

# **SPORTS ANTHROPOLOGICAL AND SOMATOTYPICAL COMPARISON BETWEEN FEMALE WRESTLERS AND HAPKIDOIN OF DIFFERENT PERFORMANCE LEVELS**

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## **ABSTRACT**

The present study compares the anthropometry and somatotyping of 13 healthy female wrestlers (age range 15–26 years) and 30 hapkidoin (age range 20–44 years) of various performance categories.

The hapkidoin of higher performance levels are 5 cm larger on average than the wrestlers and the hapkidoin of the lower class. In almost all circumferences the wrestlers achieve higher values than the Hapkidoin. For most circumferences and skinfolds, significantly higher values in the higher weight classes are observed in the wrestlers. The BMI of all examined athletes is in the normal range. In the constitution typology after Conrad (1963), the wrestlers appear to be leptomorph-metroplastical, the hapkidoin appear to be leptomorph-hypoplastical.

In the Cartesian coordinate system after Knußmann, the representatives of both martial arts disciplines are macrosom and superleptomorph, i.e. muscular, tall and slender. In the somatochart after Heath & Carter (1967), the average type of the hapkidoin is 7 – 2 – 2, that of the wrestlers is 6 – 1 – 2. These somatotypes are much stouter and less muscular than the martial arts somatotypes in the study of Gualdi-Russo et al. (1993). From this observation we can infer a considerable development potential of the examined sportswomen in our study.

**Keywords:** *sports anthropology; comparison; hapkido; wrestling; female athletes*

## **INTRODUCTION**

Hapkido is a Korean martial art. It is a form of self-defence that employs joint locks, grappling and throwing techniques as well as kicks, punches, and other

striking attacks. It contains both long- and close-range fighting techniques, utilizing jumping kicks and percussive hand strikes at longer ranges as well as pressure point strikes, joint locks, or throws at closer fighting distances. Wrestling is a combat sport involving grappling type techniques such as clinch fighting, throws and takedowns, joint locks, pins and other grappling holds.

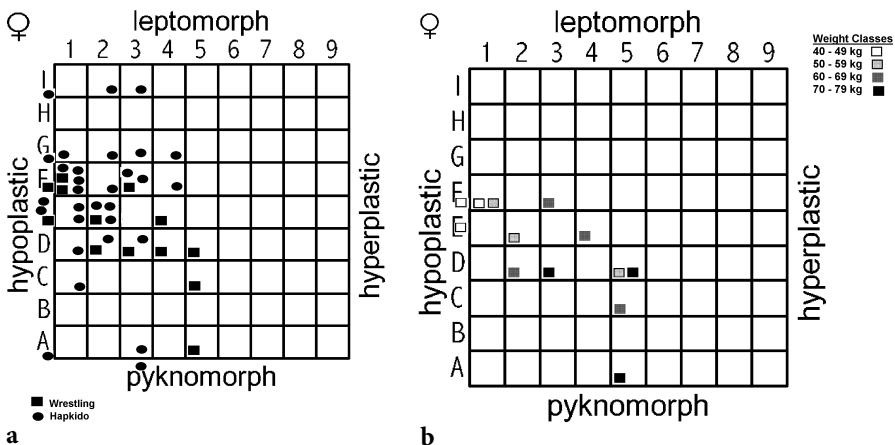
### PARTICIPANTS AND METHODS

The present study compares the anthropometry and somatotyping of 13 healthy female wrestlers (age range 15–26 years) and 30 hapkidoin (age range 20–44 years) of various performance categories.

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 (Conrad 1963, Heath & Carter, 1967, 1990, Knußmann 1996, Martin & Knußmann 1988, Raschka 2006, Tittel & Wutscherk 1972). The analysis of differences was tested by ANOVA.

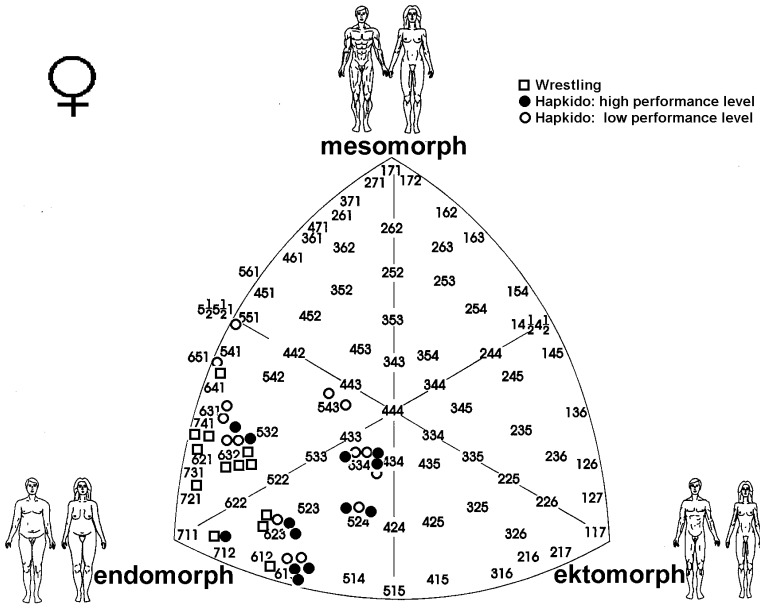
### RESULTS

The distribution of constitutional types after Conrad (1963) and the somatotypes after Parnell (1954) and Heath & Carter (1967) are summarized in Figures 1–4.



**Figure 1 a and b.** Female constitutional types of wrestlers and hapkido fighters in the chessboard pattern graphic after Conrad (1963): a) first chessboard graphic: wrestling vs. hapkido; b) second chessboard graphic: wrestling differentiated according to weight classes.

a



b

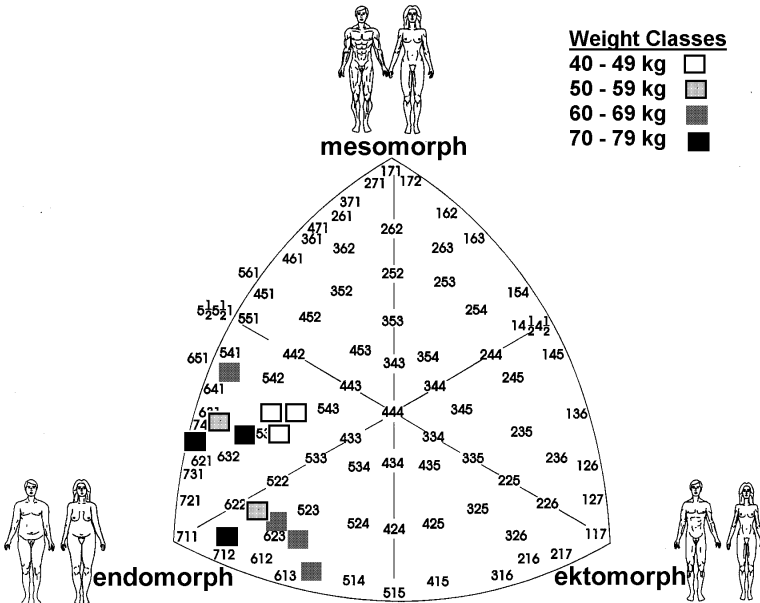
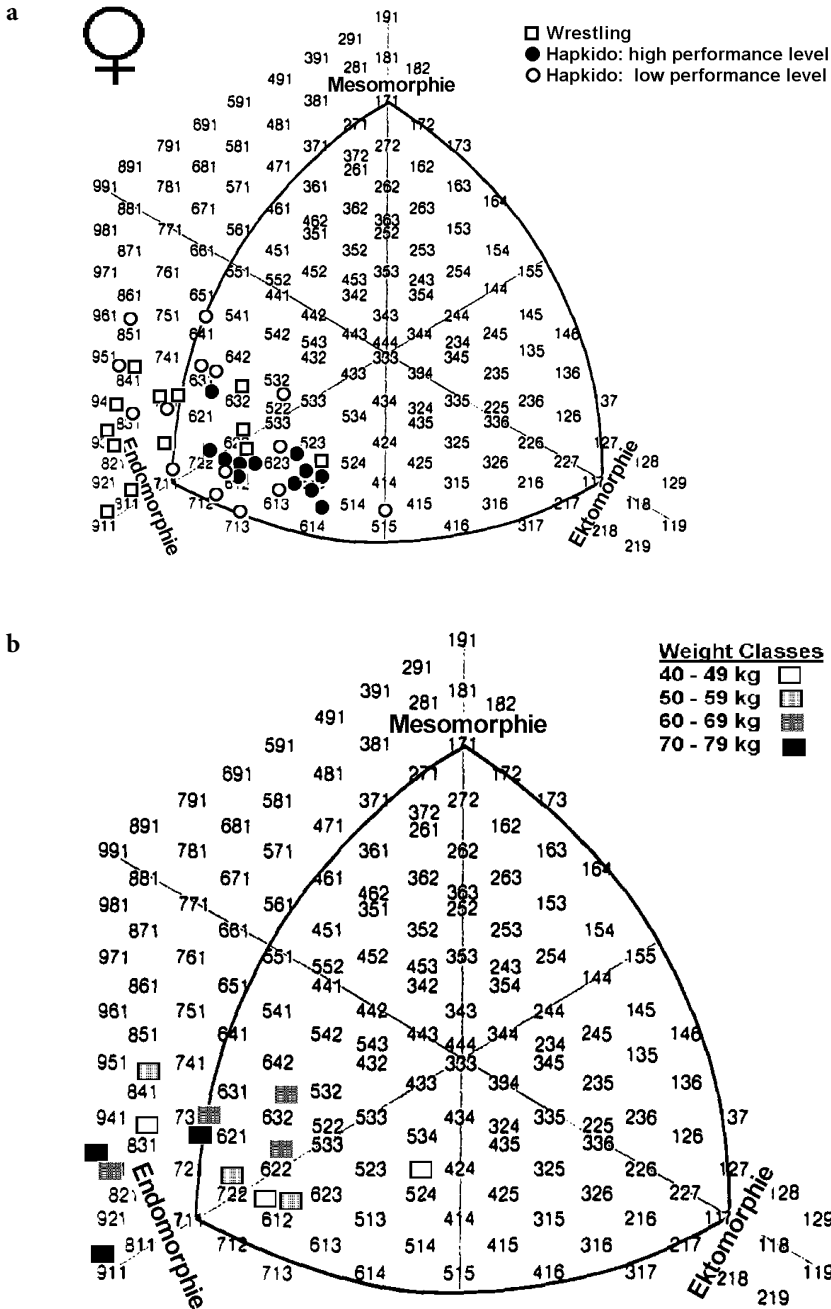


Figure 2 a and b. Female constitutional types of wrestlers and hapkido fighters in the somatochart after Parnell (1954): a) first somatochart: wrestling vs. hapkido; b) second somatochart: wrestling differentiated according to weight classes.



**Figure 3 a and b.** Female constitutional types of wrestlers and hapkido fighters in the somatochart after Heath & Carter (1967): a) first somatochart: wrestling vs. hapkido; b) second somatochart: wrestling differentiated according to weight classes.

The sports anthropometric parameters of female wrestlers and hapkidoin of different performance levels are listed in Table 1, the sports anthropometric parameters of female wrestlers differentiated according to weight classes are listed in Table 2.

**Table 1.** Sports anthropometric parameters of female wrestlers and hapkidoin of different performance levels

Parameter	Hapkido Higher Class	Hapkido Lower Class	Wrestling
Age (years)	26.4±9.6	29.8±6.1	18.0±3.85
Height (Vertex; cm)	165.0±6.2	161.6±5.7	160.8±6.6
Gnathion (cm)	143.2±5.9	139.9±5.8	138.2±5.7
Suprasternale (cm)	134.8±5.8	131.4±4.9	129.9±5.8
Acromiale (cm)	136.9±5.4	134.2±5.3	133.4±5.9
Radiale (cm)	103.3±5.2	101.8±4.6	100.5±4.4
Stylian (cm)	80.6±4.5	79.5±4.4	77.5±3.0
Dactylian (cm)	62.5±4.8	61.6±3.7	60.2±2.7
Iliocristale (cm)	99.9±4.1	97.7±4.0	96.4±4.5
Iliospinale (cm)	93.6±3.9	91.0±3.6	91.0±4.9
Tibiale (cm)	45.3±2.8	43.3±3.0	41.9±2.9
Sphyrion (cm)	6.5±1.4	5.7±0.9	5.6±0.9
Sitting height (cm)	86.1±3.6	85.2±3.1	84.0±2.9
Arm span (cm)	168.1±5.9	161.7±7.4	162.0±9.6
Shoulder width (cm)	29.5±1.9	28.8±2.3	30.3±2.3
Chest width (cm)	27.5±3.4	26.4±2.2	26.9±2.1
Chest depth (cm)	18.4±2.0	19.1±2.6	19.4±1.8
Pelvis width (cm)	24.6±1.4	24.8±2.3	26.3±2.3
Spinal distance (cm)	23.8±2.4	23.8±2.5	22.5±1.9
Epiphysis width Femur (cm)	7.1±1.1	7.3±0.9	7.0±0.9
Epiphysis width Humerus (cm)	5.9±0.7	6.0±0.5	6.4±0.6
Hand breadth (cm)	6.9±0.4	7.0±0.6	7.0±0.5
Middle finger length (cm)	8.7±0.7	8.8±0.9	8.6±0.8
Anthropometric foot length relieved	23.7±0.9	23.4±1.0	22.8±1.4
Anthropometric foot length loaded	24.2±1.1	23.6±1.1	22.9±1.3
Technological foot length	18.8±1.3	18.4±1.3	18.6±1.5
Height of head	21.8±1.3	21.7±0.9	22.6±1.8

Parameter	Hapkido Higher Class	Hapkido Lower Class	Wrestling
Neck length	8.4±1.5	8.5±1.6	8.5±1.7
Arm length	74.5±3.7	72.6±2.8	71.6±8.5
Upper and lower arm length	56.3±2.1	53.7±3.4	55.9±3.8
Upper arm length	33.7±2.0	32.8±2.1	32.9±2.6
Lower arm length	22.6±1.9	22.3±1.6	23.1±1.6
Hand length	18.2±2.5	17.9±1.4	17.2±1.1
Morphologic leg length	89.5±4.6	87.5±3.2	87.9±4.4
Physiognomic leg length	78.9±3.1	76.4±3.3	77.6±4.9
Thigh and lower leg length	83.6±3.3	81.6±3.1	82.0±4.4
Thigh length	44.9±2.1	44.1±1.8	45.7±3.4
Lower leg length	38.8±2.2	37.6±2.6	36.3±2.8
Heel width	5.4±0.5	5.3±0.5	5.3±0.3
Foot width	8.9±0.8	8.9±0.8	9.3±1.0
Neck circumference (cm)	32.8±1.0	33.2±1.8	34.2±2.3
Chest circumference (respiratory centre, cm)	77.1±3.7	77.1±4.8	76.9±5.7
Chest circumference in inspiration (cm)	81.8±4.9	80.9±4.9	76.9±5.7
Chest circumference in expiration (cm)	74.1±3.1	75.3±5.3	81.4±6.2
Waist circumference (cm)	70.7±2.6	72.4±6.0	68.5±16.9
Pelvis circumference (cm)	83.0±6.0	84.6±6.0	86.2±8.6
Upper arm circumference in flexion (cm)	27.7±1.9	27.7±2.2	29.2±3.0
Upper arm circumference extension(cm)	25.6±1.7	26.0±2.4	27.0±2.9
Forearm circumference maximum (cm), dominant side	22.9±1.0	23.1±1.4	24.0±1.8
Forearm circumference minimum (cm)	15.1±0.6	15.3±0.9	15.4±1.0
Hand circumference (cm)	17.8±0.5	17.8±1.2	17.7±1.4
Thigh circumference (cm)	50.7±3.9	53.2±2.8	52.5±4.5
Calf circumference (cm)	34.6±1.6	35.8±2.5	34.8±3.4
Lower leg circumference minimum (cm)	22.6±0.9	23.3±1.4	21.7±1.6
Foot circumference (cm)	22.7±1.1	23.2±1.0	23.2±1.8
Morphological facial height (cm)	11.5±0.5	11.2±0.6	11.7±0.4
Zyomatic breadth (cm)	11.8±0.8	11.9±0.8	11.5±0.8
Subscapular skinfold (mm)	12.9±3.8	14.3±4.9	18.5±8.1
Triceps skinfold (mm)	24.6±4.0	26.3±3.6	27.9±6.1

Parameter	Hapkido Higher Class	Hapkido Lower Class	Wrestling
Forearm skinfold (mm)	7.2±3.5	8.4±2.2	10.7±2.1
Suprailiac skinfold (mm)	24.4±6.9	23.8±7.2	29.7±7.5
Thigh skinfold (mm)	24.0±4.8	24.3±5.1	26.3±8.4
Calf skinfold (mm)	20.4±8.8	19.9±4.7	21.4±8.9
Body fat percentage (calipermetry; %)	26.4±4.2	26.5±3.7	30.5±4.8
Body fat percentage (BIA; %)	26.4±2.7	32.6±7.9	35.8±8.8
Plastik-Index after Conrad	70.1±2.1	69.8±3.7	72.0±4.6
Metrik-Index after Conrad	-0.6±0.8	-0.5±0.8	-0.4±0.4
Pyknomorphy after Knußmann	-7.8±1.1	-7.4±1.3	-7.3±2.4
Makrosomia after Knußmann	1.1±1.2	0.8±1.9	1.9±1.9
Endomorphy after Parnell	5.3±0.6	5.2±0.5	5.9±0.5
Mesomorphy after Parnell	2.0±0.9	2.7±1.0	2.3±1.0
Ectomorphy after Parnell	4.3±1.3	4.0±1.1	3.1±1.3
Endomorphy after Heath&Carter	6.0±0.9	6.4±0.9	7.2±1.3
Mesomorphy after Heath&Carter	0.5±1.7	1.7±1.8	2.2±1.3
Ectomorphy after Heath&Carter	2.5±1.1	2.2±1.6	1.8±1.1
Body weight (kg)	59.3±5.5	59.3±7.6	60.7±11.5
BMI (kg/m <sup>2</sup> )	21.8±1.9	22.8±2.6	23.4±3.7
Pelidisi-Index (kg/cm)	97.6±3.8	98.4±3.8	96.2±16.3
Quetelet-Index (g/cm)	3.6±0.3	3.7±0.4	3.8±0.6
Lean Body Mass LBM (kg)	59.3±5.5	59.3±7.6	60.7±11.5
AKS-Index (BIA)	1.0±0.1	0.9±0.2	0.9±0.2
AKS-Index (Caliper)	1.0±0.1	1.0±0.1	1.0±0.1
Body Surface (m <sup>2</sup> )	1.7±0.1	1.6±0.1	1.6±0.2
Rohrer-Index (g/cm <sup>3</sup> )	1.3±0.1	1.4±0.2	1.5±0.2
Broca-Index (%)	8.5±11.1	15.7±14.8	19.6±18.3
Height-Weight-Ratio (inches/3.√lb)	13.2±0.5	12.9±0.5	12.9±0.6

**Table 2.** Sports anthropometric parameters of female wrestlers differentiated according to weight classes

<b>Parameter – female wrestlers – weight classes</b>	<b>40–49 kg</b>	<b>50–59 kg</b>	<b>60–69 kg</b>	<b>70–79 kg</b>
Age (years)	22.3±4.7	17.0±4.4	16.3±1.5	17.0±2.7
Height (Vertex; cm)	154.0±6.7	161.3±5.3	162.4±6.7	165.0±4.4
Gnathion (cm)	131.5±6.1	139.7±3.1	139.6±5.3	141.7±3.8
Suprasternale (cm)	123.7±5.9	129.5±3.8	131.6±5.7	134.0±4.1
Acromiale (cm)	127.7±5.5	132.3±4.5	136.6±6.2	135.8±5.0
Radiale (cm)	95.5±4.3	102.0±4.6	101.9±3.6	102.3±2.3
Styilion (cm)	73.7±3.2	78.5±2.8	78.1±1.7	79.3±1.5
Dactyilion (cm)	57.0±2.7	60.3±2.5	61.4±2.0	61.8±1.3
Iliocristale (cm)	92.0±3.5	95.7±3.5	97.3±4.8	100.2±2.6
Iliospinale (cm)	86.7±4.2	91.0±4.0	92.6±5.1	93.2±5.5
Tibiale (cm)	40.2±1.9	42.8±1.0	40.8±4.3	44.2±1.6
Sphyrion (cm)	5.3±1.6	5.8±0.6	5.6±0.6	5.5±1.0
Sitting height (cm)	81.3±3.8	85.0±3.1	83.6±1.9	86.3±1.3
Arm span (cm)	152.5±6.4	160.5±4.0	165.8±13.4	168.0±2.7
Shoulder width (cm)	28.0±0.5	29.8±2.6	30.8±2.2	32.5±1.3
Chest width (cm)	24.8±1.6	26.7±1.0	26.9±1.8	29.5±0.9
Chest depth (cm)	18.0±1.0	19.3±1.6	19.8±2.3	20.3±1.5
Pelvis width (cm)	24.2±1.4	25.7±1.2	26.5±2.0	28.7±2.3
Spinal distance (cm)	23.2±2.8	21.3±1.5	22.0±1.1	23.5±2.2
Epiphysis width Humerus (cm)	6.0±0.0	6.2±0.3	6.6±0.8	6.7±0.6
Epiphysis width Femur (cm)	6.2±1.0	7.3±0.8	6.6±0.3	7.8±0.8
Hand breadth (cm)	6.5±0.5	7.0±0.5	7.4±0.5	7.0±0.0
Middle finger length (cm)	8.0±0.0	8.5±0.5	8.9±1.0	8.8±1.0
Anthropometric foot length relieved	22.0±1.3	22.7±0.6	22.9±1.9	23.7±1.3
Anthropometric foot length loaded	22.2±1.3	22.8±0.8	22.9±1.3	23.7±1.3
Technological foot length	18.3±1.5	18.0±0.0	18.5±2.2	19.5±1.8
Height of head	22.5±1.8	21.7±2.4	22.8±2.4	23.3±0.6
Neck length	7.8±1.0	10.2±1.3	8.5±2.2	7.7±0.8
Arm length	70.7±3.2	72.0±2.0	70.3±15.9	74.0±4.3
Upper and lower arm length	54.0±2.8	53.8±1.8	58.5±4.8	56.5±3.8
Upper arm length	32.2±1.6	30.3±0.6	34.8±2.9	33.5±2.8



Parameter – female wrestlers – weight classes	40–49 kg	50–59 kg	60–69 kg	70–79 kg
Lower arm length	21.8±1.3	23.5±1.8	23.8±2.1	23.0±1.0
Hand length	16.7±0.6	18.2±0.3	16.8±1.7	17.5±0.5
Morphologic leg length	84.0±3.6	87.7±3.5	89.4±4.7	89.8±5.1
Physiognomic leg length	72.7±3.6	76.3±2.5	78.8±5.1	82.2±4.0
Thigh and lower leg length	78.1±2.5	81.8±3.4	83.5±4.6	84.2±5.6
Thigh length	43.3±2.3	44.8±2.8	48.3±2.4	45.6±4.4
Lower leg length	34.8±0.6	37.0±0.5	35.1±4.0	38.7±2.6
Heel width	5.2±0.3	5.3±0.3	5.4±0.5	5.3±0.3
Foot width	7.8±0.8	9.7±0.6	9.6±0.8	10.0±0.0
Neck circumference (cm)	32.3±2.1	33.5±0.9	34.1±2.4	37.0±1.0
Chest circumference (respiratory centre, cm)	77.7±2.1	75.3±3.1	76.8±1.5	84.0±7.6
Chest circumference in inspiration (cm)	76.3±4.0	81.3±2.5	80.0±2.0	88.3±9.5
Chest circumference in expiration (cm)	69.0±3.6	72.7±2.3	74.5±1.3	81.7±8.1
Waist circumference (cm)	66.3±3.2	69.0±4.4	74.3±3.0	80.3±8.1
Pelvis circumference (cm)	76.8±3.2	81.3±6.4	90.0±6.1	95.3±4.5
Upper arm circumference in flexion (cm)	25.8±2.4	28.0±1.0	29.9±1.4	33.0±2.0
Upper arm circumference extension(cm)	24.7±2.9	25.2±0.8	27.6±1.4	30.5±2.6
Forearm circumf. maximum (cm), dominant side	21.7±1.2	24.3±1.5	24.5±1.0	25.3±1.5
Forearm circumference minimum (cm)	14.3±1.2	15.3±0.8	15.6±1.1	16.0±0.5
Hand circumference (cm)	16.7±0.6	17.3±2.3	18.5±1.3	18.0±0.0
Thigh circumference (cm)	48.0±4.4	51.0±1.7	53.8±2.5	57.0±4.6
Calf circumference (cm)	30.7±2.1	33.3±0.6	36.4±1.0	38.3±3.5
Lower leg circumference minimum (cm)	19.7±1.5	21.7±0.6	22.8±1.5	22.2±0.3
Foot circumference (cm)	20.7±0.6	24.0±1.5	23.8±1.5	24.3±0.6
Morphological facial height (cm)	11.8±0.3	11.7±0.3	11.9±0.5	11.2±0.3
Zygomatic breadth (cm)	11.7±1.2	11.0±0.0	11.5±1.1	11.8±0.6
Subscapular skinfold (mm)	12.8±2.8	13.6±3.4	18.8±5.4	28.8±9.3
Triceps skinfold (mm)	23.4±4.2	25.1±2.3	30.7±8.4	31.7±4.0
Forearm skinfold (mm)	11.7±2.2	10.2±2.2	11.3±2.5	9.6±1.5
Suprailiac skinfold (mm)	25.4±5.0	25.4±4.1	32.8±7.1	34.1±10.8
Thigh skinfold (mm)	22.8±2.8	23.8±7.7	30.8±13.5	26.3±3.5

Parameter – female wrestlers – weight classes	40–49 kg	50–59 kg	60–69 kg	70–79 kg
Calf skinfold (mm)	18.8±4.3	15.2±7.3	29.4±11.4	19.4±3.0
Body fat percentage (calipermetry; %)	26.5±2.6	28.0±2.6	32.7±5.6	33.9±4.4
Body fat percentage (BIA; %)	27.9±2.3	37.1±8.1	38.9±8.4	38.0±12.9
Plastik-Index after Conrad	66.3±2.0	71.5±4.8	73.8±3.3	75.8±2.8
Metrik-Index after Conrad	-0.7±0.2	-0.4±0.3	-0.4±0.5	-0.1±0.5
Pyknomorphy after Knußmann	-8.0±1.1	-7.6±0.5	-8.2±3.5	-5.0±1.9
Makrosomia after Knußmann	0.6±1.7	1.2±2.3	2.6±2.2	3.0±0.5
Endomorphy after Parnell	5.5±0.0	5.7±0.3	6.1±0.5	6.5±0.5
Mesomorphy after Parnell	2.5±0.0	1.5±0.5	2.6±1.0	2.7±1.5
Ectomorphy after Parnell	4.5±1.0	3.7±0.3	2.5±1.2	2.0±1.0
Endomorphy after Heath&Carter	6.4±1.1	6.4±0.6	7.5±1.5	8.2±1.3
Mesomorphy after Heath&Carter	0.9±1.9	2.3±0.3	2.9±1.0	2.5±1.0
Ectomorphy after Heath&Carter	2.9±1.0	2.2±0.2	1.3±1.1	0.8±0.8
Body weight (kg)	46.2±6.1	56.5±5.4	64.2±2.1	74.7±8.3
BMI (kg/m <sup>2</sup> )	19.7±2.1	21.7±0.6	24.5±2.4	27.3±4.2
Pelidisi-Index (kg/cm)	95.0±1.6	97.2±1.6	103.2±2.2	103.6±1.8
Quetelet-Index (g/cm)	3.0±0.3	3.5±0.2	3.9±0.2	4.5±0.6
Lean Body Mass LBM (kg)	46.2±6.1	56.5±5.4	64.2±2.1	74.7±8.3
AKS-Index (BIA)	0.8±0.1	0.9±0.1	0.9±0.2	1.0±0.3
AKS-Index (Caliper)	0.9±0.1	1.0±0.1	1.0±0.1	1.1±0.2
Body Surface (m <sup>2</sup> )	1.4±0.1	1.6±0.1	1.7±0.1	1.8±0.1
Rohrer-Index (g/cm <sup>3</sup> )	1.3±0.1	1.4±0.0	1.5±0.2	1.7±0.3
Broca-Index (%)	5.8±11.2	10.1±1.6	24.2±17.1	36.8±23.0
Height-Weight-Ratio (inches/3.√lb)	13.4±0.5	13.2±0.1	12.7±0.6	12.3±0.7

## DISCUSSION

The hapkidoin of higher performance levels are 4 cm larger on average than the wrestlers and the hapkidoin of the lower class.

In the weight categories of wrestlers also the body height increases in proportion to the weight steadily. All other height and length parameters follow this trend.

Practically in all martial arts, according to Neumann and Schüler (1994), long arms are combined with a greater range and are therefore advantageous.

A number of circumferences of the wrestlers have higher values than those of the hapkidoin. The wrestlers of the higher weight classes have significantly higher values for most circumferences and skinfolds.

The Quetelet index of the wrestlers is 3.76 g/cm on average, of the Hapkidoin 3.59 (higher performance class) and 3.67 g/cm (lower performance class). Here, the average value of the lightest weight category of the wrestlers (3 g/cm) is even below the normal range, of the heaviest weight class it is above the normal range.

The BMI of all examined athletes is in the normal range of the classification according to Biesalski et al. (2015).

In the constitution typology after Conrad (1963), the wrestlers appear to be leptomorph-metro-plastical, the hapkidoin appear to be leptomorph-hypo-plastical.

In the Cartesian coordinate system after Knußmann, the representatives of both martial arts disciplines are macrosom and superleptomorph, i.e. muscular, tall and slender.

With increasing body mass of the wrestlers, the trend changed from superleptomorph to subleptomorph.

After Parnell (1954), the average somatotype of the wrestlers is 6 – 3 – 3, of the hapkidoin 5 – 2 – 4. Thus, the Hapkidoin represent a less obese body shape. In the somatochart after Heath & Carter (1967), the average type of the Hapkidoin is 7 – 2 – 2, of the wrestlers 6 – 1 – 2. These somatotypes are much stouter and less muscular than the somatotypes in the study of Gualdi-Russo et al. (1993), who found an average value of 3.6 – 3.7 – 2.8 of different martial arts disciplines (whu shu, kung fu, karate and judo).

From this observation we can infer a considerable development potential of the examined sportswomen in our study.

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