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Morphological and Functional Aspects of Hand in Relation to Age, Gender and Sports Playing Condition

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ABSTRACT

Aim: This cross-sectional study was performed to investigate the hand anthropometric measurements and grip strength of children in three age groups. **Methods:** 546 children participated in the study and grouped as little (9-11years), youth (12-14years), junior (15-18years). A digital compass with a resolution of 0.01 mm was used for hand anthropometric measurements and a digital hand dynamometer was used for grip strength measurement. Hand dimensions and hand grip strength of both hands were measured. Eight parameters were evaluated for each hand. **Results:** Hand width values measured from little females and little males and youth males were not statistically significant in sporting and non-sporting groups. There was a statistically significant difference for both hand length of little males and junior males between sporting and non-sporting groups. When shape index values of right and left hands were compared for both groups there was a statistically significant difference for little males and females whereas there was a statistically significant difference in youth females and junior females values compared for sports playing condition. When palmar length/width ratio values were evaluated there was a statistically significant difference between sporting and non-sporting groups in little males for both hands and in junior males for right hand. When grip strength values were evaluated there was a statistically significant difference between sporting and non-sporting groups in little males for both hands and in junior males for right hand. **Conclusion:** These findings stress the morphological and functional differences of hand according to age, gender and sports playing condition.

Keywords: Anthropometry, Grip strength, Hand, Sports

INTRODUCTION

Hand is essential for various activities in daily life[1] and it is devoted to functions of manipulation and tactile sensation.[2-4] Hand development goes on as the child grows up. Appropriate morphogenetic signals and environmental factors during developmental stages, lead proper formation of hand.[5,6] Many environmental factors could influence the physical characteristics and the function of the hand.[7] The functions of hands develop during the growing up of children, so the normal morphology and function for different age groups should be determined.

In this study we aimed to evaluate the effect of sports activities on physical characteristics and function of the hand in different age groups. Anthropometric measurements of the hands were performed in order to evaluate the physical characteristics. The grip strength was chosen as an indicator of the functional aspect of the hand.

METHODS

This cross-sectional study consisted 546 children (333 males, 213 females) grouped according to age as follows:

- Little: 9-11 years
- Youth: 12-14 years
- Junior: 15-18 years

Each group was evaluated according to activity degrees of the individuals. The sporting group was composed of school teams members whom had won degrees in provincial tournaments. The non-sporting group composed of age and sex matched individuals.

Exclusion criteria were set upon our knowledge of some genetic, psycological, neurological or choronic diseases affecting hand function and anthropometric characteristics.[8,9] So diseased or disabled persons were excluded from the study according to the mentioned criteria.

Informed consents of all participants were obtained. The Ethics Committee of Bulent Ecevit University (formerly

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Karaelmas University) also endorsed its approval for the study.

Anthropometric Measurements

A digital compass (Shan 150 mm) with a resolution of 0.001 mm was used for hand anthropometric measurements. Measurements were taken from the palmar side with digits fully stretched touching on a flat, hard surface and adducting the 2nd to 5th digit along with extending the thumb slightly.

For each hand, 7 dimensions were measured and some ratios calculated using the measurements. Hand width, hand length, 3rd digit length and height were measured according to the method stated by Pheasent.[10] The hand length/body height ratio, the shape index which determines hand shape, the digit index which determines grasping capability and palmar length/width ratio which determines palmar type without the digits were also assessed.

- Palmar length: The palmar length defined as the distance between the midpoint of the distal wrist crease and the midpoint of the proximal digit crease, was calculated according to the formula hand length minus 3rd digit length.[9,12]
- Shape index (length-width index, hand index): Hand width x 100/Hand length.[11,12]
- Digit index (phalangeal index): 3rd digit length x 100/hand length.[11,12]
- Palmar length/width ratio: Palmar length/Palmar width (Palmar width = Hand width).[9,12]
- Hand length/height ratio: Hand length/Body heigth.[12]

Body weight was measured using a standard scale with light clothing on and without any footwear. Height was measured with the individual in upright position in front of a wall looking ahead and heels touching one another.

Grip Strength

A digital hand dynamometer (Takei) was used to measure the grip strength. The volunteer sat on a chair with the elbow flexed at 90^0 and the forearm in semi-pronation lying on an arm rest. The volunteers were asked to squeeze the dynamometer three times with each hand. There was a one minute resting period between each squeeze in order to overcome fatigue. The mean value of three squeezes was taken into account.[13]

Measurement Reliability

All measurements were performed by a single investigator (PD) to prevent any inter-observer errors. To achieve intra-observer precision, three widely used precision estimates were calculated: The technical error of measurement (TEM), the relative technical error of measurement (rTEM), and the coefficient of reliability (R).[14-16] The TEM was calculated as the square root of the squared difference between two corresponding measurements divided by twice the sample size.[14,15,17] The TEM is interpreted as the typical magnitude of error associated with a certain measurement and can be used to estimate intraobserver precision.[17] rTEM is calculated by dividing the TEM for a given variable by the mean for that variable and multiplying the result by 100.[14,15,17] rTEM represents an estimate of error magnitude as a percentage of object size.[17] R can be calculated using TEM and ranges from 0 (not reliable) to 1 (complete reliability). R can be calculated using the following equation: $R= 1 – [(TEM)^2/(SD)^2]$,[14-16] where SD is the standard deviation of all measurements.[14,15] R represents the proportion of between-subject variance free from measurement error.[16] All computations regarding intra-observer precision were performed using Excel 2007.

Data Analysis

Statistical analyses were performed with SPSS for windows Release 11.01. Statistical comparisons of means were performed with Paired Samples t Test for parametric conditions and Mann-Whitney U test for nonparametric conditions. A p value < 0.05 was taken to indicate statistical significance.

RESULTS

TEM, rTEM and R for all variables measured are presented in Table 1. TEM values of all hand variables measured were 0.25–2.55 mm. The TEM for height was 0.25 cm. The rTEM values were 0.17–3.64%. The R values of all variables were close to 1, suggesting that most of the variation in the variables within the sample was due to factors other than measurement error. These results suggest that an acceptable degree of intra-observer precision was obtained for the anthropometric measurements.

There were statistically significant differences in right and left hand width and shape index values between sporting and non-sporting groups. Also there were significant differences in right and left palmar length/width and right hand length/height ratios between the mentioned groups (Table 2).

Table 1: Precision estimates of hand anthropometric measurements (n=35)

Parameters	TEM (mm)	rTEM (%)	R
Heigth (cm)	0.25	0.17	0.99
Right hand width (mm)	1.1	1.53	0.93
Left hand width (mm)	0.95	1.34	0.96
Right hand length (mm)	1.22	0.74	0.98
Left hand length (mm)	1.21	0.74	0.99
Right 3rd digit length (mm)	0.78	1.11	0.97
Left 3rd digit length (mm)	2.55	3.64	0.81

TEM: Technical error of measurement, rTEM: Relative technical error of measurement, R: Coefficient of reliability

There were statistically significant differences between sporting and non-sporting groups for right and left hand width, shape index values, right and left palmar length/width values and right hand length/height ratios in males. Also significant differences were determined in females for right and left hand width, shape index values, and right and left palmar length/width ratios according to sports playing condition (Table 3).

Table 2: Comparison of parameters according to sports condition in study group

Parameters	Sporting group n=374	Non-sporting group n=172	p*
Heigth (cm)	157.99±14.36	157.01±11.36	0.391
Right hand width (mm)	78.11±7.47	75.06±6.29	0.000
Left hand width (mm)	77.05±7.34	74.57±6.35	0.000
Right hand length (mm)	172.94±16.51	170.40±13.13	0.054
Left hand length (mm)	173.68±16.85	171.81±13.35	0.164
Right 3rd digit length (mm)	74.43±7.90	73.26±6.38	0.064
Left 3rd digit length (mm)	74.70±7.85	73.85±6.16	0.170
Right shape index	45.20±2.05	44.11±2.26	0.000
Left shape index	44.46±2.10	43.42±1.96	0.000
Right digit index	43.03±1.30	42.97±1.20	0.618
Left digit index	43.09±1.63	42.99±1.14	0.417
Right palmar length/width ratio	1.26±0.06	1.29±0.07	0.000
Left palmar length/width ratio	1.28±0.07	1.31±0.07	0.000
Right hand length/height ratio	0.109±0.004	0.108±0.004	0.009
Left hand length/height ratio	0.109±0.005	0.109±0.004	0.216
Right grip strength (kg)	21.82±9.01	21.31±7.54	0.519
Left grip strength (kg)	21.36±8.73	21.35±7.81	0.989

*Paired samples t test

When the parameters obtained from little age group (9-11 years) were evaluated according to sporting condition there were statistically significant differences in right and left hand length, left 3rd finger length, right and left shape indices, right and left palmar length/width ratios, right grip strength values (Table 4).

There were statistically significant differences between sporting and non-sporting groups in little males when right and left hand length, left 3rd digit length, right and left shape index, right and left palmar length/width ratio, right and left grip strength values were considered. There were statistically significant differences between sporting and non-sporting groups in little females for right and left shape index and right palmar length/width ratio values (Table 5).

When the parameters obtained from youth group (12-14 years) were evaluated according to sports playing condition there were statistically significant differences in right and left hand width, right hand length, right 3rd finger length, right and left shape indices, right and left palmar length/width ratios (Table 6).

There were statistically significant differences between sporting and non-sporting groups in males of youth group for right and left palmar length/width ratios. There were statistically significant differences between sporting and non-sporting groups in females of youth group when right and left hand width, right and left shape indices, right and left palmar length/width ratios were considered (Table 7).

Table 3: Comparison of parameters in both sexes according to sports playing

Parameters	Males			Females		
	Sporting group n=236	Non-sporting group n=97	p*	Sporting group n=138	Non-sporting group n=75	p*
Heigth (cm)	158.91±16.27	158.86±12.93	0.973	156.40±10.10	154.61±8.43	0.171
Right hand width (mm)	79.29±8.41	76.87±6.77	0.006	76.10±4.90	72.72±4.70	0.000
Left hand width (mm)	78.42±8.17	76.53±7.03	0.035	74.71±4.86	72.03±4.19	0.000
Right hand length (mm)	174.60±18.66	172.57±14.91	0.298	170.11±11.47	167.59±9.78	0.108
Left hand length (mm)	175.40±19.02	173.84±15.43	0.434	170.74±11.77	169.20±9.51	0.299
Right 3rd digit length (mm)	74.84±8.93	74.01±7.35	0.378	73.74±5.66	72.28±4.71	0.047
Left 3rd digit length (mm)	75.21±8.82	74.51±7.18	0.453	73.84±5.73	72.99±4.41	0.234
Right shape index	45.43±2.05	44.64±2.32	0.002	44.80±2.01	43.43±2.00	0.000
Left shape index	44.82±2.07	44.05±1.98	0.002	43.85±2.00	42.59±1.60	0.000
Right digit index	42.84±1.32	42.84±1.14	0.980	43.35±1.19	43.13±1.25	0.214
Left digit index	42.88±1.42	42.84±1.18	0.807	43.44±1.89	43.17±1.06	0.265
Right palmar length/width ratio	1.26±0.06	1.28±0.07	0.002	1.26±0.06	1.31±0.07	0.000
Left palmar length/width ratio	1.27±0.07	1.30±0.07	0.011	1.29±0.07	1.33±0.06	0.000
Right hand length/height ratio	0.109±0.004	0.108±0.004	0.005	0.108±0.005	0.108±0.004	0.512
Left hand length/height ratio	0.110±0.005	0.109±0.004	0.079	0.109±0.005	0.109±0.004	0.630
Right grip strength (kg)	23.42±10.53	23.20±8.33	0.836	10.07±4.31	18.86±5.53	0.779
Left grip strength (kg)	22.77±10.24	23.18±8.68	0.714	18.94±4.29	18.98±5.76	0.957

* Paired samples t test

When the parameters obtained from junior group (15-18 years) were evauated according to sports playing condition there were statistically significant differences in right and left hand width, right and left hand length, right and left 3rd finger length, right and left shape indices, right and left palmar length/width ratios (Table 8).

There were statistically significant differences between sporting and non-sporting groups in junior males for right and left hand width, right and left hand length, right and left 3rd finger length and right grip strength values. There were statistically significant differences between sporting and non-sporting groups in junior females when right and left hand width, right and left shape indices, right and left palmar length/width ratios (Table 9).

Table 4: Comparison of parameters according to sports playing condition in little age group

Parameters	Sporting group n=111	Non-sporting group n=50	p*
Heigth (cm)	141.45±7.14	144.74±7.37	0.008
Right hand width (mm)	70.43±3.91	69.37±4.06	0.117
Left hand width (mm)	69.68±4.00	69.00±3.76	0.311
Right hand length (mm)	155.22±8.33	158.15±8.58	0.042
Left hand length (mm)	155.61±8.58	159.40±8.87	0.011
Right 3rd digit length (mm)	66.05±4.82	67.41±4.45	0.092
Left 3rd digit length (mm)	66.38±4.63	68.18±4.17	0.020
Right shape index	45.38±2.06	43.90±2.18	0.000
Left shape index	44.90±2.03	43.33±1.96	0.000
Right digit index	42.58±1.22	42.61±1.14	0.890
Left digit index	42.84±1.98	42.77±1.09	0.817
Right palmar length/width ratio	1.26±0.057	1.31±0.062	0.000
Left palmar length/width ratio	1.28±0.062	1.32±0.063	0.000
Right hand length/height ratio	0.109±0.0045	0.109±0.0037	0.404
Left hand length/height ratio	0.110±0.0047	0.110±0.0036	0.883
Right grip strength (kg)	13.65±3.33	15.09±3.42	0.013
Left grip strength (kg)	13.46±3.58	14.5±2.97	0.073

*Paired samples t test

DISCUSSION

Hands are developmentally complex structures which are the result of a long evolutionary process.[18] Information about the normal development of hand is necessary in order to evaluate various pathological conditions. The measurements of prenatal hand dimensions are based on the measurements of hand length and 3rd digit length and width.[19] These parameters and their relative proportional relationships are important during the intrauterine period, and thereafter.[12] Physical activity has an important role in proper growth and maturation of the child.[20]

It has been stated that physical activity had little effect on hand length.[21] In our study right hand length and left hand length values were higher in the sporting group than non-sporting group, the differences not being statistically significant (Table 2). These findings were seems to be concordant with the literature. When the hand width, shape index and palmar length/width ratio values were considered for both hands, these values were higher in the sporting group, the differences being statistically significant (Table 2). Right and left hand width, right and left shape index, right and left palmar length/width ratio values were

Table 5: Comparison of parameters according to sports playing condition in males and females in little age group

Parameters	Males			Females		
	Sporting group n=77	Non-sporting group n=30	p*	Sporting group n=34	Non-sporting group n=20	p**
Heigth (cm)	140.39±6.57	145.40±8.20	0.003	143.85±7.87	143.75±5.99	1.000
Right hand width (mm)	70.31±3.83	69.93±3.96	0.598	70.70±4.13	68.52±4.16	0.094
Left hand width (mm)	69.85±3.91	69.43±3.56	0.655	69.29±4.23	68.35±4.06	0.267
Right hand length (mm)	153.96±7.45	157.60±9.01	0.031	158.08±9.55	158.99±8.04	0.361
Left hand length (mm)	154.41±7.73	159.01±9.62	0.016	158.33±9.85	159.97±7.83	0.252
Right 3rd digit length (mm)	65.02±4.27	66.64±4.71	0.122	68.39±5.23	68.58±3.84	0.390
Left 3rd digit length (mm)	65.53±4.03	67.51±4.60	0.039	68.31±5.34	69.19±3.27	0.244
Right shape index	45.65±2.07	44.43±2.30	0.018	44.77±1.93	43.10±1.74	0.004
Left shape index	45.29±2.01	43.72±2.03	0.001	44.00±1.82	42.73±1.73	0.018
Right digit index	42.29±1.15	42.26±1.11	0.795	43.23±1.12	43.13±1.00	0.816
Left digit index	42.50±1.27	42.45±1.09	0.884	43.62±2.90	43.26±0.90	0.914
Right palmar length/width ratio	1.26±0.06	1.30±0.07	0.016	1.27±0.06	1.32±0.05	0.003
Left palmar length/width ratio	1.27±0.06	1.31±0.07	0.011	1.29±0.06	1.32±0.06	0.086
Right hand length/height ratio	0.109±0.004	0.108±0.004	0.134	0.110±0.005	0.110±0.003	0.733
Left hand length/height ratio	0.110±0.005	0.109±0.004	0.418	0.110±0.005	0.111±0.003	0.418
Right grip strength (kg)	13.43±3.48	15.89±3.24	0.001	14.14±2.96	13.88±3.41	0.622
Left grip strength (kg)	13.09±3.69	15.03±3.15	0.004	14.29±3.24	13.72±2.56	0.542

*Paired samples t test, **Mann-Whitney U test

higher in both sexes of sporting group than non-sporting group (Table 3). When sporting and nonsporting males along with sporting and nonsporting females compared separately, right and left hand width, right and left shape index, right and left palmar length/width ratio values were statistically higher in the sporting group. All of these findings revealed that hand dimensions in sporting group were wider and coarser than the non-sporting group. In the study of Lozovina et al, it has been suggested that longer hand seem to be an advantage for better manipulation and control of the ball, but a wider hand can be more efficient in gripping.[22] According to our results it can be suggested that a wider and coarser hand may be beneficial for sports playing.

Table 6: Comparison of parameters according to sports playing condition in youth group

Parameters	Sporting group n=114	Non-sporting group n=62	p*
Heigth (cm)	159.22±8.79	158.36±7.56	0.516
Right hand width (mm)	79.62±5.95	76.58±5.57	0.001
Left hand width (mm)	78.29±5.71	75.70±5.15	0.003
Right hand length (mm)	175.40±11.82	171.97±9.34	0.036
Left hand length (mm)	175.99±11.53	172.89±9.60	0.072
Right 3rd digit length (mm)	75.58±5.48	73.97±4.42	0.036
Left 3rd digit length (mm)	75.89±5.57	74.52±4.53	0.099
Right shape index	45.40±1.86	44.54±2.26	0.008
Left shape index	44.48±1.82	43.78±1.72	0.015
Right digit index	43.11±1.42	43.01±1.19	0.644
Left digit index	43.20±1.56	43.10±1.11	0.660
Right palmar length/width ratio	1.25±0.007	1.28±0.08	0.015
Left palmar length/width ratio	1.28±0.07	1.30±0.06	0.036
Right hand length/height ratio	0.110±0.005	0.108±0.004	0.020
Left hand length/height ratio	0.110±0.005	0.109±0.004	0.093
Right grip strength (kg)	21.04±5.89	20.84±6.05	0.832
Left grip strength (kg)	20.88±5.71	20.98±6.20	0.914

*Paired samples t test

Parameters for right and left hand length along with left 3rd finger length values were significantly higher in non-sporting little age group (9-11 y). Right and left shape indices were significantly higher in the sporting group, whereas right and left palmar length/width ratios were significantly higher in nonsporting group (Table 4). Right and left hand length values in nonsporting males were significantly higher, whereas no significant differences existed in those values from females (Table 5). Some values were found to be significantly higher in nonsporting individuals of little age group. As a probable cause for these findings, it could be suggested that the skeletal structure of the individuals belonging to the little age group have not had yet enough time to be affected by sports activities. Ozgun et al. found in their study that as the age grows up hand length of both sexes increases.[23] No data were available in literature concerning the changes in hand dimensions as a function of age. Although Subira and Malgosa. reported higher hand width and hand length values in males,[21] in our study it was interesting that the values obtained from females were higher than that of the males in that age group, but no statistical analysis were performed to compare the sex difference. This comparison was saved as the subject of another study.

The hand width, shape index, palmar length/width ratio values of the youth age group (12-14 y) for both hands

Table 7: Comparison of parameters according to sports playing condition in males and females in youth age group

Parameters	Males			Females		
	Sporting group n=81	Non-sporting group n=36	p*	Sporting group n=33	Non-sporting group n=26	p**
Heigth (cm)	160.07±8.95	159.42±8.98	0.892	157.11±8.13	156.89±4.78	0.713
Right hand width (mm)	80.40±6.38	78.05±5.90	0.085	77.72±4.25	74.54±4.42	0.005
Left hand width (mm)	79.07±6.10	77.16±5.91	0.169	76.38±4.08	73.69±2.91	0.010
Right hand length (mm)	176.60±12.62	172.83±10.18	0.152	172.45±9.07	170.77±8.08	0.691
Left hand length (mm)	176.98±12.36	173.52±11.06	0.213	173.58±8.91	172.02±7.25	0.614
Right 3rd digit length (mm)	75.93±5.83	74.51±5.05	0.195	74.73±4.47	73.22±3.31	0.189
Left 3rd digit length (mm)	76.25±5.96	75.08±5.32	0.275	75.02±4.40	73.76±3.04	0.213
Right shape index	45.52±1.89	45.14±1.96	0.317	45.09±1.77	43.72±2.42	0.007
Left shape index	44.66±1.84	44.45±1.74	0.681	44.02±1.72	42.85±1.20	0.005
Right digit index	42.99±1.50	43.09±1.00	0.311	43.42±1.18	42.90±1.42	0.095
Left digit index	43.11±1.66	43.26±1.08	0.310	43.43±1.27	42.89±1.13	0.069
Right palmar length/width ratio	1.25±0.007	1.26±0.06	0.889	1.25±0.05	1.31±0.09	0.003
Left palmar length/width ratio	1.27±0.008	1.28±0.05	0.795	1.29±0.05	1.33±0.05	0.001
Right hand length/height ratio	0.110±0.004	0.108±0.003	0.016	0.109±0.006	0.108±0.005	0.812
Left hand length/height ratio	0.110±0.005	0.108±0.004	0.041	0.110±0.005	0.109±0.004	0.878
Right grip strength (kg)	21.73±6.51	22.20±6.73	0.681	19.35±3.56	18.95±4.40	0.686
Left grip strength (kg)	21.27±6.33	22.44±6.66	0.460	19.91±3.67	18.96±4.93	0.121

*Paired samples t test, **Mann-Whitney U test

besides the right hand length, right 3rd finger length, right hand length/height ratios were significantly higher in sporting group (Table 6). When both sexes were considered there were significant differences between some measurements of female sporting individuals (Table 7). Although the values obtained from the males were found to be higher in sporting group, there were no statistically significant differences (Table 7). It could be suggested that sports playing might only affect females significantly in that age group.

Table 8: Comparison of parameters according to sports playing condition in junior group

Parameters	Sporting group n=149	Non-sporting group n=60	p*
Heigth (cm)	169.36±9.21	165.83±7.83	0.010
Right hand width (mm)	82.68±5.94	78.23±5.36	0.000
Left hand width (mm)	81.60±6.03	78.04±6.16	0.000
Right hand length (mm)	184.27±12.61	178.98±11.99	0.006
Left hand length (mm)	185.38±13.13	181.05±11.71	0.027
Right 3rd digit length (mm)	79.80±5.85	77.39±5.87	0.008
Left 3rd digit length (mm)	79.98±5.87	77.87±5.50	0.017
Right shape index	44.91±2.16	43.84±2.31	0.002
Left shape index	44.12±2.29	43.11±2.15	0.004
Right digit index	43.29±1.16	43.22±1.20	0.688
Left digit index	43.18±1.37	43.05±1.21	0.514
Right palmar length/width ratio	1.26±0.07	1.30±0.07	0.001
Left palmar length/width ratio	1.29±0.07	1.32±0.07	0.008
Right hand length/height ratio	0.108±0.004	0.107±0.004	0.120
Left hand length/height ratio	0.109±0.004	0.109±0.004	0.622
Right grip strength (kg)	28.49±8.62	26.97±7.19	0.193
Left grip strength (kg)	27.61±8.45	27.43±7.24	0.885

*Paired samples t test

The hand width, hand length, 3rd digit length, shape index, palmar length/width ratio in sporting junior age group (15-18 y) were significantly higher than measurements taken from nonsporting junior age group (Table 8). In sporting junior males hand length, hand width, 3rd finger length values for both hands were significantly higher than those of nonsporting junior males (Table 9). In sporting junior females shape index, palmar length/width ratio values for both hands were significantly higher than those of nonsporting junior females (Table 9). All of the measurements and ratios of the junior males in table 8 were higher than those of the junior females which seem to be concordant with the findings of Subira and Malgosa, but no statistical analysis were performed to compare our findings.[21] From these findings we may suggest that the effects of sporting to hand measurements and ratios in males become more evident with age. Subira and Malgosa stated that the mostly used hand measured shorter and noticeably wider.[21] In our study, sporting junior males' hands were found to be longer and wider than non-sporting junior males'. Sporting junior females' hands tended to be wider than that of the non-sporting junior females'.

Nevil and Holder have stated that there were significant differences in hand grip strength associated with physical activity.[24] In certain studies it have been stated that there was a progressive increase of grip strength with advancing age, and also difference became obvious between boys and girls at age of 10-12.[1,13,25] In a previous study by Barut et al hand anthropometric measurements and hand grip strength of children playing basketball, volleyball and handball were evaluated, but they did not take into account age and

Table 9: Comparison of parameters according to sports playing condition in males and females in junior age group

Parameters	Males			Females		
	Sporting group n=78	Non-sporting group n=31	p*	Sporting group n=71	Non-sporting group n=29	p**
Heigth (cm)	175.99±6.44	171.23±6.05	0.001	162.08±5.56	160.07±4.83	0.119
Right hand width (mm)	87.00±4.13	82.21±3.39	0.000	77.93±3.46	73.98±3.46	0.000
Left hand width (mm)	86.21±3.80	82.68±3.92	0.000	76.52±3.34	73.08±3.77	0.000
Right hand length (mm)	192.90±8.55	186.77±8.92	0.002	174.78±9.03	170.66±8.87	0.052
Left hand length (mm)	194.49±8.61	188.56±9.30	0.003	175.37±9.42	173.03±8.19	0.276
Right 3rd digit length (mm)	83.41±4.26	80.55±4.78	0.006	75.83±4.68	74.00±5.03	0.086
Left 3rd digit length (mm)	83.67±4.16	80.62±4.87	0.002	75.93±4.69	74.93±4.58	0.376
Right shape index	45.13±2.16	44.27±2.67	0.134	44.68±2.15	43.39±1.78	0.010
Left shape index	44.52±2.31	43.90±2.16	0.322	43.69±2.21	42.26±1.82	0.005
Right digit index	43.23±1.10	43.12±1.16	0.793	43.37±1.23	43.34±1.25	0.976
Left digit index	43.02±1.22	42.74±1.28	0.541	43.36±1.50	43.37±1.08	0.621
Right palmar length/width ratio	1.25±0.06	1.29±0.09	0.047	1.27±0.07	1.30±0.05	0.010
Left palmar length/width ratio	1.28±0.07	1.30±0.08	0.194	1.30±0.008	1.34±0.06	0.025
Right hand length/height ratio	0.109±0.004	0.109±0.004	0.456	0.107±0.004	0.106±0.004	0.259
Left hand length/height ratio	0.110±0.004	0.110±0.004	0.681	0.108±0.004	0.108±0.004	0.957
Right grip strength (kg)	35.04±6.55	31.41±5.90	0.007	21.30±3.09	22.22±5.13	0.321
Left grip strength (kg)	33.89±6.62	31.92±5.82	0.261	20.72±3.29	22.64±5.29	0.166

*Paired samples t test, **Mann-Whitney U test

gender.[2] In our study there was an increase in grip strength values both in males and females with the advance of age; also males were stronger than females. Interestingly, in the little age group, the grip strength was found to be significantly higher in sporting males than non-sporting males (Table 5). This age group was the smallest one in our study and as a probable cause for this finding, it could be suggested that the grip strength of the individuals in little age group have not had yet enough time to be affected by sports activities. In the other groups, sporting individuals had had higher grip strength values, the difference in between without being significant. Also these differences between groups became more evident with the advance of the age.

CONCLUSION

The results of the present study broaden our knowledge about morphological and functional aspects of hand in relation to age, gender and sports playing condition in a Turkish population sample. However prospective studies investigating the factors affecting hand morphology in terms of anthropometry during growth and development period are necessary for more detailed evaluation.

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