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ASSOCIATION OF ANTHROPOMETRIC MEASUREMENTS OF HAND AND FOREARM WITH GRIP STRENGTH IN BASKETBALL AND VOLLEYBALL PLAYERS.

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Background: - Hand grip strength is always consider as an overall indicator of physical strength, muscle performance, functional index of nutritional status, bone mineral content, functional integrity of upper extremity of hand and forearm musculature. . It is judged as one of the major reliable tool used in clinical setting for estimating hand-grip strength. As a physiological variable it can be influenced by a number of factors such as age, gender, height, weight and various anthropometric traits.

Objective: - The objective of present study was to measure the dominant handgrip strength with modified sphygmomanometer and its association with several anthropometric measurements of hand and forearm in 60 selected basketball and volleyball players of aged 15-20 years (mean age 16.1667±1.3298) from three different research settings in Uttarakhand, India.

Method: - Four anthropometric variables, i.e. height, weight, BMI, body fat percentage, 6 hand anthropometric variables, i.e. hand size, hand length, palm length, palm width, hand shape, middle finger length, 15 hand dimensions (TL, IFL, MFL, RFL, LFL, FS1, FS2, FS3, FS4, FS5, P1, P2, P3, P4, P5), Wrist circumference, two forearm anthropometric variables, i.e. forearm length, forearm circumference and handgrip strength of dominant and non dominant were measured in basketball & volleyball players by standard anthropometric techniques.

Main Outcome Measures: - Handgrip strength was measured by Modified Sphygmomanometer.

Result: - In total players dominant handgrip strength had significant (p<0.05*; p<0.01**) positive correlation with Age (r=0.313*), Height(r=0.413**), Weight(r=0.401**), Forearm circumference (r=0.377**), Wrist circumference (r=0.325*), Palm width (r=0.324*), Thumb length (r=0.341**), Index finger length (r=0.301*), Perimeter 1 (r=0.277*), Perimeter2 (r=0.288*). In basketball players

dominant handgrip strength had significant (p<0.05*; p<0.01**) positive correlation with Age (r=0.508**), Height(r=0.492**), Forearm circumference (r=0.381*), Wrist circumference (r=0.435*), Hand length (r=0.382*), Palm length (r=0.400*), Thumb length (r=0.480**), Index finger length (r=0.376*), Middle finger length (r=0.446*), Ring finger length (r=0.370*) Perimeter 1 (r=0.370*), Perimeter 2 (r=0.413*), Perimeter 3 (r=0.385*). In volleyball players dominant handgrip strength had significant (p<0.05*; p<0.01**) positive correlation with Height(r=0.373*), Weight(r=0.448*), Forearm circumference (r=0.381*)

Conclusion: - Based on the result findings it is concluded that Age, Height, Forearm circumference, wrist circumference, hand length, palm length, thumb length, index finger length, middle finger length, ringer finger length, perimeter 1,2,3 showed significant positive correlation with dominant handgrip strength, but in volleyball players only height, weight and forearm circumference showed significant positive correlation with dominant handgrip strength . The differences in the groups could be due to specific training in the different sports or due to small age group and sample size.

Key words: - Handgrip strength, Hand anthropometrics, Forearm anthropometrics, Modified sphygmomanometer, hand dimensions.

1. INTRODUCTION

Hand is one of the complex structure that can relay sensory information about the temperature, shape, texture of objects to the brain along with multitude of motor task [1] It is devoted entirely to function of manipulation and its also unique in being free of habitual locomotors duty. When a grip is formed during an activity its effectiveness in performing activities generally comprise of configuration of bone and muscle which permit opposition of the pulp surface of the thumb to the corresponding surfaces of other four finger tips, in collaboration with sensitivity, nervous control and proprioception of the fingers.[2]

The hand never functions in isolation, it is always is dependent on the integrity of the shoulder and elbow complexes which allow the appropriate positioning of the hand in space required complete the desired task appropriately .[1]

In Hand grip strength is as the maximal power generated by forceful voluntary flexion of all the fingers under normal bio kinetic conditions,[3] comprises of activity of various muscles of hand and fore arm region. In order to determine the handedness of an individual, handgrip strength can be consider as an important parameter in field of population variation in study. It is often consider as an valid indicator of overall physical strength,[5] hands and forearm muscle performance, [6] functional indexes of nutritional status, [7] physical performance, bone mineral content, and functional integrity of upper extremity. [8-12.]

Ball games require comprehensive ability of an individual which includes physical fitness , technical, cognitive and tactical abilities. Hand morphology and functional properties plays a very important role in skill and performance of an player. [13]

Volleyball and Basketball are one of the popular sports played mostly throughout the world. Which requires high level of technical, tactical, physical and suitable anthropometric characteristics. [14]

Several studies have examined the relationship between anthropometric and physiological characteristics of volleyball players and as well as in basketball player [16,17,18,19] In young and adult players different researchers have examined hand grip strength and concluded that the athletics with longer finger and greater hand surfaces generally have greater grip strength.[17,18,19]

Various modalities are used for the measurement of grip strength varied from manual muscle testing, hand dynamometer, myometer and modified sphygmomanometer. [20, 21,22]

In previous literature a strong co relation between grip strength using Jamar hand dynamometer with various anthropometric traits such as weight, height, hand length etc. are reported.[23] but using modified sphygmomanometer these correlations have been shown in non athletes.[21]

So in this study we have studied about the association between anthropometrics of hand, forearm and handgrip strength in basketball and volleyball players.

2. METHODOLOGY

A Single blind cross sectional correlation study of basketball and volleyball players age between 15-20years those who are physically active and have been playing for at least past one year with 4-5 playing hours per week were included in the study and those who were having any recent injury (musculoskeletal or neurological impairments),undergoing any rehabilitation protocol at the time of study or Athletes reporting any recent weight change (decrease >10% of body weight) were excluded from the study.

Procedure

A sample of 60 Athletes of age group 15-20 years obtained from three different settings (Maharana Pratap Sports College, Raipur; Kendriya vidyalaya O.F.D, Raipur; State basketball and volleyball academy at Parade Ground, Dehradun) was recruited for the study. The non randomised convenient sampling was preferred to divide the sample in two groups of 30 each of Basketball and Volleyball players. Both groups consisted of 8 female and 22 male players.

After taking the Ethical approval for conducting the study, data of below mentioned anthropometric parameters and the handgrip strength tests were taken.

HEIGHT MEASUREMENT

The height was measured during inspiration using a stadiometer to the nearest 0.1 cm.

WEIGHT MEASUREMENT

The weight was measured by mechanical standing weighing scale to the nearest 0.1 kg.

BMI

After treading of height and weight were taken then BMI was calculated using the formula weight (kg)/ height (m) ^{2}.

BODY FAT PERCENTAGE

This was calculated using BMI as given in the below mentioned formula

% Fat = 63.7 - 864 X (1 / BMI) - 12.1 X Gender + 0.12 X Age + 129 X Asian X (1 / BMI) - 0.091 X Asian X Age - 0.030 X African American X Age

Whereas Gender = 1 for male and 0 for female; Asian = 1 and 0 for all other

races; African American = 1and 0 for all other races; age in years (nearest tenth year).[29]

HAND DOMINANCE

To determine the hand dominance it was asked by which hand they hold the pen while writing.

HAND PARAMETERS

Anthropometrical variables of hand were measure by a method given by Visnapuu and Jürimäe (2007). Subject were explained in detail about the procedure then they were seated comfortably in chair and then command was given to them to spread and stretch out their dominant hand and place it on the paper. Researchers then have drawn the outlines of the dominant hand while contour were drawn with maximal active voluntary adduction of thumb and other fingers. After that three groups of hand anthropometric variables were measured: 5 finger spans, 5 finger lengths, and 5 perimeters of the hand. Finger spans (FS1, FS2, FS3, FS4 and FS5), finger lengths (TL, IFL, MFL, RFL, LFL), and 5 perimeters (P1, P2, P3, P4, P5) of the hand (Figure 4.6) were measured by a standard 300-mm metal ruler.[19]

HAND SIZE MEASUREMENT

The distance separating distal extremes of the first and fifth digits were measured in the dominant hand playing it in maximal width.[35]

HAND SHAPE MEASUREMENT

It was taken by taking ratio between hand width to hand length . (W/L ratio).[36]

HAND LENGTH MEASUREMENT

For hand length measurement the distance from the tip of the middle finger to the midline of the distal wrist crease when the forearm and hand are supinated on a table were taken .[34]

PALM LENGTH MEASUREMENT

For Palm length the distance between the midline of the distal wrist crease and the base of middle finger was measure using a ruler.[30]

PALM (HAND) WIDTH MEASUREMENT

The distance between the radial side of the second metacarpal joint to the ulnar side of the fifth metacarpal joint.[31]

F3 (MIDDLE FINGER) LENGTH MEASUREMENT

The distance from the tip of the middle finger to the base of the middle finger or Hand length minus Palm length.[31]

FOREARM LENGTH MEASUREMENT

The distance from the joint line of proximal head to the styloid process.[31]

FOREARM CIRCUMFERENCE MEASUREMENT

A flexible measuring tape was used to measure the maximum forearm circumflexed.[31]

WRIST CIRCUMFERENCE MEASUREMENT

A flexible measuring tape was used to measure the Wrist circumflexed at wrist crease.[31]

HAND GRIP STRENGTH TEST

To measure the hand grip strength sphygmomanometer was used. Its cuff was evenly rolled, forming a circumference of approximately 7 in to conform and then rubber band was placed around each end of the cuff to hold it in position. The cuff was inflated to 20 mmHg, which was taken as the starting position for measurement of

each subject.

Subject was positioned in a straight back chair with both feet flat on the floor. Position of the arm was explained, and then each subject was instructed to place their left hand on their right thigh and assume a position of adducted and neutrally rotated shoulders. For the arm to be tested, the elbow was flexed up to 90^{o}**,** the forearm and wrist were in neutral positions, and the fingers were flexed**.** Each subject was instructed to breathe in through his/her nose and blow out through pursed lips so that maximum grip effort can be made. Then were given a command to squeeze as harder as possible.[32-33]

Measurements for the hands were taken. Three trials were taken with a rest interval of 60 seconds between each trial.

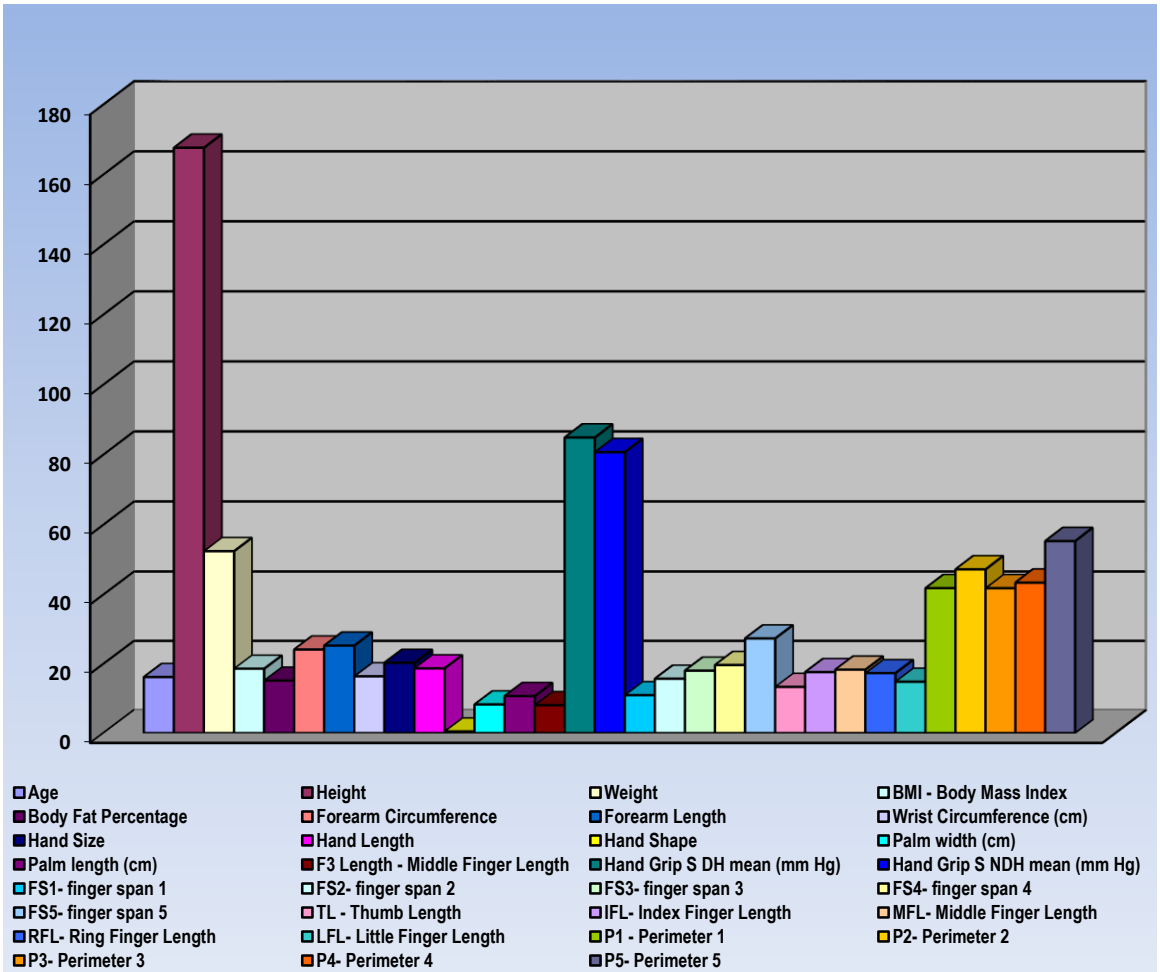
3. RESULT

All results were presented as mean standard deviation. All significant p values

Descriptive Statistics Of Anthropometric Measurements Of Hand And Forearm With Handgrip Strength In Total Players

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Age	60	15.00	20.00	970.00	16.1667	1.3298
Height	60	147.00	186.50	10059.00	167.6500	8.2715
Weight	60	35.00	77.00	3145.00	52.4167	8.8553
BMI - Body Mass Index	60	14.02	24.47	1114.79	18.5798	2.3343
Body Fat Percentage	60	3.38	31.72	908.53	15.1422	6.9519
Forearm Circumference	60	20.00	29.00	1447.50	24.1250	2.0034
Forearm Length	60	21.50	29.00	1515.00	25.2500	1.7791
Wrist Circumference (cm)	60	14.00	19.00	982.00	16.3667	1.1194
Hand Size	60	17.00	25.50	1216.60	20.2767	1.8630
Hand Length	60	16.00	20.50	1120.70	18.6783	1.0976
Hand Shape	60	.38	.50	26.45	.4408	2.5400
Palm width (cm)	60	7.00	10.00	494.50	8.2417	.6344
Palm length (cm)	60	9.00	12.00	640.20	10.6700	.6703
F3 Length - Middle Finger Length	60	6.50	9.00	482.00	8.0333	.5665
Hand Grip S DH mean (mm Hg)	60	45.33	140.00	5093.66	84.8943	19.4878
Hand Grip S NDH mean (mm Hg)	60	35.33	134.00	4843.32	80.7220	19.0096
FS1- finger span 1	60	8.50	15.20	655.80	10.9300	1.7070
FS2- finger span 2	60	11.80	22.10	940.20	15.6700	2.0198
FS3- finger span 3	60	13.40	24.90	1081.20	18.0200	2.1400
FS4- finger span 4	60	15.50	25.10	1179.20	19.6533	1.9285
FS5- finger span 5	60	21.20	36.10	1639.40	27.3233	2.9493
TL - Thumb Length	60	11.60	15.10	799.10	13.3183	.8480
IFL- Index Finger Length	60	14.90	19.60	1055.40	17.5900	1.0982
MFL- Middle Finger Length	60	15.10	20.40	1098.20	18.3033	1.1922
RFL- Ring Finger Length	59	14.10	19.20	1020.40	17.2949	1.1796
LFL- Little Finger Length	60	12.00	16.80	889.40	14.8233	.9982
P1 - Perimeter 1	60	35.10	48.90	2510.60	41.8433	3.2569
P2- Perimeter 2	60	38.50	57.40	2834.50	47.2417	3.7719
P3- Perimeter 3	60	34.20	50.10	2509.90	41.8317	2.8842
P4- Perimeter 4	60	35.50	48.10	2606.20	43.4367	2.8779
P5- Perimeter 5	60	44.80	67.20	3318.70	55.3117	4.2346

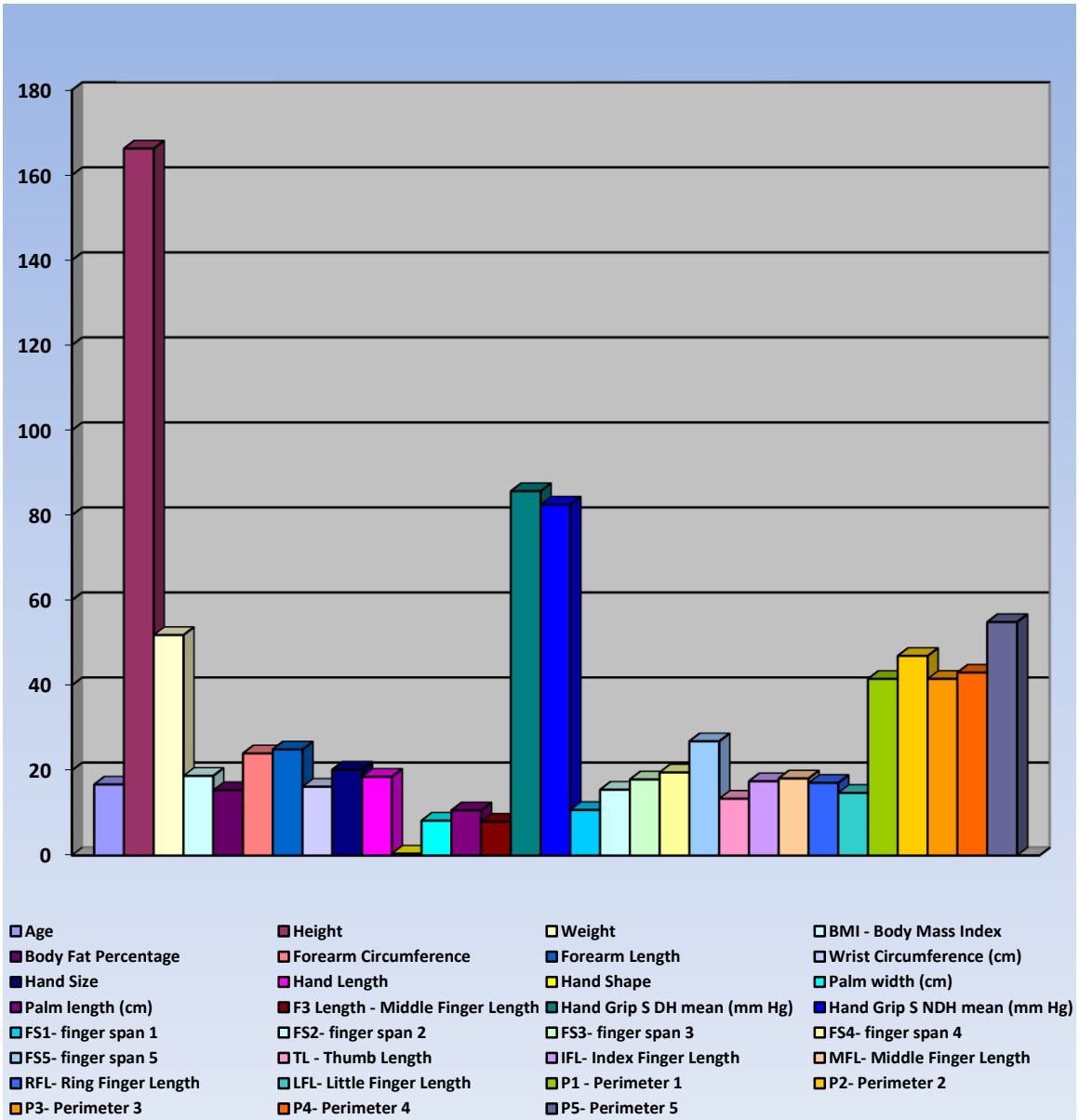
(~0.05) were indicated in bold type.



Graph 5.1 Showing the mean values of all the parameters in total players.

Descriptive Statistics Of Anthropometric Measurements Of Hand And Forearm With Handgrip Strength In Basketball Players.

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Age	30	15.00	20.00	500.00	16.6667	1.5388
Height	30	147.00	181.00	4987.50	166.2500	7.7055
Weight	30	39.00	77.00	1554.00	51.8000	8.8294
BMI - Body Mass Index	30	14.19	23.48	561.01	18.7003	2.5466
Body Fat Percentage	30	3.38	31.72	459.99	15.3330	6.8734
Forearm Circumference	30	20.50	29.00	719.50	23.9833	1.9848
Forearm Length	30	21.50	28.00	747.00	24.9000	1.6526
Wrist Circumference (cm)	30	14.50	19.00	484.50	16.1500	.9839
Hand Size	30	17.00	23.50	605.00	20.1667	1.7535
Hand Length	30	16.00	20.00	554.70	18.4900	1.0169
Hand Shape	30	.38	.49	13.25	.4417	2.6700
Palm width (cm)	30	7.00	9.50	245.50	8.1833	.6086
Palm length (cm)	30	9.00	11.50	317.70	10.5900	.6759
F3 Length - Middle Finger Length	30	7.00	8.50	238.50	7.9500	.5309
Hand Grip S DH mean (mm Hg)	30	47.33	140.00	2569.32	85.6440	17.1523
Hand Grip S NDH mean (mm Hg)	30	45.33	134.00	2474.65	82.4883	18.3568
FS1- finger span 1	30	8.50	15.00	320.60	10.6867	1.7628
FS2- finger span 2	30	12.30	19.90	463.40	15.4467	1.8829
FS3- finger span 3	30	14.60	22.30	535.60	17.8533	1.8809
FS4- finger span 4	30	16.50	23.50	584.90	19.4967	1.7002
FS5- finger span 5	30	22.50	33.60	804.40	26.8133	2.4294
TL - Thumb Length	30	11.70	15.10	399.90	13.3300	.8226
IFL- Index Finger Length	30	15.40	19.20	522.90	17.4300	1.0386
MFL- Middle Finger Length	30	15.70	20.20	542.70	18.0900	1.0771
RFL- Ring Finger Length	30	14.70	19.10	511.70	17.0567	1.0424
LFL- Little Finger Length	30	12.60	16.80	441.20	14.7067	.9468
P1 - Perimeter 1	30	35.60	47.40	1244.10	41.4700	3.2955
P2- Perimeter 2	30	40.90	53.60	1406.60	46.8867	3.4879
P3- Perimeter 3	30	37.60	46.70	1244.50	41.4833	2.5380
P4- Perimeter 4	30	37.60	46.50	1288.40	42.9467	2.3585
P5- Perimeter 5	30	47.90	62.40	1645.50	54.8500	3.7245



Graph 5.2 showing mean values of all parameters in Basketball players.

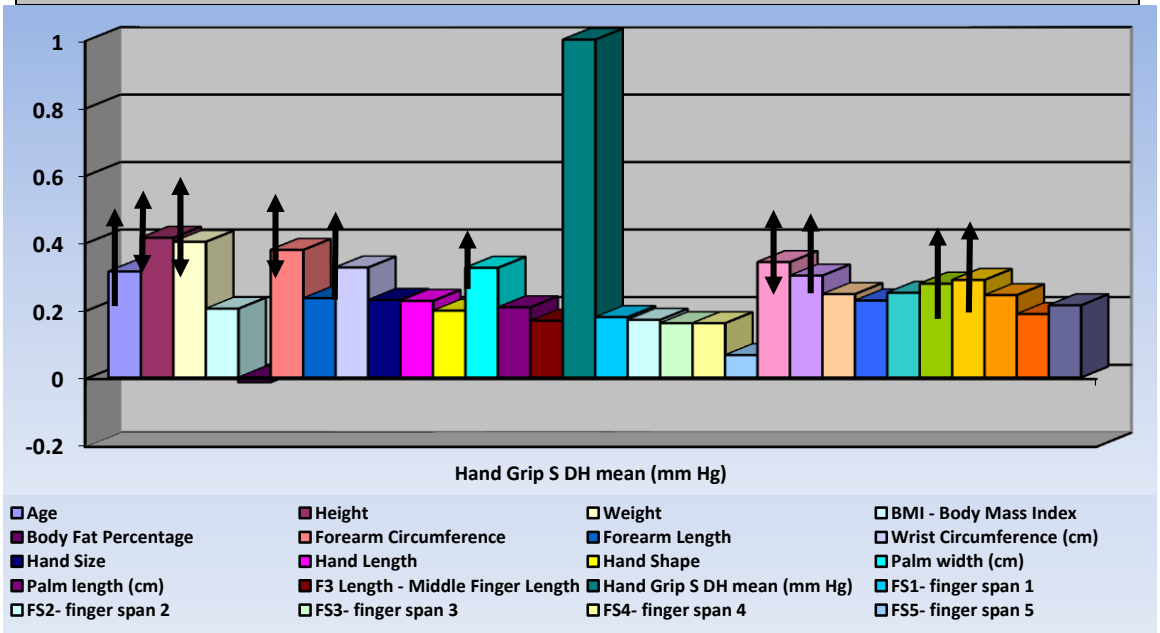
Descriptive Statistics Of Anthropometric Measurements Of Hand And Forearm With Handgrip Strength In Volleyball Players.

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Age	30	15.00	18.00	470.00	15.6667	.8442
Height	30	147.00	186.50	5071.50	169.0500	8.7043
Weight	30	35.00	70.00	1591.00	53.0333	8.9884
BMI - Body Mass Index	30	14.02	24.47	553.78	18.4593	2.1380
Body Fat Percentage	30	5.07	30.49	448.54	14.9513	7.1417
Forearm Circumference	30	20.00	28.00	728.00	24.2667	2.0457
Forearm Length	30	22.00	29.00	768.00	25.6000	1.8588
Wrist Circumference (cm)	30	14.00	19.00	497.50	16.5833	1.2183
Hand Size	30	17.00	25.50	611.60	20.3867	1.9903
Hand Length	30	16.00	20.50	566.00	18.8667	1.1592
Hand Shape	30	.39	.50	13.20	.4400	2.0200
Palm width (cm)	30	7.00	10.00	249.00	8.3000	.6644
Palm length (cm)	30	9.50	12.00	322.50	10.7500	.6663
F3 Length - Middle Finger Length	30	6.50	9.00	243.50	8.1167	.5972
Hand Grip S DH mean (mm Hg)	30	45.33	123.33	2524.34	84.1447	21.8469
Hand Grip S NDH mean (mm Hg)	30	35.33	123.33	2368.67	78.9557	19.7930
FS1- finger span 1	30	8.60	15.20	335.20	11.1733	1.6427
FS2- finger span 2	30	11.80	22.10	476.80	15.8933	2.1566
FS3- finger span 3	30	13.40	24.90	545.60	18.1867	2.3920
FS4- finger span 4	30	15.50	25.10	594.30	19.8100	2.1506
FS5- finger span 5	30	21.20	36.10	835.00	27.8333	3.3551
TL - Thumb Length	30	11.60	15.00	399.20	13.3067	.8867
IFL- Index Finger Length	30	14.90	19.60	532.50	17.7500	1.1497
MFL- Middle Finger Length	30	15.10	20.40	555.50	18.5167	1.2796
RFL- Ring Finger Length	29	14.10	19.20	508.70	17.5414	1.2780
LFL- Little Finger Length	30	12.00	16.40	448.20	14.9400	1.0500
P1 - Perimeter 1	30	35.10	48.90	1266.50	42.2167	3.2299
P2- Perimeter 2	30	38.50	57.40	1427.90	47.5967	4.0644
P3- Perimeter 3	30	34.20	50.10	1265.40	42.1800	3.1986
P4- Perimeter 4	30	35.50	48.10	1317.80	43.9267	3.2850
P5- Perimeter 5	30	44.80	67.20	1673.20	55.7733	4.7085

In total players dominant handgrip strength had a statically significant value ($p<0.05$*; $p<0.01$**) and a Positive correlation with Age (r=0.313*), Height(r=0.413**), Weight (r =0.401**),Forearm circumference (r=0.377**), Wrist circumference(r= 0.325*), Palm width (r=0.324*), Thumb length (r=0.341**), Index finger length (r=0.301*), Perimeter 1 (r=0.277*), Perimeter2 (r=0.288*).

	Hand Grip S DH mean (mm Hg)
Age	.313*
Height	.413**
Weight	.401**
BMI - Body Mass Index	.203
Body Fat Percentage	-.014
Forearm Circumference	.377**

Forearm Length	.234
Wrist Circumference (cm)	.325*
Hand Size	.229
Hand Length	.226
Hand Shape	.197
Palm width (cm)	.324*
Palm length (cm)	.207
F3 Length - Middle Finger Length	.167
Hand Grip S DH mean (mm Hg)	1.000
Hand Grip S NDH mean (mm Hg)	.832**
FS1- finger span 1	.178
FS2- finger span 2	.170
FS3- finger span 3	.160
FS4- finger span 4	.160
FS5- finger span 5	.066
TL - Thumb Length	.341**
IFL- Index Finger Length	.301*
MFL- Middle Finger Length	.246
RFL- Ring Finger Length	.227
LFL- Little Finger Length	.250
P1 - Perimeter 1	.277*
P2- Perimeter 2	.288*
P3- Perimeter 3	.243
P4- Perimeter 4	.187
P5- Perimeter 5	.213
***Correlation is significant at the 0.05 level (2-tailed).** ****Correlation is significant at the 0.01 level (2-tailed).**	

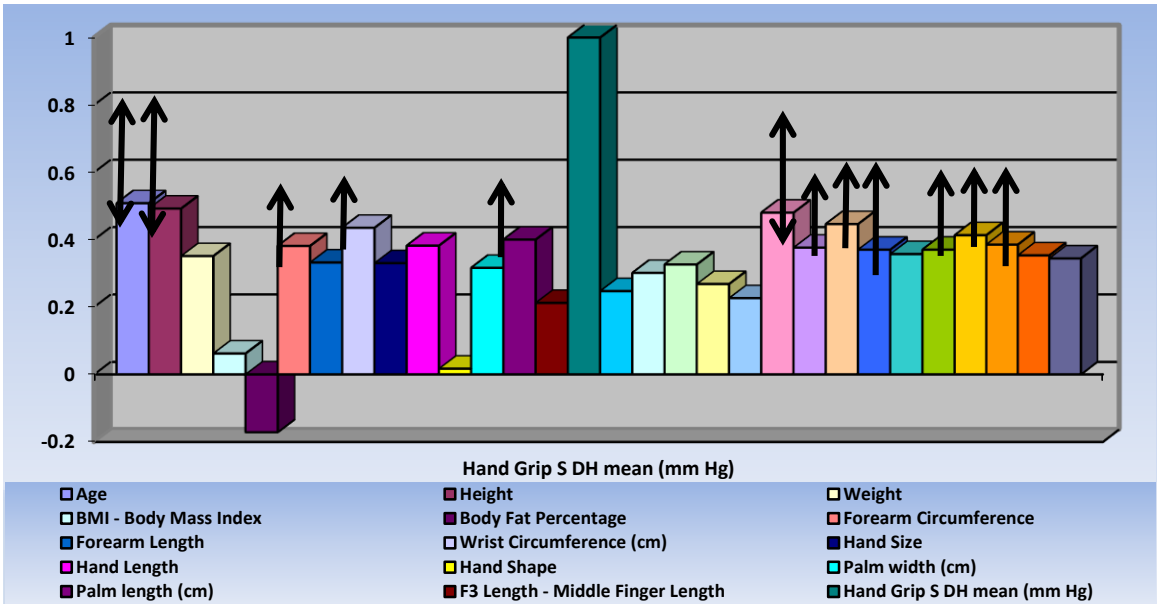


Graph 5.4 Showing correlation between different parameters and dominant handgrip

strength of total players.

In basketball players dominant handgrip strength had a significant p value ($p<0.05$*; ($P<0.01$**) and a positive Correlation with Age (r=0.508**), Height(r=0.492**) Forearm circumference (r=0.381*),Wrist circumference (r=0.435*), Hand length (r=0.382*), Palm length (r=0.400*),Thumb length (r=0.480**), Index finger length (r=0.376*), Middle finger length (r=0.446*),Ring finger length (r=0

	Hand Grip S DH mean (mm Hg)
Age	.508**
Height	.492**
Weight	.351
BMI - Body Mass Index	.062
Body Fat Percentage	-.171
Forearm Circumference	.381*
Forearm Length	.332
Wrist Circumference (cm)	.435*
Hand Size	.330
Hand Length	.382*
Hand Shape	.017
Palm width (cm)	.316
Palm length (cm)	.400*
F3 Length - Middle Finger Length	.212
Hand Grip S DH mean (mm Hg)	1.000
Hand Grip S NDH mean (mm Hg)	.872**
FS1- finger span 1	.247
FS2- finger span 2	.301
FS3- finger span 3	.326
FS4- finger span 4	.268
FS5- finger span 5	.226
TL - Thumb Length	.480**
IFL- Index Finger Length	.376*
MFL- Middle Finger Length	.446*
RFL- Ring Finger Length	.370*
LFL- Little Finger Length	.357
P1 - Perimeter 1	.370*
P2- Perimeter 2	.413*
P3- Perimeter 3	.385*
P4- Perimeter 4	.353
P5- Perimeter 5	.344
***Correlation is significant at the 0.05 level (2-tailed).** ****Correlation is significant at the 0.01 level (2-tailed).**	

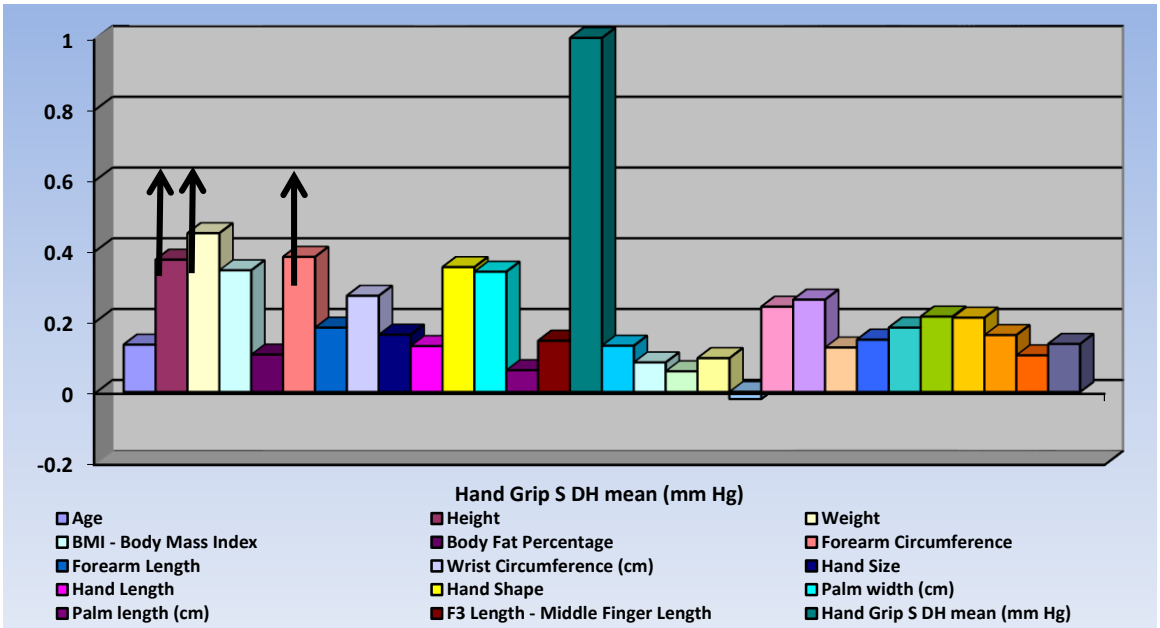


Graph 5.5 Showing correlation between different parameters and dominant hand grip strength of basketball players.

In volleyball players dominant handgrip strength had significant ($p<0.05$*; $p<0.01$**) positive correlation with Height($r=0.373$*), Weight($r=0.448$*), Forearm circumference ($r=0.381$*)

	Hand Grip S DH mean (mm Hg)
Age	.133
Height	.373*
Weight	.448*
BMI - Body Mass Index	.343
Body Fat Percentage	.105
Forearm Circumference	.381*
Forearm Length	.181
Wrist Circumference (cm)	.271
Hand Size	.161
Hand Length	.129
Hand Shape	.352
Palm width (cm)	.339
Palm length (cm)	.061
F3 Length - Middle Finger Length	.144
Hand Grip S DH mean (mm Hg)	1.000
Hand Grip S NDH mean (mm Hg)	.810**
FS1- finger span 1	.130
FS2- finger span 2	.083
FS3- finger span 3	.058
FS4- finger span 4	.095
FS5- finger span 5	-.020
TL - Thumb Length	.240
IFL- Index Finger Length	.260
MFL- Middle Finger Length	.125

RFL- Ring Finger Length	.147
LFL- Little Finger Length	.181
P1 - Perimeter 1	.212
P2- Perimeter 2	.209
P3- Perimeter 3	.160
P4- Perimeter 4	.103
P5- Perimeter 5	.135
***Correlation is significant at the 0.05 level (2-tailed). ****Correlation is significant at the 0.01 level (2-tailed).	



Graph 5.6 Showing correlation between different parameters and dominant hand grip strength of volleyball players.

4. DISCUSSION

This study was conducted to study association between hand, Forearm anthropometrics and handgrip strength in basketball and volleyball Players using modified sphygmomanometer.

According to result findings it was drawn that in total players (basketball +volleyball) Dominant handgrip strength showed significance with age, height, weight (which is in Agreement with Kamrul [38]et al where they noted significant correlation between grip strength and height, weight but not BMI), forearm circumference (which is in agreement with findings of Fraser [39]et al), wrist circumference (which is in agreement with findings of B.Ramakrishnan [40]et al), palm width(which partially supports and partially contrasts with the findings of MacDermid et al where significant correlation were noted between handgrip strength and hand width, hand length, hand span of respective sides in healthy people), thumb length & index finger length (which is in agreement with findings suggested by visnapuu et al 2007[19]

But when the groups were individually considered, Basketball players showed significant positive correlation of dominant handgrip strength with some of the above considered parameters (age, height, forearm circumference, wrist circumference, thumb

length, index finger length, perimeter 1&2) and hand length, palm length, middle finger length, ring finger length, perimeter3. But in volleyball players dominant handgrip strength showed significant positive correlation with only some of the parameters considered like height, a weight and forearm circumference. These differences between the groups can be due to the specific training[36] given in these sports or differences in the level of training done by the different groups which were taken from different research settings.

LIMITATION

Sample size was small with age group less wide and relation between arm anthropometric data with grip strength was not derived

FUTURE STUDY

Biomechanics of different sports with wider age group should be considered and data of non dominant hand anthroprometric measurement could be taken for future consideration.

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