Correlation of Forearm Circumference and Hand Length with Grip Strength in Healthy Young Adults

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Abstract

Introduction: Grip strength measurement is used as an indicator for many hand and forearm related orthopaedic injuries as well as in neurological assessment.

Aim: To find whether anthropometric measurements like hand length and forearm circumference have influence on hand grip strength of young healthy adults.

Material and Methods: 198 healthy young adults were used for the study for data collection. Grip strength of both hands were done with hand held dynamometer. Anthropometric measurements of hand length and forearm circumference was done using measuring tape.

Results and Discussion: The result showed that there is statistical significance between hand grip strength and both anthropometric measurements, that is, hand length and forearm circumference.

Conclusions: Hand grip strength has direct correlation with the anthropometric measurement of hand length and forearm circumference. Hence hand grip strength is associated with hand length and forearm circumference irrespective of age and gender.

Keywords: Grip Strength; Forearm Circumference; Dynamometer; Hand Length

Introduction

Human hand is noted for its complex structure and devoted motor function of manipulation and sensory functions of relaying various deep and superficial sensations to the brain [1]. The highly elaborated nervous control, sensitivity of the fingers and the ability to perform firm grip contributes to the sensory and motor efficacies of hand complex. Clinically the overall physical strength and health are done by assessing the hand grip strength. The importance of hand strength has been identified in predicting disability in musculoskeletal diseases and bone mineral density as well as

in likelihood of falls and fractures in osteoporosis [2]. The dynamometer has been found to give the most accurate and acceptable measures of grip strength by quantifying the amount of static force with which the hand can squeeze the dynamometer and is commonly measured in Kilograms or pounds [2].

The information regarding human sizes is essential in designing various facilities and an anthropometric measurement of hand is very important for designing of various objects dealing with human hands. There has been a positive correlation between grip strength

and anthropometrics including hand anthropometric measurements in healthy Indian men [1]. The force applied by the hand to pull on or suspend from objects is called the grip strength, a specific part of hand strength [3]. Objects with an optimum size of around 1 - 3 inches diameter permit the hand to wrap around objects, which are usually cylindrical in nature.

Grip strength is often used in physiotherapy as a specific type of hand strength, purpose of testing, including to diagnose disease, evaluate and compare treatment, to document progression of muscle strength and provide feedback during rehabilitation process as a measure indicating the level of hand function, and also be able to predict a decline in function in old age.

Many factors which includes fatigue, hand dominance, time of day, state of nutrition, pain, cooperation of patients, presence of amputation, restriction of movements, sensory loss are affected by hand grip [4].

Types of grips

Hand grips are divided into the following:

Power grip: There are 3 types:

- a) **Cylindrical:** All fingers are flexed around the object which is usually at a right angle to the forearm and the thumb around the object held.
- b) **Spherical:** All the fingers and the thumb are adducted around the object. Fingers spread apart, palm often not involved.
- c) **Hook grip:** Involve second through fifth finger flexed around an object in a hook like manner. Usually thumb is not involved.

Precision grip

- Tends to hold the object between the tips of the finger and thumb
- Thumb is abducted
- Used in the fine movements and accuracy
- Objects are small or fragile
- No involvement of palm and proximal joints

There are 4 types

1. Pad to pad (pinch)
2. Tip to tip (pincer grip)
3. Lateral prehension
4. Lumbrical grip

Grip strength measurement

Can be measured by using hand dynamometer. Normal value for adult male / female in kg [6]

	Male	Female
Excellent	>64	>38
Very good	56-64	34-38
Above average	52-55	30-33
Average	48-51	26-29
Below average	44-47	23-25
Poor	40-43	20-22
Very poor	<40	<20

Table A:

Methodology and Materials

The subjects for this observational study design were selected by simple random sampling.

The study sample size is 198 subjects and study was done for a duration of three months.

Inclusion criteria

- Apparently healthy individuals both males and females of age between 18 to 24 years
- Willingness to participate

Exclusion criteria

- History of any systemic disorders
- History of any fracture, hand or nerve injury in upper limb
- Pain in the upper extremity
- Post - surgical condition and neurological pathology.

Materials

- Consent form
- Recording sheets
- Hydraulic hand dynamometer
- Inch tape
- Weighing machine
- Stadiometer

Procedure

After clearance from institutions ethical clearance committee, a prior informed consent was obtained from the participants and those who fulfilled the selection criteria were selected among those individuals. Simple random sampling method was used for selection.

Figure 1: Stadiometer.

Figure 2: Electronic Weighing scale.

Hand held dynamometer [5]

Record the participant's hand dominance. Participants were made to be seated in a comfortable chair with back support and fixed arm rest. Participants were informed to keep their forearm on the arms of chair and feet flat on the ground.

When squeezing the dynamometer, participants feet should not raise from the ground and the thumb should be facing upwards with the hand placed at edge of the chair's arm.

Handle should be grasped from one side with thumb and other side with fingers.

Position of red needle on dial should be at "0" when starting the procedure.

Handle should be squeezed tightly till needle stops.

Readings of measurements are taken in kg which is seen in outer dial and total of three readings are taken alternatively for both hands.

Figure 3: Position of patient with hand held dynamometer.

Hand dimension measurements

The measurement techniques of hand dimensions were carried out by using a standard measurement tape as proposed for both hands [7]. Largest and thinnest parts of forearm were taken for forearm and wrist circumference.

Perimeter of the middle part of the hand was considered for palm length. For palm length, distance from the distal wrist crease up to the base of the middle finger and lastly for the hand length, the distal wrist crease to the tip of the middle finger was considered for measurement.

Figure 4: Hand dimensions measurement.

Forearm circumference measurements

With arm extended, measurement of forearm girth was taken where maximum muscle bulk was present in forearm with 3 readings [7].

Figure 5: Forearm circumference measurement.

Statistical analysis

Statistical analysis was done using SPSS 20 and T test was used for statistical measurement for grip strength and forearm circumference and hand length. Statistical method used between grip strength and BMI was ANOVA.

T-Test

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Forearm Circumference Left	25.49	43	4.026	0.614
	Grip Strength Left	24.21	43	10.188	1.554

Table 1: Paired Samples Statistics.

		N	Correlation	Sig.
Pair 1	Forearm circumference left and Grip strength left	43	0.035	0.826

Table 2: Paired Samples Correlations.

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Hand length (Cm) R	19.03	188	1.825	0.133
	Grip strength right	25.21	188	9.975	0.727

Table 3: Paired Samples Statistics.

		N	Correlation	Sig.
Pair 1	Hand length (Cm) R and grip strength right	188	0.366	0.000

Table 4: Paired Samples Correlations.

ANOVA					
BMI	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	614.613	38	16.174	1.175	0.246
Within Groups	2050.595	149	13.762		
Total	2665.207	187			

Table 5: Grip strength left- BMI.

ANOVA					
BMI	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	846.142	39	21.696	1.765	0.008
Within Groups	1819.065	148	12.291		
Total	2665.207	187			

Table 6: Grip strength right- BMI.

Figure 6: Graph representing distribution of male and female participants.

Figure 7: Graphical representation of forearm circumference and grip strength.

Figure 8: Graphical representation of hand length and grip strength.

Results and Discussion

From the results of this study, it is evident that the correlation between forearm circumference and hand grip strength (both right and left) is statistically significant which is similar to the studies by other prominent authors in the past. There is statistically significant correlation between hand length and hand grip strength on both right and left sides.

Physical strength of an individual is measured by assessing the effective muscle contraction. Muscle contraction depends on cross sectional area of muscle and its intensity of recruitment. Individuals with more type II fibres have greater physical endurance. The strength capability analysis is done by asking the individual to perform a particular task like pushing or lifting an object.

The observations are compared with capabilities of a section of population. The quantification of hand grip strength can be done by measurement of static force that the hand exerts on a dynamometer [1].

The grip strength depends on the synergistic forearm flexor and extensor muscle action and its interplay [8]. Movement of the forearm and hand are mostly performed by forearm muscles.

The flexor muscles of the forearm and hand create grip strength while performing gripping activities whereas the stabilization of the wrist is carried by the extensors of the forearm [9].

There was statistical analysis between all anthropometric data and grip strength in both males and females that showed a positive correlation. This finding was similar to the report from study which showed strong correlation between hand circumference and grip strength [10]. Therefore, muscle strength is impaired in obese people due to the sedentary lifestyle and low physical fitness [11]. Also, there was significant correlation with forearm circumference and hand grip strength, the higher the forearm diameter the higher is the grip strength [12].

The fiber diameter of the flexor digitorum sublimis on the flexion contractile ability of the hand influences and explains the correlation between forearm girth and handgrip strength. Consequently, the forearm circumference and hand length can be used as a medium of hand grip strength among young adults [12-27].

Conclusion

Hand grip strength has direct correlation with the anthropometric measurement of hand length and forearm circumference. Hence hand grip strength is associated with hand length and forearm circumference irrespective of age and gender.

Conflict of Interest

No conflict of interest in any matter existed among the corresponding author and other authors.

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