphy, mesomorphy and ectomorphy by playing position. A significant function was found in the first measurement. The Wilks' Lambda (= .642) results with p<.05 a significant result of the average values of the discriminant function of positions. The canonical correlation coefficient between the calculated values of the discriminant function and the playing position with r=0.552 was quite unsatisfactory. The discriminant analysis correctly predicted 8 of 24 defenders, 15 of 30 midfielders, 4 of 13, and 3of 5 goalkeepers in total. Around 41.4% of the cases originally grouped were correctly classified. Results of the discriminant function analysis are presented in <Tables 2, 3>.

Table 2. The results of discriminating analysis between the position and body composition in all Function trials.

Function	Eigen-value	% of the variance	Canonical R	Wilks' Lambda	Chi-Sqr.	df	p-level
1st	.437	84.1	.552	.642	29.468	15	.014
2nd	.072	13.8	.259	.923	5.335	8	.721
3rd	.011	2.1	.105	.989	.736	3	.865

† significant discriminative function on the first measurement product (p < .05).

Table 3. The structure matrix and correlation with the discriminant function (r) in all Function trials.

Variable	1st trial r	2nd trial r	3rd trial r
Ectomorphy	-.256	-.613	-.336
BMI	-.504	-511	-.123
Mesomorphy	.495	.485	-.655
Endomorphy	.045	.153	-.189
∑4SKFS	.143	.038	-.161

Common correlations within the groups between discriminance variables and standardized canonical discriminance function.

<Figure 1> shows the somatochart on which the somatotype of each individual subject was plotted. The means (circles) for the field positions were similar (3.2 – 5.0 – 2.4; mesomorph-endomorph) (p >.05).
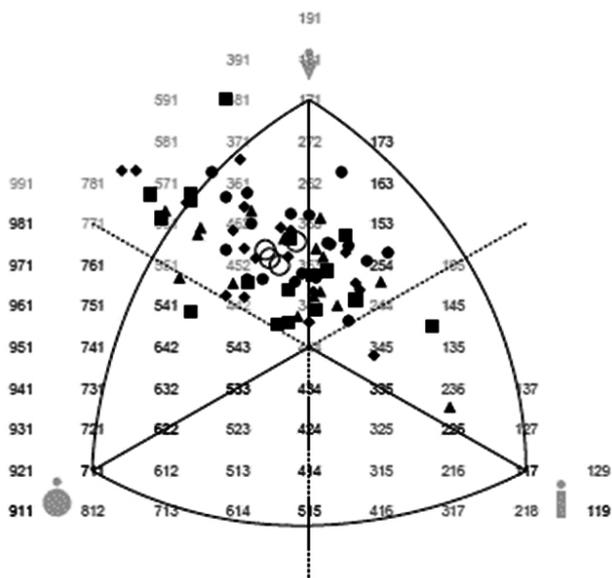

Figure 1. *Mean and Somatotype distribution of amateur soccer players.*

Comparison of soccer teams

<Table 4> depicts the mean anthropometric, body composition and somatotype components results of the amateur soccer players of the four Fifth Division teams. None of the means of the variables under investigation were different between the teams (p >.05).

Table 4. *Means and standard deviations of anthropometric, body composition and somatotype
components of amateur soccer players of fifth Division Teams (Values are means ± SD).*

	Team A	Team B	Team C	Team D
Age	24.9 ± 4.4	23.1 ± 3.2	22.7 ± 3.4	24.5 ± 3.9
Body height (cm)	179.5 ± 4.7	180.0 ± 6.5	181.2 ± 6.9	167.3 ± 5.6
Body weight (kg)	76.8 ± 7.7	77.6 ± 7.5	81.1 ± 11.3	74.6 ± 10.8
BMI (kg.m^{-2})	24.0 ± 2.8	23.9 ± 1.9	23.8 ± 2.4	24.6 ± 2.9
Relative Body fat (%)	15.5 ± 4.0	14.1 ± 3.2	16.4 ± 2.1	16.5 ± 3.5
Σ4SKFS (mm)	39.6 ± 12.7	32.1 ± 8.1	37.9 ± 12.0	39.9 ± 13.2
Biepicondylar humerus breadth	7.1 ± 0.5	7.3 ± 0.4	7.0 ± 0.2	7.3 ± 0.5
Biepicondylar femur breadth	10.0 ± 0.4	10.0 ± 0.5	9.8 ± 0.5	10.1 ± 0.5
Arm girth	32.0 ± 2.8	32.2 ± 1.7	32.1 ± 1.9	32.4 ± 2.8
Calf girth	37.0 ± 2.6	38.3 ± 1.7	38.3 ± 2.2	38.0 ± 3.3
Thigh girth (cm)	59.3 ± 3.8	58.5 ± 4.0	61.2 ± 5.1	58.5 ± 4.6
Endomorphic	3.2 ± 1.2	2.7 ± 0.8	3.3 ± 1.1	3.4 ± 1.0
Mesomorphic	4.8 ± 1.1	5.1 ± 0.7	4.9 ± 1.3	5.2 ± 1.1
Ectomorphic	2.5 ± 1.2	2.4 ± 0.8	2.3 ± 1.1	2.3 ± 1.0

Discussion

This study focused on the anthropometric characteristics of amateur soccer players in regards to team ranking and related to the appropriate field position of players.

In a review article et al. (1984) described the specific physical features of Olympic athletes between 1928 and 1976. Norton & Olds (2001) described how the physical conditions in professional sports have changed over the last 20 years. Carter & Heath (1990) demonstrated that genetic dispositions, degree of maturity and somatotype can limit morphological attributes and athletic performance. Further research supported the conclusion that athletes with ideal physical and mental features can be more successful.

In addition to the anthropometric and physiological characteristics, skills such as group dynamics, social skills and playing strategies may be important determinants

of success in team sports (Carter, 2003). The secular morphology trend observed in athletes has developed more quickly compared to the general population.

Comparison of playing position

The mean body weight (mean value 77.5, SD= 9.3 kg) of the players in this study (n=72) was similar (77.9 kg) to that of professional players reported in other studies (Rienzi et al., 2000; Strudwick, Reilly, & Doran, 2002) and larger (179.2 cm vs. 176.0 cm) and heavier (77.5 kg vs. 72.0 kg) than those described by Kutlu and colleagues (2007) (p <.05). This discrepancy could be due to different methods of measurement, different times of data collection, differences in training performance levels and training duration.

The results of the present study suggest that goalkeepers show differences in anthropometry compared to field players.

Some studies (Bangsbo & Franks, 2000; Carter, 2003; Matkovic et al., 2003; Arnason et al., 2004; Gil et al., 2007) have shown that the goalkeeper is significantly taller (180.0 cm), whereas midfield players proved to be the shortest (173.0 cm) and goalkeepers had longer legs (104.3 cm) and arms (79.2 cm) than the field players (legs 100.4 cm, arms 77.6 cm). A taller goalkeeper is advantageous for defending the goal.

Matkovic et al. (2003) concluded that the somatotypes were within the same range of mesomorphism as compared to Hungarian players (2.1 - 5.1 - 2.3). They found no significant difference between the morphology of the regular population and soccer players. However, the latter had significantly lower amounts of fat and larger body circumferences. The researchers explained this as a consequence of larger muscle mass. Tahara et al. (2006) focused on body composition in soccer players. The researchers reported that goalkeepers were significantly taller and heavier compared to field players. Silvestre et al. (2006) reported that goalkeepers had more body mass than the rest of the team. Gil et al. (2007) described in their study that young elite goalkeepers between 11 and 16 years of age were the tallest (179.5 cm) and heaviest (73.9 kg) players. The heavier weight was presumably due to the fact that endurance is less important for goalkeepers than field players.

As Raschka & Wolthausen (2007) and Reilly et al. (2000) pointed out, soccer players in professional teams are dissimilar in their anthropometry: "Elite soccer teams are characterized by a relative heterogeneity in body size" (Reilly et al., 2000).

The findings of the present study corroborate the results of these reference studies in three ways. First of all, tall players tend to have an advantage in certain playing position, notably in goalkeeping. Second, body composition is a crucial fitness factor for soccer players, as during athletic movements superfluous body weight acts as dead weight. Third, field players show in comparison to goalkeepers clearly less body weight.

On the other hand, Hencken & White (2006) established whether homogeneity existed within a sample (n = 24) of professional Premiership soccer players in respect of the gross anthropometric characteristics related to their playing positions. The researchers concluded that soccer players contracted to clubs in the Premiership were already categorized as elite performers, so discrepancies in increments of skinfolds should be minimal across all positions, as the training volume, intensity, and the duration will be similar.

They argued that it is not reasonable to compare absolute anthropometric values of individuals, as it would be logical to expect larger individuals to have larger measures of each variable.

The findings of the present study differ with the mentioned Hencken & White study (2006) on the following relevant points: Our study applies to several teams, whereas Hencken & White (2006) examined only one team. Also, different training periods and performances per team could have resulted in different values in their study.

Ramadan & Byrd (1987) concluded that goalkeepers had significantly higher values for endomorphy (3.0) and mesomorphy (5.5) when comparisons were made by position (endomorphy: defender = 2; midfielder = 1.63; striker = 2.1; mesomorphy: defender = 4.19; midfielder = 4.63; striker = 4.45). The lower amount of running in training and play could contribute to the higher value for endomorphy. The higher mesomorphic component is consistent with the explosive movement by goalkeepers. The present study revealed heterogeneity in mesomorphy among goalkeepers (6.1) and field players (defender = 5.0; midfielder = 4.7; striker = 5.3).

Bandyopadhyay (2007) compared physical characteristics, anthropometric measurements, body composition and somatotype of soccer players with volleyball players and the general population in India. As could be expected, they found significant differences between athletes and the general population. Soccer players in India were ectomorphic mesomorphs (2 － 5.5 － 2). Chin et al. (1992) found that mean body height and weight were lower in Hong Kong soccer players than in

players from both the English (White et al., 1988) and the Italian Leagues (Faina et al., 1988) even if their body fat was lower in comparison to other soccer teams (e.g. Australian soccer players, Kuwaiti World Cup team). Nutrition and ethnology were discussed as a possible explanation of these results. The present study did not agree with the findings of the study above. Nutrition and ethnology may be important factors to explain the observed differences between the two studies.

Salokun (1994) investigated the influence of somatotypes on the injury rate among 180 Nigerian soccer players from six highly-rated clubs. They observed that the incidence of injury varied considerably from one body type to another with the ectomorphs recording the highest at 85%. Among the mesoectomorphs, 50% were injured while 45% and 44% respectively of the ectomesomorphs and mesomorphs sustained injuries. The mean somatotypes of our study confirmed those found in the Nigerian study, indicating that German amateur soccer players already show an injury-preventive somatotype.

Comparison of soccer teams

A few studies (Thomas & Reilly, 1979; Reilly et al., 2000; Wisloff et al., 2004; Bloomfield et al., 2005) examined the role of physiological characteristics (body fat, endurance capacity, muscle strength, vertical jump ability) in soccer performance. Only one study used the finishing position in the league as a proxy of success. Kalapotharakos et al. (2006) conducted a survey of three Greek professional soccer teams in relation to their ranking in the championship. The best team showed significantly lower relative body fat values (9%), higher running velocity at the lactate threshold (14 $km.h^{-1}$), higher peak torque of knee extensors (276 Nm) and higher vertical jump ability (47.2 cm) compared with the middle (10,6%, 13.2 $km.h^{-1}$, 231 Nm, 42.4 cm) and lowest teams (11%, 13.3 $km.h^{-1}$, 239 Nm, 41.9 cm) in the same division.

The present study covering amateur soccer teams in the same divisional league showed no significant differences between the teams in respect of anthropometry and somatotypes. It can be argued that training intensities in amateur soccer teams are lower than in professional teams and that the training intensities among the amateur teams may be similar. The fact that training influences body composition by fat reduction, leading to an increase in fat free mass (Casajus, 2001; Kutlu et al., 2007) and higher girth of the extremities (Thomas & Reilly, 1979) may partially

explain our findings. Also, while we were taking our measurements, the training had started after the preparatory phase, typically a period with lower training intensities.

In some competitive sports, players with a lower body fat percentage and greater muscle cross sectional area invariably have better performance (Thomas & Reilly, 1979; Ostojic, 2002).

Further studies, including longitudinal designs, are needed to confirm our findings and to evaluate the effect of the training intensity changes over a season on the anthropometric characteristics in amateur soccer players and on team success.

Conclusion

According to this study it can be concluded that amateur soccer players are mesomorph- endomorphs, that the goalkeepers are larger and heavier, have larger arm girth compared to the field players, havewider biepicondylar humerus breadth than defenders and midfielders, and have wider biepicondylar femur breadth, calf and thigh girths, and mesomorphy than the midfielders. Finally, the anthropometric characteristics seem to have no significant impact on the rankings within the same amateur division.

Acknowledgments

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