

Original article:

Effect of hand dominance and body mass index on maximal isometric hand grip strength in normal young adults

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Abstract:

The present study was carried out with the aim to measure and compare maximal isometric handgrip strength in dominant and non-dominant hand in right and left handed individuals. The study was done at TNMC & BYL Nair Hospital, Mumbai after approval from the ethics committee. Subjects selected for study comprised of 100 normal, healthy individuals (73 males and 27 females) of age 18-26 years, free of any lesion or impairment in upper limbs. The anthropometric measurements recorded in the above selected subjects were body weight and height and the body mass index (BMI). After taking the measurements, subjects were made to sit comfortably on the chair and hand grip strength was measured by hand held dynamometer. The maximal isometric handgrip strength was measured in the standard arm position in both the dominant and non-dominant hand in right and left handed individuals using a hand grip dynamometer in all the subjects (study group). The maximal handgrip strength in dominant hand (41.75 ± 10.822) as found to be more and that of the non-dominant hand (32.855 ± 9.013) in both male and female study group. Also the results revealed that the maximal isometric handgrip strength in dominant and non-dominant hand in male individuals (46.66 ± 7.97 & 36.12 ± 7.65) were more than that in females (28.49 ± 4.49 & 24.01 ± 6.02). Also when the handgrip strength was compared with the body mass index, no statistically significant difference ($p > 0.05$) was found between BMI and handgrip strength among both male and female study group.

KEY WORDS: Hand grip strength (HGS), body mass index (BMI)

Introduction

Human hand is one of the very important structure which is able to perform wide range of movements, be it gross or skilled. The function of the hand intricately involves the motion, strength, dexterity and motivation. Most of the daily activities involves interaction with objects that are to be grasped in the hand. The manipulative ability of the human hand requires effective force and dexterity.

The power of handgrip is the result of forceful flexion of all finger joints with the maximum voluntary force that the subject is able to exert under normal bio kinetic condition.^{1,2}

Measurement of handgrip strength is measured by hand held dynamometer, which has been found to give the most accurate and acceptable measures of grip strength.

Maximal isometric handgrip strength is a physiological variable affected by age, gender, body size and hand dominance. Also it is fast, easy to perform and is simple to record as well.³

There is a great disparity that exists in literature over relationship between handgrip strength and body mass index. Studies have been shown that if $BMI < 18.5 \text{ kg/m}^2$, is alone sufficient for the diagnosis of chronic energy deficiency (CED) in adults. A low BMI in an adult is indicative of a reduction in body

energy stores. This reduction manifests as a decrease in fat mass as well as lean body mass including muscle. Therefore skeletal muscle function as measured by maximal momentary grip strength can be used for assessment of nutritional status.

Also analysis of grip strength is an important index of hand rehabilitation programme because it assesses the patient's initial limitations and can be compared with normal. Many hand rehabilitation treatment protocols compare the strength of the injured limb with that of uninjured limb. This is useful when pre-injury strength is similar in both the upper limbs. Therefore it is essential to find out differences in handgrip strength between dominant and non-dominant hand of an individual. So the present study was designed to measure and compare maximal isometric hand grip strength in dominant and non-dominant hand in right and left handed individual and its relationship with BMI in a normal young adults of age 18-26years.

Aims and objectives:

- To measure and compare maximal isometric handgrip strength in dominant and non-dominant hand in right and left handed individuals using a hand grip dynamometer in a normal young adults of age 18-26years (study group)
- To compare body mass index (BMI) with maximal isometric hand grip strength in the same study group.
- Comparison of above obtained results and draw conclusions.

Material and methods:

The study population comprised of 100 normal, healthy individuals of either sex of 18-26 years of age and free of any lesion or impairment in upper limbs who fulfilled the following criteria,

- Inclusion criteria :
 - Age between 18-26 years.
 - Healthy individual of either sex.
 - No restriction of movement in upper limbs.

- No history of Rheumatoid arthritis.
- No history of inflammatory joint disease, neurological disorder, injury to upper extremity by self report.
- Exclusion criteria :
 - Age less than 18 or more than 26 years.
 - Smokers.
 - Alcoholics.
 - Pregnant females.
 - Ambidextrous individuals.
 - Pain and aching in their shoulder, arm/hand at rest/when moving- on most of the days of month.
 - Joint stiffness.
 - Complete history and preliminary examinations were done for the subjects.

The procedure was fully explained to the subjects in simple language which he / she could understand and written informed consent for the same was taken. The subjects were called in morning hours after having a light breakfast and the following anthropometric measurements were recorded in the study subjects:

Body weight (kg): was measured by portable human weighing machine. The machine was placed on the plane surface and the subjects were asked to remove heavy outer garments and shoes. Subject were asked to stand erect on the centre of the machine with hands at sides and looking straight ahead.

Height (m): was measured with the help of an anthropometric rod. The subject were asked to remove shoes and stand erect with head straight, feet together on the floor and the vertical distance from the ground to the vertex of the subject was measured.

Calculation of Body mass index (BMI): it was calculated from recorded weight (kg) and height(m).The following formula was used to measure BMI.

$$\text{BMI} = \text{weight (kg)} / \text{height (m}^2\text{)}$$

This was followed by measurement of **hand grip strength** which was measured with the help of a hand held dynamometer. Handgrip strength was measured in both the hands, dominant and non-dominant in every subject. The grip strength of both right and left hands was measured using a standard adjustable digital hand grip dynamometer (Takei Scientific Instruments Co. Ltd., Japan).

Before taking the measurements, subjects were requested to sit comfortably on the chair with straight back, without armrest with the feet flat on the floor, shoulder adducted and neutrally rotated, elbow flexed at 90° , forearm in neutral position, wrist between $0-30^{\circ}$ of extension and between $0-15^{\circ}$ of ulnar deviation.

Subjects were asked to hold the dynamometer in above said position and were instructed to squeeze the dynamometer as hard as possible without moving the body. Thus final grip strength was measured from the dynamometer scale when the pointer no longer moved. Three attempts for each subject was conducted, alternating right and left hands with 1 minute rest between two attempts to overcome the fatigue. Mean of these three trials were taken as the reading. The participants were not provided with any visual or verbal feedback regarding their work intensity.

Parameters studied:

- Handgrip strength in a dominant and nondominant hand.
- Body mass index (BMI)
First sampling frame was prepared. Then selection of every third student was done randomly. The method of analysis was done by z test (standard error of difference between two means). Confidentiality of the data was maintained.

Statistical analysis

The SPSS 8.0 for Windows package program was used for statistical analysis. The data was analysed

using Mann-Whitney U test and student's t test. p values equal to or less than 0.05 were accepted as significant ($p < 0.05$)

Observations and results:

Table 1: The study population comprised of 100 normal, healthy individuals of either sex of 18-26 years of age. This table illustrates the distribution of males (73%) and females (23%) in the study.

Table 2 illustrates the handgrip strength in the dominant and nondominant hand in the study population. The mean \pm SD in the dominant hand in the study population was 41.752 ± 10.822 and that in the nondominant hand was 32.855 ± 9.013 . The difference in the handgrip strength in the dominant and nondominant hand was found to be statistically significant.

Table 3 indicates the body mass index in the study group population.

Table 4&5 shows the hand grip strength in the dominant and nondominant hand in males and females respectively. The handgrip strength in the dominant hand in males and female group was 46.66 ± 7.97 and 28.49 ± 4.49 respectively. The handgrip strength in nondominant hand in males and females was 36.12 ± 7.65 and 24.01 ± 6.02 respectively. There was a statistically significant difference in the handgrip strength in dominant and nondominant hand in both the males and females.

Table 6 indicates the comparison of body mass index and hand grip strength in the dominant and nondominant hand in the study population by Pearson correlation.

Table 7& 8 illustrates the comparison of body mass index and handgrip strength in the dominant and nondominant hand in both males and females. There was no statistical significant difference in either groups.

Results and observations:

Table No 1: Distribution of study group as per gender

Gender	Frequency	Percent
Male	73	73.0
Female	27	27.0
Total	100	100.0

Table No 2: Comparison among study group for Handgrip strength

Handgrip strength	N	Mean	Std. Dev	Median	IQR	Mann-Whitney Test	P value
In dominant hand	100	41.752	10.822	43.165	20.045	2731.5	<0.001
In non-dominant hand	100	32.855	9.013	32.495	11.587	Difference is significant	

Note: Normality Test (Shapiro-Wilk) failed ($p < 0.05$), thus Mann-Whitney Rank Sum Test applied.

Table No 3: Comparison among study group for Body mass index

Body mass index	N	Mean	Std. Dev	Median	IQR	Mann-Whitney Test	P value
Male	73	21.984	21.984	21.984	2.525	847.5	0.286
Female	27	21.186	4.534	21.200	4.000	Difference is not significant	

Note: Normality Test (Shapiro-Wilk) failed ($p < 0.05$), thus Mann-Whitney Rank Sum Test applied.

Table No 4: Comparison among study group for Handgrip strength in dominant hand

Handgrip strength in dominant hand	N	Mean	Std. Dev	Median	IQR	Mann-Whitney Test	P value
Male	73	46.66	7.97	48.00	12.84	63	< 0.001
Female	27	28.49	4.49	28.00	7.27	Difference is significant	

Note: Normality Test (Shapiro-Wilk) failed ($p < 0.05$), thus Mann-Whitney Rank Sum Test applied.

Table No 5: Comparison among study group for Handgrip strength in non-dominant hand

Handgrip strength in non-dominant hand	N	Mean	Std. Dev	Median	IQR	Unpaired T test	P value
Male	73	36.12	7.65	35.66	9.17	7.416	4.38E-11
Female	27	24.01	6.02	22.33	11.02	Difference is significant	

Table no 6: Relationship between body mass index and handgrip strength in dominant and nondominant hand

Parameter	N	Mean	Std. Dev	Pearson Correlation	P value
Body mass index	100	21.77	3.91		
Handgrip strength in dominant hand	100	41.75	10.82	-0.104	-0.131
Handgrip strength in non-dominant hand	100	32.85	9.01	0.302	0.194

Table no 7: Relationship between body mass index and handgrip strength in males

Parameter	N	Mean	Std. Dev	Pearson Correlation	P value
Body mass index	73	21.98	3.67		
Handgrip strength in dominant hand	73	46.66	7.97	-0.326	0.005
Handgrip strength in non-dominant hand	73	36.12	7.65	-0.268	0.022

Table no 8: Relationship between body mass index and handgrip strength in females

Parameter	N	Mean	Std. Deviation	Pearson Correlation	P value
Body mass index	27	21.19	4.53		
Handgrip strength in dominant hand	27	28.49	4.49	-0.072	-0.151
Handgrip strength in non-dominant hand	27	24.01	6.02	0.721	0.452

Discussion:

Maximal isometric hand grip strength is widely used in adults as an indication of strength in fitness testing and seen as a representative of total body strength.⁴ Handgrip strength measurement provides an objective index of the functional integrity of the upper extremity. Dominant hand was defined as the one preferred

for daily activities like writing and eating and for handling heavy objects.⁵ The assessment of handgrip strength assumes importance in a number of situations like is measured in several sport disciplines i.e. lawn tennis, club volleyball, rock climbing, on admission tests for different types of work as police, army/fire brigade and also used in the investigation and follow up of patient with neuromuscular disease of upper limb and to assess impairment and treatment outcome of hand function after surgical intervention. Our study compared the hand grip of dominant and nondominant hand (table 4 & 6). In the present study the hand grip strength in the dominant hand in male subjects (46.66 ± 7.97) was more than that in the nondominant hand (36.12 ± 7.65) and also similarly it was found that the hand grip strength in the dominant hand in female subjects (28.49 ± 4.49) was more than that in the nondominant hand (24.01 ± 6.02). This difference

might be due to use of more muscle and muscular hypertrophy in dominant hand which leads to increased strength in the dominant hand as compared to the nondominant hand. Similar results were observed by Peterson et al their studies.⁶ In our study it was found that handgrip strength in males are significantly stronger than aged- matched females.⁷ Also it was greater in both the dominant & non- dominant hand in males when compared to that in females. The gender difference in grip strength variation might be due to the variation of the activity level in two sexes. In everyday life, it is observed that males performed more physical activities with greater work load as compared to females. On the other hand greater muscle mass may be another contributory factor

Studies have shown that there are strong correlations between grip strength and various anthropometric traits, such as weight, height, hand length and BMI as has been reported earlier by Ross and Rosblad.⁸ It is a physiological variable affected by various factors including age, gender, body size, posture, hand dominance. A general rule is often used to suggest that dominant hand is about 10% stronger than non-dominant hand.^{9, 10}

Handedness inherits genetically, but hand grip strength is affected greatly by nutritional status of an

individual.^{11, 12,13}Hence hand grip strength has been considered as a functional index of nutritional status. However in our study negative correlation was found between handgrip strength & BMI in both males & females.

Conclusion:

We conclude that the handgrip strength is significantly greater in dominant hand compared to non-dominant hand, both in males & females irrespective of them being either right or left handed. This difference may be attributed to the fact that left

Acknowledgement:

A special thanks to Dr Arun Chutani for compilation of data and statistical analysis.

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handed people are temporarily forced to use their nondominant hands for daily activities in this right hand dominant world. Most of the hand equipments are designed for right-handed people, necessitating the increased usage of their nondominant hand by the left-handed population and this may be a potential reason for this difference. A negative correlation was found between HGS & BMI in both males & females.