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THE ASSOCIATION BETWEEN HAND GRIP STRENGTH AND HAND DIMENSIONS IN HEALTHY INDIAN FEMALES

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ABSTRACT

Background: The human hand is a very complex structure and devoted to the functions of manipulation. Hand grip strength is used in clinical settings as an indicator of overall physical strength and health. **Objectives**: This cross-sectional study was performed to study the association between hand grip strength and anthropometric measurements (height, weight, body mass index, hand dimensions) in healthy Indian female population. **Methods and Measures:** A total of 50 healthy female subjects, satisfying the selection criteria were recruited in the study. Subjects were then assessed for height, weight, body mass index (BMI), hand and forearm anthropometric measurements. The grip strength of both dominant and non-dominant hands were measured using Jamar dynamometer. Measurements followed standardized procedures and instructions. **Statistical analysis:** The data was analyzed by Pearson's correlation coefficients and 5% level of probability was used to indicate statistical significance. **Results:** In females, dominant and non-dominant grip strength have significant positive correlation ($p<0.05$ - 0.001) with height ($r = 0.572, 0.570$), weight ($r = 0.404, 0.411$), hand length($r = 0.39, 0.40$), hand span ($r = 0.44, 0.46$), wrist circumference($r = 0.37, 0.31$) and forearm girth ($r = 0.39, 0.35$). **Conclusion:** The results show that height, weight, hand length, hand span, wrist circumference and forearm girth positively correlate with hand grip strength. Hand grip strength is not associated with BMI and hand breadth in healthy Indian females.

Key words: Hand grip strength, Jamar dynamometer, anthropometric measurements

INTRODUCTION

The human hand is a very complex structure and devoted to the functions of manipulation. It is also capable of relaying sensory information about temperature, shape and texture of the object to the brain[1]. Its effectiveness is due to the ability to perform firm grip, together with highly elaborated nervous control and sensitivity of fingers[2]. Full function and adequate strength of hand are necessary for dealing with demands of daily life. Hand grip strength is used in clinical settings as an indicator of overall physical strength and health[3].

Hand strength has been identified as an important factor predicting disability in musculoskeletal diseases [4], bone mineral density [5,6], and the likelihood of falls and fractures in osteoporosis [7,8].It even predicts complications and general morbidity after surgical interventions [9],general disability and future outcome in older age [10-12].

Hand grip strength can be quantified by measuring the amount of static force that the hand can squeeze around a dynamometer. The force has most commonly been measured in kilograms and pounds[13]. The Jamar dynamometer has been found to give the most accurate and acceptable measures of grip strength[14].

Anthropometric data is very useful in designing functions concerning with human. Without such data, the designs cannot fit the people who are going to use them. Therefore the information regarding the human sizes is essential to be implemented in the design of various facilities. Hand dimensions (anthropometry) is very important and used in designing objects dealing with human hands[15].

Hand grip strength is positively correlated to height, weight, body mass index (BMI) and hand anthropometric measurements in healthy Indian men[16]. The information regarding hand grip strength and anthropometric measurements of healthy women is scanty from India. Since women are the most important source of work force in India, their hand grip strength and anthropometric data are essential in the implements from ergonomic considerations. Keeping these factors in view, a study has been undertaken to generate hand grip strength and anthropometric data of normal adult Indian women and to determine whether these parameters are associated.

MATERIALS AND METHODS

This was a cross-sectional descriptive study and was conducted in post graduate research laboratory at Yenepoya University, Mangalore, Karnataka. Approval was taken from Yenepoya University Ethical Committee prior to the commencement of the study. The data was collected from 50 healthy adult females of age group 20-80 years. Informed consent was obtained from all subjects prior to data collection.

The inclusion criteria in the study was that subjects should be healthy. Subjects were excluded if they reported any neurological or musculoskeletal impairment of upper-limbs, cardiovascular or systemic illness.

Procedure

Healthy females were assessed for the - height (cm), weight (kg), body mass index (BMI) as recommended by World Health Organization (WHO).

Hand dimensions: The precision of the measures was 0.5 cm. The hand length, hand breadth, hand span, wrist circumference and forearm girth measurements were therefore rounded to the nearest whole centimeter.

Measurement of Hand length: Measurements of the hand length was taken in both hands (perpendicular distance) from the tip of the middle finger to the distal wrist crease [17,18] (**figure 1**)

Hand breadth Measurement: Measurements of the hand breadth was taken in both hands from the radial side of metacarpal D2 (index finger) to ulnar side of metacarpal D5 (small finger)[17,18] as shown in **figure 2**.

Measurement of hand span: Hand span was measured in both hands from the tip of the thumb to the tip of the small finger with the hand opened as wide as possible[19] (**figure 3**).

Wrist circumference: Measurement of the wrist circumference was taken for both sides around distal wrist flexion crease[20].

Forearm girth: Measurement of the forearm girth for both sides was taken around the maximum girth immediately distal to the elbow with arm extended in front of the body and palm up[21].

Handgrip strength was measured using a Jamar dynamometer **(figure 4)**. Grip strength is tested by placing the subject in seated position with his arm side, elbow

flexed 90°, forearm in mid-prone position, wrist extended between 0°- 30° & ulnarly deviated 15°. The subject alternatively grips the dynamometer with his dominant and non-dominant hands, performing 3 trials, using different grip spans in random order, allowing a 1-minute rest between the measurements[22-24]. The reported precision of the device was 0.1 kg. For each measure, the hand to be tested first was chosen randomly. For Jamar dynamometer the grip span equivalence for the different positions are as follows: position 1 - 3.5 cm; position 2 - 4.8 cm; position 3 - 6.0 cm; position 4 - 7.3 cm; and position 5 - 8.6 cm.

Statistical analysis

Pearson's correlation coefficients were applied to establish the correlations of dominant and non-dominant hand grip strength with height, weight BMI and hand anthropometric measurements. A 5% level of probability was used to indicate statistical significance.

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RESULTS

In **table 1,** descriptive statistics of age, height, weight and BMI of the subjects is depicted. The data regarding hand anthropometric measurements and grip strength are given in **table 2**.

The dominant and non-dominant grip strength have significant positive correlation ($p<0.05$ - 0.001) with height(r = 0.572,0.570) and weight(r = 0.404,0.411), but not correlated with BMI as shown in **table 3**.

The dominant and non-dominant grip strength have significant positive correlation ($p<0.05$ - 0.001) with hand length(r =0.39,0.40), hand span(r= 0.44, 0.46), wrist circumference (r = 0.37,0.31) and forearm girth(r = 0.39,0.35), but not correlated with hand breadth (r= 0.20,0-25) as illustrated in **table 4.**

DISCUSSION

The evaluation of grip strength is of paramount importance in hand rehabilitation. It assesses the patient's initial limitation and provides a quick reassessment of patient's progress throughout the treatment. In our study 50 healthy Indian adult females were evaluated for grip strength using jamar dynamometer. The mean dominant and nondominant grip strength was observed to be 21.72kg and 19.42kg respectively. The dominant grip strength is stronger than that of the nondominant side and this finding agree with results of Bansal[25]. Grip strength is influenced by factors like age, synergistic muscle action, state of nutrition, cooperation of patient, restricted range of motion, pain and sensory loss[26].

This study investigated the correlation between grip strength and anthropometric variables like height, weight, BMI, and hand dimensions (hand length, hand breadth, hand span, wrist cicumference and forearm girth) in both dominant and non dominant sides. The findings of the study indicates that both dominant and nondominant grip strength positively correlates with all the anthropometric variables except BMI and hand breadth of the respective sides. This finding partially supports and partially contrasts with the findings of Koley etal[27], where in dominant right hand grip strength strongly associated with hand length, hand width, forearm girth and was not associated with height, weight and BMI in 18-25 years aged healthy Indian collegiate females. Both dominant and nondominant grip strength positively correlates with the wrist circumference. This finding is in agreement with that of Ramakrishnan etal[28], where in wrist circumference has a reasonably good correlation with nondominant hand grip strength in both males and females.

LIMITATIONS AND FUTURE SCOPE

Due to small sample size and the type of population used, these results cannot be reflected to the entire population of India. The use of electronic dynamometers should also be considered since this might reduce limitations of the measurements performed with the hydraulic dynamometer mainly due to deviation of wrist position from the optimum one. Various studies which have been reported showed significant differences between rural and industrial communities regarding handgrip strength. Our subjects in this study were from rural setting, so future research should also take urban population into consideration.

CONCLUSION

There are important findings to consider from this study on healthy Indian women. The first finding was that the dominant grip strength is stronger than that of the nondominant side. The second major finding was a clear association between hand grip strength (both dominant and nondominant side) and height, weight, hand length, hand span ,wrist circumference and forearm girth of the respective sides. The last finding was that grip strength was not associated with BMI and hand breadth in both sides. Based on the results of our study, as well as those previously published data on hand grip strength, an international effort for the establishment of coefficients for grip strength evaluation should be the future target. These coefficients should incorporate anthropometric measurements such as height, weight and hand dimensions in order to evaluate the optimal normal grip strength for the postoperative or the post-traumatic hand based on hand dominance and on grip strength of the contra-lateral side.

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Table 1: Descriptive statistics of age, height, weight, BMI

Age group (yrs)	Number (n)	Age* (yrs)	Height*(cms)	Weight* (kg)	BMI*(kg/m^2)
20 – 40	20	28.35 ± 6.65	153.50 ± 6.56	57.05 ± 12.11	24.09 ± 4.56
40 – 60	20	48.60 ± 4.84	153.73 ± 7.45	58.63 ± 9.30	24.71 ± 2.77
60 – 80	10	66.00 ± 3.74	150.05 ± 6.77	54.40 ± 6.82	24.20 ± 3.50

*Values are mean ± SD

Table 2: Descriptive statistics of hand dimensions

	Females (n = 50)	
	Dominant side	Non-dominant side
Hand length*(cm)	17.84 ± 0.94	17.77 ± 0.95
Hand breadth*(cm)	8.02 ± 0.45	8.02 ± 0.45
Hand span *(cm)	18.56 ± 1.13	18.56 ± 1.13
Wrist circumference *(cm)	15.55 ± 0.89	15.24 ± 0.91
Forearm girth*(cm)	23.82 ± 1.69	23.59 ± 1.79
Grip strength *(kg)	21.72 ± 3.87	19.42 ± 3.94

*Values are mean ± SD

Table 3: Correlation coefficient (r) of dominant and non-dominant hand grip strength with height, weight and BMI

		Grip strength (kg)	
		Dominant side	Non dominant side
1.	Height(cm)	0.572**	0.570**
2.	Weight(cm)	0.404*	0.411*
3.	BMI(kg/m^2)	0.140	0.151

Dependent variable- grip strength (*P<0.05, ** P<0.001)

Table 4: Correlation coefficient (r) of dominant and non-dominant hand grip strength with Hand dimensions

	Grip strength (kg)	
	Dominant	Non dominant
Hand length (cm)	0.39*	0.4*
Hand breadth (cm)	0.20	0.25
Hand span (cm)	0.44**	0.46**
Wrist circumference (cm)	0.37*	0.31*
Forearm girth (cm)	0.39*	0.35*

Dependent variable- grip strength (*P<0.05, ** P<0.001)

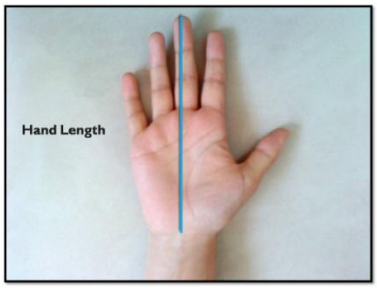

Fig 1. Hand length

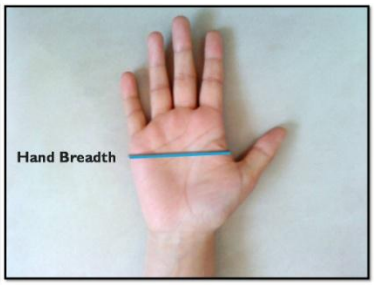

Fig 2. Hand breadth

Fig 3. Hand span

Fig 4. Hand grip strength