

Original Research Article:

## CO-RELATION OF ANTHROPOMETRY ON GRIP AND PINCH STRENGTH IN YOUNG ADULTS IN INDIA - A CROSS-SECTIONAL STUDY

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**Abstract:** The purpose is to find out correlation of anthropometry on grip and pinch strength. 230 subjects in the age group 20-40 years for both hands were assessed for grip, pinch strength, specific anthropometry including hand span, palm length, digit length, hand length and hand breadth. Hand span shows significant correlation ( $p < 0.01$ ) on grip strength and pinch strength of right and left hand. Hand breadth also shows significant correlation ( $p < 0.01$ ) on grip and pinch strength of right and left hand.

**Key words:** Anthropometry, Grip strength, Pinch strength.

Hand is an intricate part of the upper extremity with functions like grasp, dexterity, expression and orientation. Hand strength becomes an integral part of hand assessment for estimation of hand function and proper integrity of the muscles. It is imperative to assess for grip and pinch strength for rehabilitation of upper extremity work related musculoskeletal disorders, to diagnose and evaluate the level of indicating hand function for sports like wrestling, baseball, football, tennis, badminton, boxing, judo as well as to document ADL activities like eating and lifting heavy object.

Researchers have found that there is geographical variation of basic body anthropometry in Africa, India, China, Australia, America, Caribbean and Asia. Hanten WP et al<sup>1</sup> developed prediction equations for maximum grip strength of right and left hand on the basis of variables of gender, height, weight, and age and hand dominance.

Researchers over the ages have explored the influence of anthropometry on grip strength.

Bear LJ et al.<sup>2</sup> performed a study on hand grip strength and hand size (palm length) among preschoolers and noticed that The 5 year olds have strongest grip and pinch ability and larger hands than the 3 year olds and 4 year olds. Saied Alkholy WA, et al<sup>3</sup> concluded significant correlation with age group 7-18 yrs between whole arm length, upper arm length, forearm length, hand width and grip strength which is strong in primary grades and less in secondary grades. Significant differences in height, weight, BMI, hand length, hand breadth in right dominant and left dominant female labourers between the age group 18-40 years have been found signifying that these factors play a major role in the middle age group<sup>4</sup>. Series of studies conducted in elderly population from different Western and other Asian countries proved significant correlation between different anthropometric variables and hand grip strength<sup>5,6</sup>.

A study of spherical grip strength in children 3-6 yr old found a positive correlation between hand breadth and grip strength.<sup>7</sup> Hager-Ross C et al<sup>10</sup> provided norms for grip strength in children aged 4-16 years and shows that strong correlations exist between grip strength and anthropometric measures in particular height, weight and hand length. A study by Gunther CM et al.<sup>11, 12</sup> shows a positive co-relation of hand

span with key pinch strength in the age group 20-95 years.

Indira E et al.<sup>14</sup> from India proved relation between anthropometric variables and grip strength in the age group 3-5.5 yr. Sandhu R et al<sup>15</sup> from Punjab India concluded parameters like height, weight, gender, BMI, hand length and hand breadth are predictors of grip strength in the age group 50-60 yr old. Thus there is a dearth of literature to explore the effects of anthropometric factors on grip and pinch strength in the Indian population. The objective of this study was to find the correlation of specific anthropometry on grip and pinch strength in young adults in India in the age group of 20-40.

### Method:

#### Study participants

Study approval was obtained from relevant Ethics board. Written informed consent was obtained from all the participants. Readings were documented in data collection forms which included demographic data from all the participants including name, age, gender, hand dominance before the start of the test. 230 subjects were collected from community dwelling young adults from colleges, bank and health exhibitions age group 20-40 years. Subjects were stratified by 5 year age groups. Sample size was calculated according to the 80% power. All subjects included were free from work related musculoskeletal disorders and neuromuscular disorders or system pathology affecting the upper limb, pain in the upper extremity and any restriction in the range of motion of upper limb especially shoulder, elbow and wrist that interfere with position of grip strength.

### Data analysis:

Data were analyzed using SPSS -13(version). Percentage, mean and standard deviation are calculated for the data according to the age group and also according to the gender. Independent t test was applied for the comparison between males and females for the variables-specific anthropometry, grip and pinch strength. Pearson's Correlation Coefficient was established for specific anthropometry on grip and pinch strength. Significance level was set at  $p < 0.05$  or  $p < 0.001$

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## Methods-

1. Hand span (distance between thumb and little finger with stretched hand placed on metric ruler). 2. Digit length (measured from the proximal flexion crease to the tip of that digit). 3. Palm length (distance between distal flexion wrist crease and proximal flexion crease of middle finger.) 4. Hand length was calculated by summation of the palm length and digit length of 3rd metacarpal. 5. Hand width (breadth) (distance between the radial sides of the second metacarpal joint to the ulnar side of fifth metacarpal joint) with the help of inch tape. (Fig 1)

**Grip strength**<sup>15,16,17,18</sup>: The standard Hand Dynamometer (90.90 kgs) by Baseline® Evaluation Instruments, White Plains New York, USA to measure grip strength and Baseline® Evaluation Instruments Pinch gauge (13.63 kgs) was used to measure tip –tip, key and three fingered pinch strength<sup>19,20</sup>

As recommended by American Society of hand therapist-Subjects were seated with shoulder adducted neutral rotation, elbow flexed to 90° and forearm in neutral position, wrist between 0° and 30° dorsiflexion and between 0° and 15° ulnar deviation. The handle of dynamometer was kept at setting two for comfortable grip. Subjects were asked to give their maximum force in one single effort when tested thrice. Hands were chosen alternately and were always recorded in kgs. Instructions to hold and squeeze the instrument with maximum force were given. The instrument was calibrated by resetting it to zero after every test. Three trials were performed for both the hand and 15 secs rest was given between each trial. Thus average of the three trials was taken. (fig 2)

## Pinch strength

Pinch strength was tested with the instrument in a standard position. Standard position of testing was followed seated with shoulder adducted neutral rotation, elbow flexed to 90° and forearm in mid prone position and wrist between 0° and 30° dorsiflexion and 0° and 15° ulnar deviation. Thus all pinches were tested in forearm mid prone position. The average of the three trials was taken. (fig 3).

## Results

### Demographic data

The demographic data of the subjects were collected and are summarized in Table 1. A total of 230 participants were included in this study. They consisted of 118 (51.3%) males and 112 (48.7%) females, ranging from 20 to 40 years age. Majority of the sample were men (51.3%), right hand dominance (98.3%), with normal body mass index (66.1%).

### Hand -grip strength (HGS) and hand pinch strength (HPS) descriptive statistics by gender

Table 2 shows the means and standard deviation of HGS and HPS by gender. The mean HGS for the

Male participants are more than females. The mean HPS for the males are more than females.

### Anthropometry descriptive statistics by gender

Table 3 shows the anthropometric parameters mean and standard deviation according to gender. It shows increasing trend in males than females for very parameter like hand span, palm length, digit length, hand length and hand breadth.

### Specific anthropometry correlation on grip and pinch strength

Table 4 describes specific anthropometry correlations on grip and pinch strength

Hand span of right hand shows significant correlation  $p < 0.001$  with grip ( $r = 0.402$ ) tip pinch ( $r = 0.230$ ) key pinch ( $r = 0.312$ ) and three fingered pinch ( $r = 0.339$ ) of right hand. Hand span of left hand shows significant correlation with grip ( $r = 0.405$ ), tip pinch ( $r = 0.284$ ) key pinch ( $r = 0.321$ ) and three fingered pinch ( $r = 0.348$ ). Hand breadth of right hand shows significant correlation with grip ( $r = 0.515$ ) tip pinch ( $r = 0.312$ ), key pinch ( $r = 0.542$ ) and three fingered pinch ( $r = 0.422$ ) and hand breadth of left hand shows significant correlation with grip ( $r = 0.601$ ), tip pinch ( $r = 0.36$ ), key pinch ( $r = 0.588$ ) and three fingered pinch ( $r = 0.486$ ).

Palm length of right hand shows weak correlation with grip ( $r = 0.65$ ,  $p = 0.325$ ), tip pinch ( $r = -0.005$ ,  $p = 0.934$ ), key pinch ( $r = 0.063$ ,  $p = 0.339$ ) and three fingered pinch ( $r = -0.030$ ,  $p = 0.651$ ). Digit length of all digits shows significant correlation with grip and pinch strength of both the hands except index finger length of right hand.). Hand length is a combination of palm length and digit length of 3rd finger. As palm length and digit length of 3<sup>rd</sup> finger of right hand shows no correlation, thus hand length of right hand shows no correlation with grip and pinch strength.

## Discussion

Hand grip strength is a physiological variable that is affected by a number of factors including age, gender, and body size among others. Hand grip strength was more in males as compared with females due to physiological differences between them. Dominance is one of the factors affecting grip and pinch strength. We followed the 10% rule where it is always right hand grip strength is more than left hand grip strength. Relation between dominance and grip strength of right hand had no significance ( $p = 0.138$ ). As the no of subjects for right hand dominance are 226 and left hand dominance are 4, so we ignored the issue of dominance due to small sample size. Research about pinch strength and factors influencing it is less so this study explored factors like gender and age and specific anthropometry. Although no statistical associations between age and HGS were identified in this study, it follows the literature with initial increment of HGS reaching a peak during the third decade, culminating with decline after the fifth decade. This pattern can be observed in our data when the sample was divided by age groups; (table 1) To support this, studies have been performed in children, teenagers and elderly men and women<sup>9,10,11,12</sup>.

Lauwers T et al<sup>21</sup> performed exploratory study to investigate parameters influencing grip and pinch strength between the age 18-80 years. Our study includes the age group 20-40 years in which till date the influence of hand span, palm length, digit length and hand length to grip strength and pinch strength in India has never been performed. This is very important information as it influences ergonomics in the design of hand tools in specific population.

Specific anthropometry may get affected by occupational factors however this study did not take this factor into account. This study explores how each specific anthropometry variable affects grip and pinch strength in normal individuals. Thus further studies are encouraged to highlight this relation more in subgroups of population within an occupational framework.

**CONCLUSION:** Hand span and hand breadth shows a significant co-relation with grip and pinch strength and are important factors that affect hand function. Therefore we can conclude that in future evaluation of grip and pinch strength for hand rehabilitation must include assessment of specific anthropometry parameters.

**Conflict of interest:** Nil

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**Ethical Clearance:** Taken from Ethical Committee of Father Muller Medical College.

Characteristic	No of subjects	Percentage
<b>Age</b>		
20-24	60	26.1
25-29	60	26.1
30-34	52	22.6
35-39	58	25.2
<b>Gender</b>		
Male	118	51.3
Female	112	48.7
<b>Hand dominance</b>		
Right hand	226	98.3
Left hand	4	1.7
<b>Body mass index</b>		
Below Normal	22	9.6
Normal	122	66.1
Overweight	56	24.3

Table 1 Demographic data of the subjects

	gender	mean±s.d	S.E
grip rt hand	M	28.09±7.14	0.657
	F	19.89±4.19	0.395
grip lt hand	M	29.04±7.27	0.669
	F	19.91±4.13	0.390
tip pinch rt hand	M	3.14±1.58	0.145
	F	2.44±1.28	0.120
tip pinch lt hand	M	3.03±1.37	0.126
	F	2.33±1.13	0.106
key pinch rt hand	M	7.05±1.61	0.148
	F	5.35±1.18	0.111
key pinch lt hand	M	6.93±1.55	0.143
	F	5.17±1.18	0.111
three fingered pinch rt hand	M	5.66±1.53	0.141
	F	4.57±1.27	0.120
three fingered pinch lt hand	M	5.52±1.53	0.140
	F	4.39±1.22	0.114

Table 2:descriptive statistics of grip and pinch strength according to the gender [rt- right, lt –left, s.d- standard deviation, S.E-standard error, M-male, F-female]

	gender	mean±s.d	S.E
hand span rt	M	19.47±1.84	0.170
	F	18.06±1.36	0.129
hand span lt	M	19.44±1.87	0.171
	F	18.08±1.36	0.128
palm length rt	M	11.88±9.60	0.883
	F	10.23±0.59	0.554
palm length lt	M	11.01±0.66	0.611
	F	10.24 ±0.60	0.565
thumb length rt	M	6.62 ±0.63	0.057
	F	6.20 ±0.59	0.055
thumb length lt	M	6.61 ±0.58	0.053
	F	6.18 ±0.56	0.053
index finger length rt	M	7.14 ±0.55	0.050
	F	7.26 ±5.65	0.533
index finger length lt	M	7.15 ±0.55	0.050
	F	6.73 ±0.54	0.050
middle finger length rt	M	7.86 ±0.58	0.053
	F	7.41 ±0.56	0.053
middle finger lt	M	7.85 ±0.58	0.053
	F	7.42 ±0.56	0.053
ring finger rt	M	7.20 ±0.59	0.054
	F	6.78 ±0.52	0.048
ring finger lt	M	7.22 ±0.61	0.056
	F	6.79 ±0.52	0.049
little finger rt	M	5.71 ±0.53	0.049
	F	5.38 ±0.51	0.048
little finger lt	M	5.73 ±0.54	0.496
	F	5.39 ±0.52	0.488
hand length rt	M	18.72 ±1.68	0.1547
	F	19.04±14.90	1.4082
hand length lt	M	18.83 ±1.14	0.1050
	F	17.64 ±0.99	0.0934
hand breadth rt	M	19.93 ±1.25	0.1150
	F	18.18 ±1.56	0.1470
hand breadth lt	M	19.87 ±1.22	0.113
	F	18.19 ±1.17	0.111

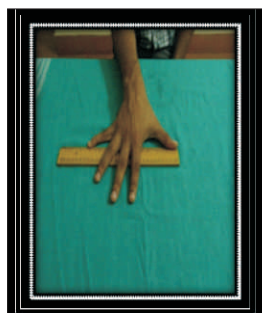
Table 3:Descriptive statistics of specific anthropometry according to the gender [rt- right, lt –left, s.d- standard deviation, S.E-standard error, M-male, F-female]



Specific Anthropometry		Karl pearson Correlation coefficient r value	Specific Anthropometry		Karl pearson Correlation coefficient r value
span rt	grip rt	0.402(**)	palm rt	grip rt	0.65*
	tip rt	0.230(**)		tip rt	-0.005*
	key rt	0.312(**)		key rt	0.063*
	three rt	0.339(**)		three rt	-0.030*
span lt	grip lt	0.405(**)	index finger rt	grip rt	-0.053*
	tip lt	0.284(**)		tip rt	-0.015*
	key lt	0.321(**)		key rt	-0.016*
	three lt	0.348(**)		three rt	-0.025*
hand breadth rt	grip rt	0.515(**)	hand length rt	grip rt	0.013*
	tip rt	0.312(**)		tip rt	0.029*
	key rt	0.542(**)		key rt	0.096*
	three rt	0.422(**)		three rt	0.002*
hand breadth lt	grip lt	0.601(**)			
	tip lt	0.360(**)			
	key lt	0.588(**)			
	three lt	0.486(**)			

Table 4- Correlation of specific anthropometry on right and left grip and pinch strength of the hand.

[rt-right, lt-left, \*\*-p&lt;0.001 significance, \*no correlation]



(A)



(B)



(C)



(d)

fig 1 a-hand span b-digit length c-palm length d-hand breadth



Fig 2: Grip strength



Fig 3. Jamar pinch gauge and the position of measurement (A) Key pinch is thumb pad to lateral aspect of middle phalanx of index finger (B) Tip pinch is thumb to index finger (C) Tripod pinch is thumb pad to pads of index and middle fingers.



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