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Evaluating The Relation Between Dominant and Non-Dominant Hand Perimeters and Handgrip Strength of Basketball, Volleyball, Badminton and Handball Athletes

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ABSTRACT

In this study, it's aimed to evaluate the relation between dominant and non-dominant hand perimeters and handgrip strength of basketball, volleyball, badminton and handball athletes. Totally 101 active athletes (49 females, 52 male), of the average age in female 20±1.42 years, in male 21±1.99 years, joined to this study. Height, body weight, BMI (Body Mass Index) and handgrip strength of all the athletes were measured according to international standards. Hand perimeters were measured at a certain standard with digital camera and was calculated with the software developed. The data was analyzed by SPSS 22 programme and Student t test, Pearson Correlation test and One Way Anova was applied. A significance level of $p < 0.05$ was adopted in the analysis. Results of the analysis showed that dominant and non-dominant handgrips of athletes in all disciplines and gender are significantly different and hand and finger perimeters developing different depending on the way they use the ball or racket grip.

KEYWORDS
Badminton, basketball, handball, hand span, handgrip strength, volleyball

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Introduction

The complicated anatomy of the hand consists of 27 bones (8 carpal, 5 metacarpal, 14 phalges), 27 joints, 34 muscles, more than a hundred ligaments and tendons, innumerable blood vessels, nerves and soft tissues. One hand is more preferred than the other in skills carried out with one hand. In the developmental process of the individual; the genetic structure, external factors encountered, occupation, purpose-oriented trainings in different sports branches which are done with hand play a significant role in the configuration and differentiation of the hand. The skill of handgrip is one of the basic functions of the upper extremity.

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The appearance of the normal grasping patterns depends on the anatomic coherence of the hand and its capability of achieving the normal functions of the supportive neural structures (Gürcan, 2008).

Hand size relates to grip strength: the longer the bones, the longer the muscles and hence the greater the number of contractile units that can be incorporated. Lengthening muscle by adding sarcomeres in series is associated with only increasing the speed of a muscle contraction and not its force (Lieber, 2002). Dimensional characteristics of the hand in many sports branches, especially in branches such as basketball and handball that include grasping something and moves of throw, anthropometric dimensions of the hand and correspondingly the handgrip strength affect success (Visnapuu, 2007). It has been shown that the maximum handgrip strength can differ to a great extent even if it is compared within people with the same age range and same sex. Different bodily measurement values such as genetic characteristics, body weight and height and different bodily uses peculiar to a certain society can play a significant role. In addition, it is required to have data related to the differences of hand measurement in order for making the dimension of hand-held tools (such as ball, racket, glove) more ergonomic and being more productive biomechanically (Lin, 2015; Yu, 2013; Mirmohammadi, 2015).

There are many studies in literature showing that the maximum handgrip strength can be affected by numerous anthropometric measurement values such as gender, age, height, body weight, body mass index (BMI), dominant hand, hand length and width and that those can be used to estimate the handgrip strength of an individual (Plogmaker, 2013). Hand measurements are crucial in revealing their differences among branches as well as estimating the rates of tall stature and other extremities (Paulis, 2015; Jee, 2015; Ahmed, 2013; Uhrová, 2015; Ishak, 2012). Today, it has been tried to improve more useful, cheaper and different methods with lower error rate which can be alternative to standard anthropometric measurements and they have been proved to be able to be used statistically instead of manual measurements (Maunier, 2000; Jiang, 2012; Rogers, 2008). Measurements carried out by taking photos are less time-consuming and enable participants to be more enthusiastic as there is no measurement tool contacting the body. In addition, the archivability of the data helps them to be reinterpreted in the future (Habibi, 2013).

By looking at this information, it is aimed in this study to reveal the relationship between palm reaches of dominant and non-dominant hands and handgrip strengths of elite athletes in basketball, volleyball, handball and badminton, and to make an inter-branch comparison. The findings of the study will help creating ideas on determining criteria during the process of choosing skills, specifying the influences of goal-oriented trainings and producing tools in proportion to the hand sizes of the users in sports branches such as basketball, volleyball, handball and badminton in which handgrip strength is crucial.

Materials and Methods

Totally, 101 active athletes from the branches of 21 basketball players (9 female, 12 male), 34 volleyball players (14 female, 20 male), 19 badminton players (9 female, 10 male) and 27 handball players (17 female, 10 male) participated in this study. To determine anthropometric measurements of subjects, in accordance with international standards, the height with anthropometer, body weight with

100 gr sensitive electronic weigher (Lohman, 1998; Weiner, 1988). Body mass index (BMI) was calculated as the body mass per (height)^2 in kg/m^2 as the general anthropometric variables. Then three groups of hand anthropometric variables were measured: 5 finger spans and 5 perimeters of the hand.

Handgrip strength measurements; right-hand grip strength and left-hand grip strength values were measured using hand grip dynamometer according to international standards with the dynamometer. The right and left hand were measured separately twice and best value kg. was detected.

The following parameters for span of the fingers were measured (Figure 1): from the tip of the thumb (T) to the tip of the index (I) finger (finger span 1-FSl; from the tip of T to tip of the middle (M) finger (finger span 2-FS2); from the tip of T to the tip of the ring (R) finger (finger span 3-FS3); from the tip of T to the tip of the little (L) finger (finger span 4-FS4); and from the tip of T to the tip of each finger (finger span 5-FS5). WTIW = from the W joint to the tip of T to the tip of I finger and to the W joint; WTMW = from the W joint to the tip of T to the tip of M finger and to the W joint; WIMW = from the W joint to the tip of I finger to the tip of M finger and to the W joint; WMRLW = from the W joint to the tip of M finger to the tip of R finger to the tip of L finger and the W joint; WTIMRLW = from the W joint to the tips of all fingers and to the W joint.

Figure 1. Measured finger perimeters of the dominant and non-dominant hands

Both hands of subjects opened maximum were photographed and the calculations were made through the software by marking reference points. In application, the upper left corner of the photo to be scaled is supposed the starting point (0,0) on two-dimensional space (xy coordinate). After finding the ratio of the distance in pixels from the distance in centimeters between any two points, with the help of this ratio, real distance of any two point or area of polygons are calculated on the same photo. Application was developed by using Microsoft.net Framework 4.5, Windows Presentation Foundation technologies and programming language C #. Then, after opening the image in the software, using the ruler next to hand, the number of pixels/unit of length was defined and then by drawing a line between the desired points, we obtained the distance between them. The table with the sizes was compatible to Microsoft Office Excel.

In this way, the error while entering the numbers into analyses software like Excel or SPSS was resolved and a lot of time saved.

The basic principle of the application can be explained as follows; measuring the distance in the plane, we use Euclidean Distance Formula for. According to the Euclidean distance formula, the distance between two points in the plane with coordinates (x,y) and (a,b) is given by $dist\ ((x, y), (a, b)) = \sqrt{(x - a)^2 + (y - b)^2}$

The data was analyzed by SPSS 22 programme and Student t test, Pearson Correlation test and One Way Anova was applied. A significance level of $p < 0.05$ was adopted in the analysis.

Results

101 (49 females, 52 male) athletes' general anthropometric parameters and handgrip strengths have been measured among which the average age in female is 20±1.42 years and in men 21±1.99 years in basketball, volleyball, badminton and handball. Descriptive statistics in terms of age, body height, body weight, Body Mass Index, dominant and non-dominant handgrip strength of the athletes who have been measured are shown in Table 1.

As a result of the Paired Sample t Test which have been carried out to determine whether there is a significant difference between dominant and non-dominant handgrip strength of the athletes in branch and gender subtitles, it has been observed that in all the branches the dominant hand is significantly different than the non-dominant hand both in male and female athletes. The results of the Paired Sample t Test are shown in Table 2.

The data obtained as a result of female's dominant and non-dominant hand size comparison in all the branches are shown in Table 3. According to the Paired Samples t Test, dominant hand P1, P2, P3, P4, P5 and FS5 values of female basketball players show a significant difference in proportion to their non-dominant hand ($p<0.05$). When FS1, FS2, FS3, FS4 dominant hand values in the same group have been compared with the non-dominant hand values, it has been observed that there is not a significant difference between them ($p<0.05$). Female volleyball players' dominant hand P1, P2, P3, P4, P5 and FS1, FS2, FS3, FS4, FS5 values show a significant difference in proportion to their non-dominant hand values ($p<0.05$). Female badminton players' dominant hand P1, P2, P3, P5 and FS1, FS2, FS3, FS5 values show a significant difference in proportion to their non-dominant hand values ($p<0.05$). When dominant hand P4 and FS4 values are compared with the non-dominant hand values in the same group, it has been observed that there is not a significant difference between them ($p<0.05$). Female handball players' dominant hand P1, P2, P3 and FS5 values show a significant difference in proportion to the non-dominant hand values ($p<0.05$). When dominant hand P4, P5 and FS1, FS2, FS3, FS4 values are compared with the non-dominant hand values in the same group, it has been observed that there is not a significant difference between them ($p<0.05$).

The data obtained as a result of the comparison of all the male athletes' dominant and non-dominant hand sizes in all branches are shown in Table 4. According to the Paired Samples t Test results, male basketball players' dominant hand P1, P2 and FS5 values show a significant difference in proportion to the non-dominant hand values ($p<0.05$). When dominant hand P3, P4, P5 and FS1, FS2, FS3, FS4 values are compared with the non-dominant hand values in the same group, it has been observed that there is not a significant difference between them

($p<0.05$). However, among male volleyball, badminton and handball players, dominant hand P1, P2, P3, P4, P5 and FS1, FS2, FS3, FS4, FS5 values show a significant difference in proportion to the non-dominant hand values ($p<0.05$).

Table 1. Mean general anthropometric parameters and handgrip strength of athletes ($\bar{x}$-SD)*

Descriptive Statistics		Age (year)	Height (cm)	Weight (kg)	BMI (kg.m-2)	Dominant handgrip strength (kg)	Non-dominant handgrip strength (kg)
Basketball	Male (N=12)	22±1.81	181.84±6.60	77.73±8.75	23.49±2.11	48.25±5.42	43.84±6.39
	Female (N=9)	20±1.15	165.51±4.60	56.76±6.95	20.65±1.66	32.00±4.04	28.81±3.18
Volleyball	Male (N=20)	21±1.59	178.24±8.17	76.43±8.35	24.08±2.31	45.67±7.08	42.33±7.64
	Female (N=14)	21±1.76	167.06±5.31	58.14±5.67	20.82±1.55	29.95±3.27	27.02±2.87
Badminton	Male (N=10)	21±2.50	174.08±6.28	72.39±8.74	24.09±2.11	50.71±10.23	43.32±8.45
	Female (N=9)	20±1.03	161.06±3.72	56.03±4.51	21.58±1.24	31.57±3.38	27.91±2.59
Handball	Male (N=10)	22±2.34	176.43±6.20	76.50±9.70	24.5±1.66	48.60±9.91	45.20±8.60
	Female (N=17)	20±1.41	165.61±5.11	60.38±5.77	22.03±2.10	33.51±3.68	30.65±3.72

*p<0.05

Table 2. Paired Samples t Test comparison of dominant-non-dominant handgrip strength of athletes

		Mean	Std. deviation	t	df	Sig. (2-tailed)
Basketball	Male	440.833	327.982	4.656	11	0.001
	Female	318.889	288.333	3.318	8	0.011
Volleyball	Male	342.500	200.686	5.912	11	0.000
	Female	257.778	345.607	2.238	8	0.056
Badminton	Male	574.167	533.947	3.725	11	0.003
	Female	395.556	260.150	4.561	8	0.002
Handball	Male	342.000	119.970	2.851	9	0.019
	Female	265.556	219.380	3.631	8	0.007

*p<0.05

Table 3. Paired Samples t Test comparison of dominant-non-dominant perimeters of female athletes

		Mean	SD	t	df	Sig. (2-tailed)
Basketball	DP1-NP1	576.222	578.201	2.990	8	0.017
	DP2-NP2	674.667	614.338	3.295	8	0.011
	DP3-NP3	381.000	180.659	6.327	8	0.000
	DP4-NP4	814.778	867.884	2.816	8	0.023
	DP5-NP5	1.525.556	1.021.708	4.479	8	0.002
	DFS1-NFS1	0.17111	108.174	0.475	8	0.648
	DFS2-NFS2	0.16000	111.243	0.431	8	0.678
	DFS3-NFS3	0.21333	113.645	0.563	8	0.589
	DFS4-NFS4	0.40000	121.992	0.984	8	0.354
	DFS5-NFS5	576.665	510.232	3.182	8	0.012
Volleyball	DP1-NP1	324.667	180.073	5.409	8	0.001
	DP2-NP2	349.000	135.779	7.711	8	0.000
	DP3-NP3	339.000	169.527	5.999	8	0.000
	DP4-NP4	288.556	0.82580	10.483	8	0.000
	DP5-NP5	472.333	366.127	3.870	8	0.005
	DFS1-NFS1	0.77667	0.80926	2.879	8	0.021
	DFS2-NFS2	104.556	0.95905	3.271	8	0.011
	DFS3-NFS3	103.778	109.164	2.852	8	0.021
	DFS4-NFS4	0.86556	0.96310	2.696	8	0.027
	DFS5-NFS5	345.000	146.772	7.512	8	0.000
Badminton	DP1-NP1	705.889	507.773	4.170	8	0.003
	DP2-NP2	543.778	458.354	3.559	8	0.007
	DP3-NP3	588.111	530.002	3.329	8	0.010
	DP4-NP4	225.889	884.876	0.766	8	0.466
	DP5-NP5	587.222	386.324	4.560	8	0.002
	DFS1-NFS1	175.889	129.580	4.072	8	0.004
	DFS2-NFS2	146.444	130.274	3.372	8	0.010
	DFS3-NFS3	135.222	118.453	3.425	8	0.009
	DFS4-NFS4	0.73667	103.648	2.132	8	0.066
	DFS5-NFS5	555.672	462.361	3.430	8	0.006
Handball	DP1-NP1	276.333	326.427	2.540	8	0.035
	DP2-NP2	437.667	454.059	2.892	8	0.020
	DP3-NP3	734.556	691.021	3.189	8	0.013
	DP4-NP4	811.000	1.340.217	1.815	8	0.107
	DP5-NP5	982.556	1.496.263	1.970	8	0.084
	DFS1-NFS1	0.20556	0.59138	1.043	8	0.328
	DFS2-NFS2	0.39000	0.83383	1.403	8	0.198
	DFS3-NFS3	0.18333	0.82455	0.667	8	0.524
	DFS4-NFS4	-0.17111	0.59202	-0.867	8	0.411
	DFS5-NFS5	402.561	421.041	1.989	8	0.018

*p<0.05

Table 4. Paired Samples t Test comparison of dominant-non-dominant perimeters of male athletes

		Mean	SD	t	df	Sig. (2-tailed)
Basketball	DP1-NP1	801.167	538.688	5.152	11	0.000
	DP2-NP2	668.750	382.328	6.059	11	0.000
	DP3-NP3	290.083	1.019.940	0.985	11	0.346
	DP4-NP4	325.250	1.357.918	0.830	11	0.424
	DP5-NP5	281.750	1.545.410	0.632	11	0.541
	DFS1-NFS1	-0.06667	159.367	-0.145	11	0.887
	DFS2-NFS2	0.05917	135.007	0.152	11	0.882
	DFS3-NFS3	0.08917	0.76108	0.406	11	0.693
	DFS4-NFS4	-0.10333	0.84617	-0.423	11	0.680
	DFS5-NFS5	589.648	322.200	5.041	11	0.001
Volleyball	DP1-NP1	512.500	567.061	4.042	19	0.001
	DP2-NP2	498.150	442.755	5.032	19	0.000
	DP3-NP3	581.300	587.038	4.428	19	0.000
	DP4-NP4	555.000	656.247	3.782	19	0.001
	DP5-NP5	769.650	656.879	5.240	19	0.000
	DFS1-NFS1	0.79400	0.82942	4.281	19	0.000
	DFS2-NFS2	0.54250	0.81007	2.995	19	0.007
	DFS3-NFS3	0.77650	0.83283	4.170	19	0.001
	DFS4-NFS4	0.95600	0.89113	4.798	19	0.000
	DFS5-NFS5	562.160	498.768	4.678	19	0.000
Badminton	DP1-NP1	800.600	660.626	3.832	9	0.004
	DP2-NP2	691.900	387.716	5.643	9	0.000
	DP3-NP3	563.300	580.600	3.068	9	0.013
	DP4-NP4	572.800	534.740	3.387	9	0.008
	DP5-NP5	1.108.300	525.272	6.672	9	0.000
	DFS1-NFS1	110.300	100.537	3.469	9	0.007
	DFS2-NFS2	0.93300	0.83569	3.530	9	0.006
	DFS3-NFS3	0.92400	0.87377	3.344	9	0.009
	DFS4-NFS4	114.800	0.43840	8.281	9	0.000
	DFS5-NFS5	722.500	562.640	4.751	9	0.002
Handball	DP1-NP1	913.100	603.051	4.788	9	0.001
	DP2-NP2	858.000	639.885	4.240	9	0.002
	DP3-NP3	897.500	822.180	3.452	9	0.007
	DP4-NP4	1.015.600	915.818	3.507	9	0.007
	DP5-NP5	1.714.800	1.151.506	4.709	9	0.001
	DFS1-NFS1	123.300	0.79035	4.933	9	0.001
	DFS2-NFS2	158.100	0.63990	7.813	9	0.000
	DFS3-NFS3	142.800	112.240	4.023	9	0.003
	DFS4-NFS4	0.83000	0.66269	3.961	9	0.003
	DFS5-NFS5	864.200	620.382	4.564	9	0.001

*$p<0.05$

Discussion

It's very important to develop new alternative measurements besides classical anthropometric measurements to shorten the time of researches in sports science. This study serves this aim as using low error rate digital measurement technics. Similarly, in their study aiming at the comparison of the measurements carried out with the use of calliper and 2D screening i.e. via photography, Habibi et al. (2013) have evaluated 204 workers' hand measurements. They have found that 19.68±2.08 cm hand length measured on photography was 19.56±2.23 cm when measured with calliper and there is no significant difference between the measurements, the measurements carried out on photography can be used instead of manual methods.

Big hand, long fingers have direct relationship with shots on target. Visnapuu et al. (2008) evaluated the relationship between the test results of young male basketball and handball players' anthropometric hand measurements and their shots, and they confirmed that height and P3 or P1 are dependent in basketball players. In their study which they analysed the influences of young male basketball and handball players' basic body and hand anthropometric characteristics upon different shot tests, Visnapuu et al. (2008) have determined that height in handball, and LFL in basketball players are the most important characteristics, basketball players' height and P3 and P1 are dependent and hand anthropometric parameters have affected the results of shot test more. In their study, Semproli et al. (2007) stated that FS2 are the most important hand span parameter, the importance of FS1 and FS3 in older age groups is increasing, the most important finger length is IFB, the variance of RFL values in older age groups increased to 45%. They also found that among the sizes used while explaining the variability of handgrip strength, the most important one among young people is P', P3 and P4 with their influence upon the variance is around 30-40% in older age groups. In their study in which they analysed the influence of male athletes and sedanters' hand measurements, hand shape and some anthropometric characteristics upon the handgrip strength, Fallahi et al. (2011) confirmed that there is a significant and a positive correlation between the handgrip strength and hand sizes. It has been measured that athletes' height was 1,82 cm, body weight was 85,25 kg, BMI was 24,42, dominant handgrip strength was 48,15 kg and non-dominant handgrip strength was 45,64 kg. It has been calculated that P1 was 48.28 cm^2, P2 was 53.79 cm^2, P3 was 45.84 cm^2, P4 was 47.57 cm^2, P5 was 61.76 cm^2 and they show a parallelism with the data of the study.

In their study in order to determine the hand indexes of female and male, Ibeachu et al. (2011) have found that right hand length of males was 19.09±0.07 cm, left hand length was 19.02±0.08 cm, right hand length of female was 17.62±0.07 cm and left hand was 17.69±0.3 cm. They have revealed that male's hand sizes are statistically and significantly bigger in proportion to female's hand sizes. Barut et al. (2008) have found a significant difference for right and left hand width, right hand length/height, left hand length/height values between handball and volleyball players. In addition, they have found a statistically significant difference in female athletes in terms of right-left hand width, right and left handgrip strength and right-left hand 3rd finger length. In the same study, it has been determined that hand anthropometric measurements among the branches are statistically different and the reason of that is the applications of different

sports branches. Visnapuu et al. (2007) have expressed that specific hand anthropometric measurements of handball and basketball players between 10 and 17 years are more influential upon the handgrip strength in proportion to the general anthropometric measurements. Besides, they have emphasized that finger lengths are significantly related to the maximal handgrip strength of hand spans, and that they have to be measured in branches such as basketball and handball. The results of these studies supports the hypothesis and results of recent study.

Ruiz et al. (2006) have determined that there is a relationship between optimal handgrip span and hand span of male and female between 13 and 18, and they developed a mathematical equation. Similarly, in their study touching upon the relationship between hand span and optimal handgrip span, Espana et al. (2008) stated that male's hand span was 17.8±1.5 cm and female's hand span was 17.2±1.4 cm, and that male had higher levels of handgrip strength and handgrip span in proportion to female. Clerke et al. (2005) analysed the influence of hand shape upon maximal handgrip strength of 116 male and 112 female participants, they found that male are stronger than female, their dominant hands are stronger than their non-dominant hands, there is no difference originating from the shape of the hand. Tajika et al. (2015) took 133 baseball players' handgrip strength and hand anthropometric measures, and found that dominant hand is stronger than the non-dominant hand and there is a significant relationship between dominant hand handgrip strength, length, body mass and BMI. Similarly, Miyakate et al. (2012) have observed that especially in male there is a positive correlation between handgrip strength, length and lean body mass. In their study analysing the influence of some anthropometric parameters in young female and male upon the handgrip strength and endurance, Smrithi et al. (2012) have confirmed that male's handgrip strength and endurance are significantly higher than female's. They have found that there is a negative correlation between handgrip strength and body weight in overweight male, and there is a significant and positive correlation between handgrip strength, endurance, body weight and BMI in thin male.

In their study which they aimed at determining the difference between dominant and non-dominant handgrip strength of male and female whose ages are between 18 and 25, Koley and Singh (2010) have found that right dominant and non-dominant handgrip strength averages of male are in turn 41.31±6.00 kg (n:103) and 38.14±6.20 kg; left dominant and non-dominant handgrip strength averages are 41.12±6.88 kg (n:48) and 37.76±7.34 kg. These values in female are; right dominant and non-dominant handgrip strength averages are 23.82±3.71 kg (n:129) and 21.03±3.49 kg; left dominant and non-dominant handgrip strength averages are 23.48±3.29 kg (n:23) and 21.46±3.37 kg. In both genders, there has been found a significant difference in favour of the dominant hand.

In the study, there is a significant difference between dominant and non-dominant handgrip strength of the athletes in branch and gender subtitles, it has been observed that in all the branches the dominant hand is significantly different than the non-dominant hand both in male and female athletes. Kaplan et al. (2014) determined that elite female fencers' handgrip strength average is 34,35 kg, non-dominant handgrip strength average is 29,11 kg and there is a significant difference between the hand that holds the fence and the other hand. Tillar et al. (2004) have stated that there is a positive correlation in handball players between

isometric handgrip strength and the speed of throwing the ball in both genders. Ferreira et al. (2011) have evaluated the difference between the dominant and non-dominant handgrip strength in terms of age and gender, and determined that dominant handgrip strength of male between 17 and 19 is 46,66 kg, non-dominant handgrip strength is 45,69 kg; dominant handgrip strength of girls in the same age group is 29,19 kg, non-dominant handgrip strength is 27,19 kg. They revealed that handgrip strength increases with age and male have higher values. In their study focusing on whether the influence of body typologies upon physical performance is different according to the gender or not, Fuster et al. (1998) have found that male's right handgrip strength is 50.21±7.1 kg, left handgrip strength is 46.90±7.8 kg, female's right handgrip strength is 30.06±4.1 kg, left handgrip strength is 27.82±4.7 kg. Results related to the strength variables appeared to be significantly high in favour of male. In their study comparing the dominant hand anthropometric measures of elite volleyball players and sedentary group, Öcal et al. (2010) have found that athletes' hand measurements are significantly different, and the reason of that is based on their trainings of their branches. As a result of their study on 393 university students, Kulaksız et al. (2002) have found that right hand has higher values in terms of hand span and hand shape index, and environmental factors such as hand activity, hormones and brain asymmetry can play an effective role upon hand anthropometric measurements. In their study focusing on revealing the relationship between handgrip strength, gender, body weight and height, Ploegmaker et al. (2013) have found that male show more significant momentum about handgrip strength and there is a strong relationship especially between handgrip strength, height and body weight. In their study aiming at determining the variables related to handgrip strength based on gender and age, Nevill et al. (2000) have confirmed that there is a linear relationship between the level of physical activity and handgrip strength.

The data of the study can be applied to aptitude selection of sports branches. In their study on their estimation of the influence of anthropometric characteristics upon handgrip strength of 115 male and 114 female between 20 and 25, Chandrasekaran et al. (2010) have revealed that age, height and body weight are important determinants of handgrip strength. In their study on 295 healthy children between 6 and 13, de Souze et al. (2014) have revealed the relationship between the handgrip strength and age, gender, body composition. They have found that handgrip strength of both hands increases with age, dominant hand is stronger than the non-dominant hand, and handgrip strength shows a correlation with lean mass and height. In their study carried out on 1417 healthy children between 5 and 18 years for determining norms related to handgrip strength, Newman et al. (1984) have confirmed that male have higher levels of handgrip strength than female, and handgrip strength shows a correlation with height and body weight. In a similar study carried out by Aktaş et al. (2013), it has been determined that there is a positive and significant relationship between the handgrip strength of volleyball players and their arm and forearm. Nicolay et al. (2005) compared the dominant and non-dominant handgrip strength and endurance between genders, and they have determined that male are stronger than female and dominant hand is stronger than the non-dominant hand. In their study revealing the comparison between male's right and left handgrip strength and biometric endurance, and their relationship with age and other physical activities, Chatterjee et al. (1991) have confirmed that handgrip strength and body weight have a positive correlation with height and

body surface area. In their study focusing on the influence of the handgrip strength upon handgrip span and type, Fransson et al. (1991) have found that the difference in terms of the handgrip strength of male and female is 35% lower in accordance with female's hand sizes. Semproli et al. (2007) have stated that basic and specific hand anthropometry has a higher influence on handgrip strength in male in proportion to female in the increasing ages.

The data obtained as a result of the comparison of all the male-female athletes' dominant and non-dominant hand sizes and handgrip strengths in all branches show significant differences. In all branches in dominant hands P1, P2 and FS5 values are significantly different and at female basketball and handball players DFS5 value is higher than the other branches. This can be related to grip of the ball. All the findings of this study serves determining criteria during the process of choosing skills, specifying the influences of goal-oriented trainings and producing tools in proportion to the hand sizes of the users in sports branches such as basketball, volleyball, handball and badminton and shows new ways for the future studies.

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No potential conflict of interest was reported by the authors.

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