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SPORTS ANTHROPOLOGICAL AND SOMATOTYPICAL INVESTIGATION OF FEMALE HANDBALL PLAYERS OF DIFFERENT PERFORMANCE CLASSES

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ABSTRACT

The present study examines anthropometric and somatotypical differences between female handball players of the first and the second national league (n = 24, the age range 16–31 years) on the one side and female handball players of the district league (n = 24, age range 18–48 years) on the other side. Anthropometric data and computed constitutional and somatotypical parameters correspond to international standards.

For the body height there is a highly significant difference in both leagues, as well as for the arm span in favor of higher performance classes. Finally, the arm length determines essential leverage ratios and throwing power and hence the performance in handball. Also for most of the rest of the height parameters the national leagues are dominating the district leagues.

Within the study cohort, the goalkeepers are the largest, followed by the backcourt.

The national league handball players have the expected smaller percentage of body fat and a higher lean body mass than the district players. The body weight of the female national league players surpasses the body mass of the district players by 3.6 kg. In the chess-board pattern graphic after CONRAD the players of the national leagues are more hyperplastic.

The average somatotypes after PARNELL (1958) for the female handball players of the national leagues are 4-3-3 and for the district league 5-3-2. The corresponding somatotypes after HEATH and CARTER are 4.3-3.5-1.8 and 4.9-3.9-1.8.

Keywords: *sports anthropological investigation, somatotypical investigation female handball players, sports anthropometry*

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INTRODUCTION

Handball was codified at the end of the 19th century in Northern Europe, chiefly in Germany and Scandinavia. The modern set of rules was published in 1917 in Germany, and has had several revisions since.

The present study focused on sports anthropometric and somatotypical differences in German female handball players of different position and performance classes.

MATERIAL AND METHODS

The present study examines anthropometric and somatotypical differences between female handball players of the first and the second national league (n = 24, age range 16–31 years) on the one side and female handball players of the district league (n = 24, age range 18–48 years) on the other side.

Each proband participated voluntarily and the data were used anonymously.

Anthropometric data and computed constitutional and somatotypical parameters in this work correspond to international standards [3, 6, 7, 9, 11, 13, 15]. The analysis of differences was tested by ANOVA.

RESULTS

The distribution of constitutional types after Conrad [3] and the somatotypes after Parnell [12] and Heath & Carter [6, 7] are summarized in Figures 1–3.

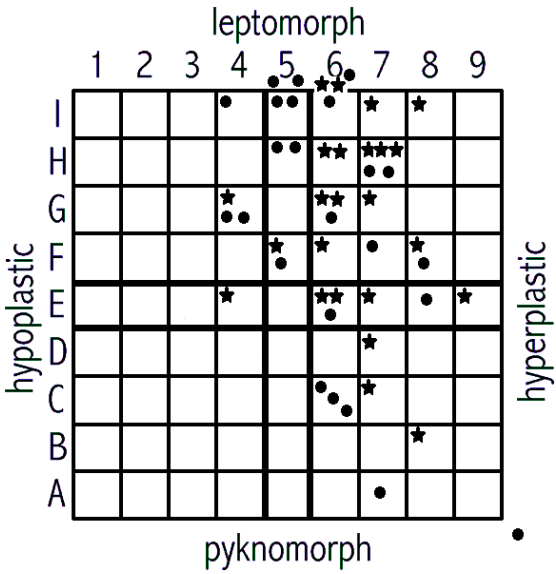

Figure 1. Higher leagues (stars; n=24) and lower leagues (circles; n=24) in the chessboard pattern graphic after CONRAD [3].

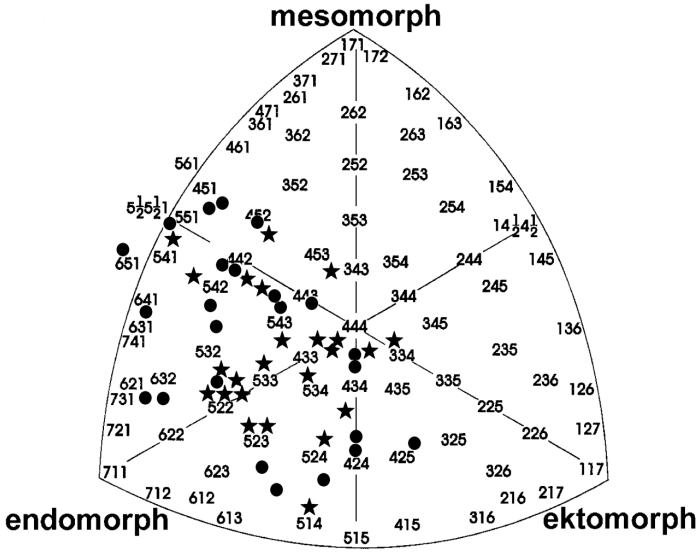

Figure 2. Higher leagues (stars; n=24) and lower leagues (circles; n=24) in the somatochart after Parnell [12].

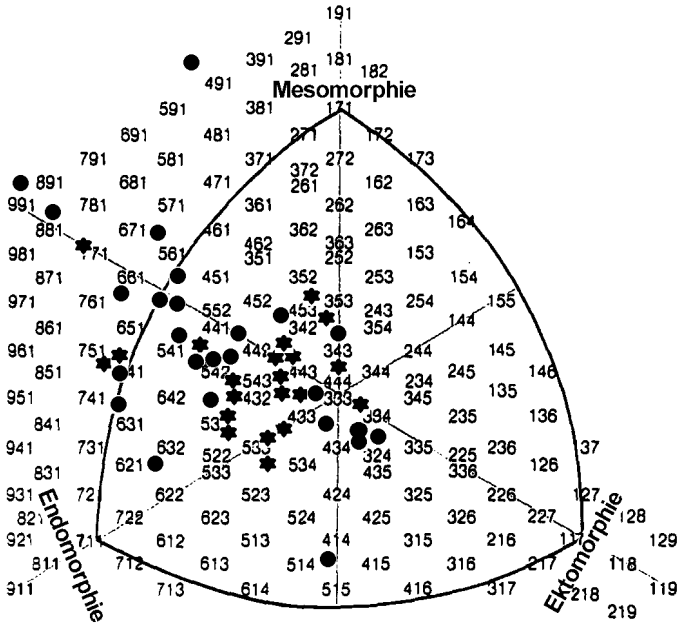

Figure 3. Higher leagues (stars; n=24) and lower leagues (circles; n=24) in the somatochart after Heath and Carter [6, 7].

In the following table all the collected anthropometric parameters are listed.

Table 1. Anthropometric and index parameters of female handball players of the first and second national league (n = 24) and female handball players of the district league (n = 24)

Parameter	1. and 2. National League				District League			
	Goalkeeper	Wingman	Pivot	Backcourt	Goalkeeper	Wingman	Pivot	Backcourt
Height (cm)	171.0±5.6	164.6±3.9	172.5±3.9	173.0±3.6	166.2±5.4	166.7±6.1	162.0±3.6	166.0±4.2
Gnathion (cm)	150.9±5.4	143.1±4.3	149.8±3.3	149.5±3.7	143.8±5.0	143.9±6.2	140.2±3.2	143.9±3.9
Suprasternale (cm)	141.6±6.1	132.6±2.3	141.2±3.8	140.4±2.6	134.5±4.0	135.7±5.6	131.5±3.6	134.4±4.4
Acromiale (cm)	144.6±5.7	134.0±2.7	143.0±3.9	143.3±2.4	135.6±4.5	137.5±6.5	132.1±4.3	135.6±4.6
Radiale (cm)	111.6±4.3	103.4±1.2	111.2±3.0	110.1±3.1	104.8±3.1	106.1±6.0	102.9±3.5	105.1±3.0
Stylion (cm)	87.2±3.8	80.4±0.9	87.4±2.6	86.8±2.4	82.6±2.6	82.9±3.6	79.8±2.3	82.1±2.8
Dactylion (cm)	68.2±3.2	62.7±0.8	68.1±1.6	66.6±2.0	63.8±1.9	63.8±2.9	62.0±2.0	63.8±1.1
Iliocristale (cm)	106.5±4.5	99.1±2.2	104.0±3.0	104.9±2.9	100.1±3.6	100.9±6.0	96.6±4.4	100.6±4.4
Iliospinale (cm)	99.1±4.9	92.3±2.4	95.4±3.9	97.7±1.8	92.8±4.2	93.5±5.3	90.1±4.6	94.5±4.0
Tibiale (cm)	48.8±1.5	45.8±1.6	47.3±1.9	48.0±1.7	45.5±1.6	46.7±3.0	43.5±2.5	45.1±2.7
Sphyrion (cm)	6.8±1.3	6.9±1.5	7.4±1.6	7.3±1.4	8.1±1.1	7.8±0.9	7.9±0.9	7.4±0.6
Sitting height (cm)	88.5±3.5	85.3±2.1	89.2±2.5	90.0±2.9	87.3±2.4	86.1±2.9	85.6±1.0	86.9±1.7
Zygomatic breadth (cm)	12.4±0.8	12.5±0.5	12.9±0.6	12.5±0.5	12.6±0.5	12.5±0.9	12.5±0.5	12.4±0.4
Morph.facial height (cm)	11.7±0.8	11.5±0.7	11.5±0.4	11.3±0.6	11.1±0.7	11.6±0.7	11.0±0.6	11.0±1.0
Arm span (cm)	176.7±5.5	166.7±6.9	172.7±5.1	174.8±4.4	166.8±6.2	168.2±7.5	162.2±4.0	168.3±7.5
Shoulder width (cm)	37.7±1.4	36.0±1.5	36.9±1.8	37.7±0.9	36.1±1.1	36.5±2.0	36.3±1.8	36.2±1.4
Chest width (cm)	28.5±1.1	27.2±1.8	27.6±1.0	29.2±1.5	27.3±2.0	27.1±1.6	27.0±1.7	27.2±1.9
Chest depth (cm)	19.4±2.9	17.5±0.6	18.6±1.8	18.8±1.2	19.1±1.2	18.4±2.0	17.1±1.1	17.8±1.7
Pelvis width (cm)	26.2±2.2	24.8±1.8	25.8±1.0	25.5±2.1	25.4±0.9	25.8±3.2	25.6±1.1	23.6±2.3
Epiphysis width Humerus (cm)	5.8±0.4	5.6±0.7	6.1±0.4	6.1±0.3	5.8±0.5	5.6±0.4	5.7±0.6	5.7±0.5

Parameter	1. and 2. National League				District League			
	Goalkeeper	Wingman	Pivot	Backcourt	Goalkeeper	Wingman	Pivot	Backcourt
Radioulnar breadth (cm)	5.0±0.3	4.8±0.4	4.8±0.5	5.0±0.6	4.9±0.4	4.9±0.1	4.8±0.3	4.9±0.3
Hand breadth (cm)	7.3±0.5	7.2±0.4	7.3±0.4	7.4±0.5	7.3±0.2	7.1±0.5	7.4±0.4	7.1±0.5
Middle finger length (cm)	9.2±0.5	8.8±0.6	9.3±0.5	8.8±0.4	8.6±0.5	8.8±0.8	8.8±0.3	8.8±0.4
Epiphysis width femur (cm)	8.7±0.9	7.5±0.8	8.3±0.5	8.3±0.6	8.4±0.5	8.2±0.5	8.2±0.4	8.2±0.5
Ancle breadth (cm)	6.6±0.4	6.3±0.3	6.8±0.3	6.7±0.5	6.3±0.3	6.5±0.4	6.3±0.4	6.4±0.4
Neck circumference(cm)	33.9±0.5	33.8±1.1	33.1±0.9	34.2±1.5	33.9±34.0	34.0±3.3	32.7±1.8	32.3±2.1
Chest circumference, respiratory centre (cm)	93.9±5.3	89.8±3.0	90.3±2.9	93.5±3.2	91.6±6.0	91.2±8.2	88.7±2.9	87.6±7.9
Chest circumference, in inspiration (cm)	96.8±4.9	94.2±3.3	93.7±3.4	96.9±2.6	95.7±7.9	94.8±7.8	92.0±3.3	91.7±7.6
Chest circumference, in exspiration (cm)	92.8±5.3	87.8±3.2	88.8±3.2	91.9±2.8	90.4±7.6	90.9±8.5	87.1±2.9	86.5±8.2
Waist circumference (cm)	81.5±6.6	73.6±2.7	74.6±2.3	78.4±5.6	79.1±8.9	79.7±11.5	75.8±3.3	73.2±10.5
Pelvis circumference (cm)	88.6±6.0	80.5±1.8	83.2±1.9	84.4±7.8	88.2±8.1	88.0±14.8	84.3±5.9	80.0±11.6
Upper arm circumf. in extension (cm) right side	29.3±2.5	27.6±0.9	28.4±1.6	29.1±1.0	29.8±2.6	29.1±3.4	28.6±2.5	27.3±2.3
Upper arm circumf. in flexion (cm) right side	31.0±2.3	29.6±0.8	30.3±1.3	31.5±2.0	31.2±2.1	30.3±2.8	29.6±2.1	28.8±1.8
Upper arm circumf. in extension (cm) left side	29.4±1.7	27.5±1.3	28.1±2.0	29.7±2.3	29.1±2.3	28.8±3.3	28.3±2.2	26.8±2.0
Upper arm circumf. in flexion (cm) left side	30.7±1.4	30.0±1.1	29.6±1.3	31.5±2.1	30.5±2.8	30.3±3.4	29.6±2.5	28.6±2.0
Forearm circumference maximum (cm) right side	25.5±1.5	25.0±0.8	25.7±1.2	26.2±1.6	25.9±1.1	25.8±2.6	25.3±1.2	24.7±1.4
Forearm circumference minimum (cm) right side	16.8±0.5	15.7±0.7	16.4±0.9	17.1±0.9	16.5±0.5	16.5±1.7	15.9±1.0	16.3±0.6
Forearm circumference maximum (cm) left side	25.2±1.4	24.3±1.1	24.8±1.7	25.7±1.7	24.9±1.3	24.9±2.4	24.1±1.1	23.9±1.5

Parameter	1. and 2. National League				District League			
	Goalkeeper	Wingman	Pivot	Backcourt	Goalkeeper	Wingman	Pivot	Backcourt
Forearm circumference minimum (cm) left side	16.8±0.8	15.8±0.6	16.0±0.9	16.6±0.9	16.3±0.6	16.5±1.5	15.8±0.9	16.0±0.7
Hand circumference (cm)	19.4±0.2	19.0±0.5	19.4±1.2	19.7±1.1	18.9±0.5	19.3±0.9	18.9±0.9	19.2±1.1
Thigh circumference (cm)	56.5±5.7	53.0±1.5	55.7±2.5	57.6±3.8	58.0±4.5	58.8±12.0	57.6±4.7	53.5±3.8
Calf circumference (cm)	38.8±2.8	37.1±1.5	37.4±2.3	39.0±3.2	38.0±2.3	39.3±5.1	38.1±3.7	36.6±3.2
Lower leg circumference (cm) minimum	23.0±1.5	22.0±0.7	22.9±0.9	22.8±1.4	22.6±1.5	23.0±2.5	22.3±1.9	22.0±1.1
Anthr. foot length (cm)	25.0±1.0	23.3±0.4	24.3±0.8	24.5±0.9	23.1±0.9	24.3±1.2	23.3±0.8	23.8±1.0
Techn. foot length (cm)	23.8±1.0	22.2±0.8	23.4±0.8	23.1±1.1	21.8±1.1	23.0±1.1	21.6±0.9	22.0±1.2
Heel width (cm)	5.2±0.3	4.8±0.5	4.9±0.3	5.0±0.1	4.9±0.3	5.1±0.5	4.9±0.5	5.1±0.4
Foot width (cm)	9.2±0.4	9.0±0.6	9.3±0.5	9.0±0.6	8.4±0.4	8.9±0.6	8.8±0.5	8.5±0.8
Foot circumference (cm)	24.0±0.7	23.9±0.8	23.7±1.3	23.8±0.9	22.6±0.9	23.9±1.3	23.0±0.8	23.2±0.7
Weight (kg)	76.2±8.6	62.7±3.2	69.8±4.3	74.1±6.5	70.6±7.2	70.8±14.1	64.6±7.1	62.6±9.0
Body fat (%)	22.0±3.5	19.3±1.9	20.7±3.0	19.6±3.8	21.9±3.3	21.3±3.2	21.3±1.7	21.1±4.1
BMI (kg/m²)	25.2±2.8	23.2±0.6	23.4±1.1	24.8±2.9	25.6±3.3	25.7±6.5	24.6±2.8	22.8±3.7
Triceps skinfold (mm)	14.7±5.7	11.4±3.4	14.4±5.6	11.9±3.7	14.3±3.1	12.9±2.9	13.6±2.5	14.4±2.8
Forearm skinfold (mm)	4.3±1.0	4.1±0.6	4.9±0.8	5.4±1.1	5.2±1.4	6.3±2.0	4.7±0.3	5.1±1.1
Suprailiac skinfold (mm)	18.0±6.0	14.3±2.0	14.8±3.2	14.5±6.7	18.4±7.0	18.3±6.3	17.4±2.9	15.8±9.1
Subscapular skinfold (mm)	17.3±3.5	12.2±1.7	13.5±2.5	13.8±3.4	19.3±6.3	15.6±7.0	16.1±4.7	14.1±7.0
Thigh skinfold (mm)	13.0±4.9	12.2±4.7	12.5±3.6	12.7±2.4	14.4±3.5	12.0±2.8	14.2±3.8	11.8±2.6
Calf skinfold (mm)	12.3±1.6	11.4±3.4	10.5±2.3	11.2±1.9	15.0±3.5	13.0±3.8	11.6±3.0	11.7±0.7
Head height (cm)	23.0±1.3	21.4±0.8	22.8±1.3	23.5±0.8	22.4±1.4	22.7±0.9	21.8±1.4	22.1±1.1
Neck length (cm)	9.3±1.1	8.8±1.5	8.6±1.4	9.2±2.0	9.3±1.4	8.3±1.3	8.7±1.2	9.5±0.6
Pelvis height (cm)	21.2±1.1	19.9±1.0	20.7±1.2	21.9±2.4	21.2±0.8	20.3±2.6	20.1±1.9	21.5±1.1

Parameter	1. and 2. National League				District League			
	Goalkeeper	Wingman	Pivot	Backcourt	Goalkeeper	Wingman	Pivot	Backcourt
Arm length (cm)	76.4±3.5	71.3±3.1	74.9±3.1	76.8±1.4	71.8±3.1	73.7±4.2	69.3±2.7	71.8±3.7
Length of upper arm and forearm (cm)	57.4±2.7	53.6±2.2	55.6±2.6	56.5±2.1	53.0±2.4	54.6±3.7	52.3±3.1	53.5±3.0
Upper arm length (cm)	33.0±1.7	30.5±1.9	31.8±2.0	33.2±2.3	30.8±1.7	31.4±1.9	29.3±1.5	30.6±1.8
Forearm length (cm)	24.4±1.6	23.0±0.6	23.8±1.4	23.3±1.3	22.2±1.1	23.2±3.0	23.1±2.7	23.0±1.7
Hand length (cm)	19.0±1.0	17.7±1.1	19.4±1.4	20.2±1.9	18.8±1.2	19.1±1.4	17.8±1.1	18.3±2.2
Leg length (cm)	94.7±4.4	88.5±2.2	91.4±3.9	93.6±1.7	89.0±3.9	89.8±4.8	86.8±4.3	91.0±3.6
Length of thigh and calf (cm)	88.6±5.2	82.0±3.3	84.5±3.6	86.8±2.9	81.3±4.2	82.3±5.2	78.9±4.1	83.6±4.0
Thigh length (cm)	46.7±3.6	43.2±2.0	44.7±3.3	46.3±0.9	44.0±3.2	43.5±2.6	43.3±2.4	45.9±1.6
Calf length (cm)	42.1±2.1	39.0±2.5	39.9±1.7	40.7±2.6	37.4±1.6	39.0±3.4	35.6±2.0	37.7±2.9
Muscle index right side	6.1±3.8	7.6±3.6	7.0±4.4	8.3±4.8	4.9±4.2	4.2±2.4	3.8±2.5	5.4±2.2
Muscle index left side	4.6±1.9	9.0±2.1	5.6±4.8	6.0±1.7	5.1±4.6	5.3±1.7	4.6±2.2	6.6±2.3
Metrik-Index/CONRAD	–0.7±1.1	–1.1±0.4	–1.1±0.6	–0.8±0.7	–0.8±0.8	–0.9±1.1	–1.1±0.7	–1.1±1.0
Plastik-Index/CONRAD	80.3±3.0	80.8±3.0	82.0±2.9	82.5±1.1	79.9±2.4	80.6±5.0	79.3±3.1	79.3±3.0
Pyknomorphy/Knussmann	–2.2±2.2	–1.8±2.5	–1.8±2.2	–0.2±1.5	0.0±1.8	0.1±3.7	–0.1±1.4	–1.0±1.7
Makrosomia/Knussmann	2.8±0.4	0.7±1.1	2.2±1.8	2.7±1.5	0.6±0.8	1.3±1.3	0.3±1.4	1.0±1.0
Endomorphy/PARNELL	4.8±0.6	4.3±0.6	4.4±0.8	4.3±0.7	5.1±0.7	4.7±0.8	4.6±0.4	4.5±0.9
Mesomorphy/PARNELL	2.8±0.7	2.7±1.0	3.0±1.0	3.3±1.3	2.8±1.8	3.3±1.4	3.9±1.7	2.8±1.1
Ektomorphy/PARNELL	2.4±0.8	2.4±0.6	2.9±0.7	2.7±0.9	2.1±1.1	2.6±1.5	2.2±1.0	3.2±1.1
Endomorphy/Heath-Carter	4.9±1.1	4.0±0.7	4.3±1.0	4.0±1.2	5.2±1.4	4.7±1.3	5.0±0.7	4.5±1.5
Mesomorphy/Heath-Carter	3.4±0.5	3.4±0.8	3.2±0.9	3.8±1.4	4.1±1.7	3.9±2.2	4.3±1.4	3.4±1.3
Ektomorphy/Heath-Carter	1.6±1.0	1.7±0.4	2.1±0.6	1.8±0.9	1.2±1.2	2.1±2.1	1.4±1.0	2.4±1.5
AKS-Index	1.13±0.10	1.14±0.04	1.08±0.03	1.15±0.11	1.20±0.15	1.22±0.31	1.20±0.13	1.08±0.15

Both for the body height as well as for the gnathion, the suprasternale, the acromiale, the radiale, the arm span, the technological foot length, the thigh length, the makrosomia after Knussmann [9] there were highly significant mean differences with respect to the league, but not with respect to the playing position.

For the radiale and the dactylion there were highly significant mean differences for the league and significant mean differences with respect to the playing position.

For the iliocristale, the iliospinale, the length of the upper arm and forearm and the upper arm length there was only a very significant mean difference, for the tibiale, the chest width, the anthropological foot length, the foot width, the foot circumference, the sitting height, the forearm skinfold, the arm length and the muscle index of the right side there was only a significant mean difference with respect to the league.

DISCUSSION

A special anthropometric position is occupied by the body height. For the body height there is a highly significant difference in both leagues, as well as for the arm span in favor of higher performance classes. Finally, the arm length determines essential leverage ratios and throwing power and hence the performance in handball. Also for most of the rest of the height parameters the national leagues are dominating the district leagues.

In an international comparison of body heights of the investigated handball players they rank in the span of the available literature data, as the following table 2 illustrates.

Table 2. Body height comparison of female elite handball players from different countries

Authors	Height (mean, cm)	Country	n
Hirata (1979) [8]	172.0	Olympics (Montreal)	?
Hasan et al. (2007) [5]	175.0±3.5	China	14
Hasan et al. (2007) [5]	168.0±7.4	Japan	16
Hasan et al. (2007) [5]	172.0±9.0	Kazakhstan	14
Hasan et al. (2007) [5]	169.0±5.0	South Korea	16
Štěpnička (1972) [14]	165.6±4.9		78
Eiben (1981) [4]	168.5±5.3	Hungary	29
Čavala et al. (2008) [2]	178.2±3.6	Croatia	53
Bayios et al. (2006) [1]	165.9±6.3	Greece	222
Tittel/Wutscherk (1972) [15]	170.4	East Germany	?

Concerning all the other height dimensions of Hungarian national team players collected over 30 years ago by Eiben [4] (suprasternale, acromiale, radiale etc.) they are surpassed by the high-class players in the present survey.

Within the study cohort, the goalkeepers are the largest, followed by the backcourt.

Regarding the width extents the German top players are, however, behind the Hungarian athletes of Eiben Eiben [4], but before the German players in the study of Tittel & Wutscherk [15].

To compare the body composition parameters with literature data, the next table shows the relevant parameters.

Table 3. Body composition of female elite handball players from different countries

	Tittel/Wutscherk (1972)	Eiben (1981)	Bayios et al. (2006)
Body weight (kg)	66.0	64.9	65.1
Body fat percentage (%)	15.3	–	25.9
BMI (kg/m²)	–	–	23.6
Triceps skinfold (mm)	11.2	16.2	–
Suprailiac skinfold (mm)	9.6	15.6	–
Subscapular skinfold (mm)	6.5	14.1	–
Thigh skinfold (mm)	18.0	–	–
Calf skinfold (mm)	11.6	13.2	–

The national league handball players have the expected smaller percentage of body fat and a higher active body substance (lean body mass) than the district players, which corresponds to a higher muscle percentage of the higher performance classes. The body weight of the female national league players surpasses the body mass of the district players by 3.6 kg. In the chess-board pattern graphic after Conrad [3] the players of the national leagues are more hyperplastic.

The majority of the circumferences of the national league players ranked over the values of the district league.

To compare the circumference measurements with literature data, the following table shows the relevant parameters.

Table 4. Circumferences of female elite handball players from different countries

Circumference (cm)	Tittel/Wutscherk (1972)	Eiben (1981)	Čavala et al. (2008)
chest, respiratory centre	91.6	87.2	89.9
Chest in inspiration	94.9	–	–
Chest in exspiration	89.3	–	–
Waist	–	81.8	–
Pelvis	–	95.5	–
Upper arm, in extension	27.2	25.6	28.5
Upper arm, in flexion	–	27.5	30.3
Forearm maximum	25.1	24.2	–
Forearm minimum	–	15.4	–
Thigh	54.1	58.1	–
Calf	35.7	36.2	38.8
Lower leg minimum	–	22.7	–

The average somatotypes after Parnell [12] for the female handball players of the national leagues are 4-3-3 and for the district league 5-3-2. The corresponding somatotypes after Heath and Carter [6, 7] are 4.3-3.5-1.8 and 4.9-3.9-1.8.

The international comparison shows somatotypes of 4.5-4.1-2.2 for the Hungarian national players of Eiben [4], 4.1-4.3-2.3 (Štěpnička [14]) and 4.2-4.7-1.8 for the Greek players of Bayios et al. [1].

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