Correlation between Hand Circumference and Maximum Grip Strength

Muhammad Noman Tasawer[1]*, Ashfaq Ahmad and Sadia Khan[1]

[1]University Institute of Physical Therapy, The University of Lahore, Lahore, Pakistan
*nomanbhatti784@gmail.com

Highlights:

- Maximum Grip-Strength (MGS) is influenced by gender, BMI, forearm and hand circumference.
- Hand circumference is the best predictive of MGS in males and females for right and left hands than forearm circumference and BMI.
- Males have higher BMI, hand and forearm circumference and grip-strength than females.

Abstract:

Grip Strength (GS) is a reliable parameter that reveals general hand condition and to determine effectiveness of treatment protocol. GS is also effective for rehabilitation of hand also for ergonomists as a way of optimizing the requirements of hand tool design.

Objective:

To measure the relationship between hand circumference, BMI, forearm circumference and maximum hand grip strength.

Methodology:

Cross-sectional study design was used. After obtaining informed consent form 62 healthy participants, 40 males and 22 females in the age group 19 to 26 years were recruited. Participants were selected using a non-random convenience sampling method. GS was measured using Jamar Plus Digital Dynamometer. Body mass index, hand and forearm circumference in males and females were measured. Pearson's correlation coefficient test was applied to evaluate the correlation and 5% probability level was applied to specify the statistical-significance.

Results:

Significant correlation between body mass index, hand and forearm circumference with GS. Hand circumference had the strongest correlation with MGS for both hands in males (right r=.771**, left r=.731**) and females (right r=.768**, left r=.737**) Forearm circumference had the moderate relationship with MGS for both hands in males (right r=.631**, left r=.629**) and in females (right r=.639**, left r=.624**). Body mass index had the weakest correlation with MGS in females (right r=.424*, left r=.450*) whereas, males have moderate relationship (right r=.528**, left r=.527**). Males have higher hand grip strength than females for right hand (102.32±13.55, 48.87±7.99) and left hands (93.99±13.09, 42.66±8.29) respectively.

Conclusions:

MGS was influenced by gender, BMI, forearm and hand circumference. Hand circumference is the best predictive of MGS in males and females for right and left hands than forearm circumference and BMI.

Key Words:

Hand circumference, Forearm circumference, Maximum grip strength

Introduction:

Health and appropriate strength of musculoskeletal system is one of the essential components to perform routine movement. Along with routine movement hand grip strength is fundamental to various games and is considered while an ingredient in enhancing action and control.[1] The human hand is a complicated architecture and is most responsible to the purpose of manipulation. It helps in transfer of sensory information about temperature, shape and surface of any object to the brain.[2] Measuring GS is easy, but evaluation of the Hand Grip Strength (HGS) has several

importance that reveal someone's overall health, muscle strength, or even aging.[3, 4] GS is the power of many muscles in the hand and its strength is the strong bending of whole finger joints, with a maximum intentional force. The strength has usually been measured in kilograms (kg) and pounds (lbs), some studies have also used milliliters of mercury (mmHg) and also newton's. Anakwe et al., has observed that relation with hand and lower arm circumference have also been considered to be exceptional sign of HGS[5]. Studies have also confirmed that HGS is changed through position and other anthropometrical characteristics alike ratio of the fat your body contain and hand circumference[6] Gender and age are the two main causes affecting maximum hand grip strength, where gender accounts for the major percentage of the general change.[7]

The anthropometric traits depend on populations and are changed for many ethnic populations. Even for a population of the same ethnic group, some differences in hand dimensions are noticed. Furthermore, the association between GS with interrelated variables is different in many studies.[8] GS testing is used to make decisions for returning those who suffer from local hand injuries back to work and to estimate the amount of bone mineral density.[7,9] GS is of significance to ergonomists as a way of enhancing the demands of workplaces and tools strategy[10] Handheld-dynamometers have been utilized to evaluate muscle power. The Jamar Hydraulic Hand Dynamometer was detected to provide the much precise plus satisfactory measurement of HGS.[11, 12]

Ke Li *et al.*, had done a research in 2010 and concluded that MGS can be forecasted utilizing hand circumference only.[13] Manjunath Hemberal *et al.*, had done a research in 2014 and concluded that the hand circumference had the greatest association with MGS in both genders.[14]Kumar *et al.*, had done a research in 2016 and established that hand circumference is a worthy forecaster of GS as compared to body mass index.[15] There is no published data available on present study in Pakistan. The main purpose of this study is to search the correlation between anthropometrical characteristics like body mass index, hand and forearm circumference with MHGS in normal population. The study will be unique that will try to further characterize and describe the statistically significant anthropometrics variables related to HGS. GS is a reliable parameter that reveal general hand condition and to determine effectiveness of treatment protocol.

Methodology:

Cross-sectional study was done after approval from the Ethical Committee. Sixty two healthy participants including 40 males and 22 females in the age class 19-27 were approached and the subjects signed an informed consent form before contribution. Data was collected through questionnaire planned for the aim of this study which includes socio demographic information like name, age, gender, hand dominance, occupation. Participants with any wrist and elbow joint complications, fracture history, upper extremity abnormalities, hand swelling, any vascular problem, hand edema, any neurological problem. MHGS was counted by asking the participants seated in chair without an arm rest with 90 degrees elbow flexed and with wrist slight extended and slightly deviation on ulnar side. The subjects were asked to grip the dynamometer with maximum force. Three trials for both right and left hands with normal period of one min rest interval between trials were accomplished. The maximum force was sustained for period of two to three seconds and best value out of three was recorded and the result was taken in lbs. The BMI was measured utilizing person's weight in kilograms divided by height in meters squared (kg)/(m)^2.The forearm and hand circumference was measured using flexible measuring tape(cm) and correlated with MGS. The analyses of the data were accomplished by SPSS version 21. An independent-sample t test was applied to

examine the variances among genders. Moreover, paired-sample t test was implemented to analyse strength variability among right and left hands. To inspect the relationship between MGS and other anthropometric factors, Pearson correlation test was used. The correlations were characterized according to Hopkins' scale[16]

Results:

A total 62 healthy participants (40 males 64.50%, 22 females 35.48%) with mean age 21.45±1.73 years, all of the participants were recruited from university of Lahore, Lahore.

Table1 represent the anthropometric characteristics and MGS of the participants. Mean Height of male and female subjects were 5.62±0.30, 5.43±0.18 respectively and have p-value 0.008 which shows statistically significant difference between both genders, males are taller than females.

BMI was significantly greater in males than females (males 23.49±3.71, females 20.96±3.48). Right and left hand circumference were significantly larger in males than females (males 21.11±0.91, females 18.88±1.01), (males 20.75±0.93, females 18.55±0.96) respectively. Right and left FAC were significantly larger in males than females (males 26.54±1.78, females 23.98±2.19), (males 26.02±1.82, females 23.50±2.18) respectively Right hand MGS is significantly larger in males than females (males102.32±13.55, 48.87±7.99). Left hand MGS is significantly larger in males than females (males 93.99±13.09, females 42.66±8.29). There were variations in grip-strength of both hands in males and females; right hand was stronger than left.

Abbreviations SD= Standard Deviation, BMI= body mass index, MGS= maximum grip strength.

*independent sample t test, p-value significant at 0.05

	Gender	Mean ± SD	p-value
Height	Male	5.62±0.3	0.008*
	Female	5.43±0.18	
Weight	Male	69.76±12.19	<0.001*
	Female	55.5±8.85	
BMI	Male	23.49±3.71	0.011*
	Female	20.96±3.48	
Right Hand Circumference (cm)	Male	21.11±0.91	<0.001*
	Female	18.88±1.01	
Left Hand Circumference (cm)	Male	20.75±0.93	<0.001*
	Female	18.55±0.96	
Right Forearm Circumference (cm)	Male	26.54±1.78	<0.001*
	Female	23.98±2.19	
Left Forearm Circumference (cm)	Male	26.02±1.82	<0.001*
	Female	23.5±2.18	
Right Hand MGS (lbs)	Male	102.32±13.55	<0.001*
	Female	48.87±7.99	
Left Hand MGS (lbs)	Male	93.99±13.09	<0.001*
	Female	42.66±8.29	

Table 1: Anthropometric parameters and Maximum Grip-strength of the participants

Table 2 represents the Pearson's correlation of anthropometric parameters with MGS among males. Hand circumference had the highest correlation with maximum grip-strength for both right and left hands in males (right r = .771**, left r = .731**). Forearm circumference had the moderate relationship with MGS for both hands in males (right r = .631**, left r = .629**). BMI had the moderate relationship with MGS in males (right r = .528**, left r = .527**).

	Right HC (cm)	Left HC (cm)	Right FAC (cm)	Left FAC (cm)	Right Hand MGS (lbs)	Left Hand MGS (lbs)
BMI	0.576**	0.595**	0.732**	0.734**	0.528**	0.527**
Right HC (cm)		0.982**	0.744**	0.742**	0.771**	0.734**
Left HC (cm)			0.747**	0.754**	0.766**	0.731**
Right FAC (cm)				0.992**	0.631**	0.626**
Left FAC (cm)					0.632**	0.629**
Right hand MGS (lbs)						0.973**

Table 2: Pearson's correlation between anthropometric parameters with MGS among males
Abbreviations HC=Hand circumference, FAC=Forearm circumference, MGS=Maximum grip strength, BMI= Body mass index.
**. Correlation is significant at the 0.01 level (2-tailed)

Table 3 represents the Pearson's correlation of anthropometric parameters with MGS among females. Hand circumference had the highest relationship with MGS for both hands in females (right r = .768**, left r = .737**) whereas, Forearm circumference had the moderate relationship with maximum grip-strength in females (right r = .639**, left r = .624**). Body mass index had the weakest correlation with MGS in females (right r = .424*, left r = .450*).

	Right HC (cm)	Left HC (cm)	Right FAC (cm)	Left FAC (cm)	Right hand MGS (lbs)	Left hand MGS (lbs)
BMI	0.625**	0.624**	0.852**	0.833**	0.424*	0.450*
Right HC (cm)		0.995**	0.713**	0.693**	0.768**	0.748**
Left HC (cm)			0.715**	0.696**	0.746**	0.737**
Right FAC (cm)				0.995**	0.639**	0.633**
Left FAC (cm)					0.629**	0.624**
Right hand MGS (lbs)						0.961**

Table3: Pearson's correlation between anthropometric parameters and MGS among females
Abbreviations HC=Hand circumference, FAC=Forearm circumference, MGS=Maximum grip strength, BMI=Body mass index.
**.Correlation is significant at the 0.01 level (2-tailed)*. Correlation is significant at the 0.05 level (2-tailed).

Discussion:

Measuring hand grip strength (HGS) is a vital factor for hand rehablitation. It evaluates the patients early limitations and delivers a rapid reexamination of patients progress throughout the management.[17] The current survey was planned to establish the correlation between HGS and other anthropometric characteristics using a standard procedure. The present survey used the third handle-position of the Jamar Plus Digital Dynamometer[18], the anthropometrical characteristics of healthy individuals in the age

class 19 to 27 years were gathered and it revealed that there is significant difference in anthropometrical characteristics of both males and females, overall, male participants(5.62±0.30)are taller than their counterparts(5.43±0.18)and their anthropometrical characteristics are greater than female participants including BMI, hand circumference, forearm circumference. This shows that height, weight, BMI, hand circumference and forearm circumference have significantly influenced by gender. These result correlates well with the findings in earlier studies[20-22] Overall, it can be concluded that anthropometrical characteristics like weight, height, BMI, hand and forearm circumference were considerably different between both males and females.

In this study the maximum grip strength of 62 participants [22 (64.5%) male and 40 (35.5%) female] of mean age 21.45±1.734 years were assessed using a Jamar Plus Digital Dynamometer to inspect correlation between MGS and other anthropometrical characteristics including BMI, hand circumference, forearm circumference. In our research mean maximum hand-grip strength of participants was 83.35±28.355 (lbs) for right hand and 75.78±27.316 (lbs) for left hand. The mean MGS of both right and left hands in males were (102.32±13.55, 93.99±13.09) respectively higher than their counterparts(right48.87±7.99, left42.66±8.29) which is also constant with earlier result[2324] demonstrating that males are constantly stronger than females.

The present study established correlation between BMI and MGS whereas, moderate correlation between body mass index and MGS in males while, correlation was weak between BMI and MGS in females. The previous studies also found the correlation between body mass index and maximum grip-strength [24-26] whereas, no significant association was found between BMI and MGS.[27] The present study illustrates that correlation between MGS and forearm circumference was found moderate in males and females for right and left hands. Previous study results found lower relation between these two variables in both genders[28] whereas, Nicolay and Walker established a strong association between these two variables.[29]

The present study illustrate that there was positive correlation between anthropometrical characteristics like BMI, hand circumference and forearm circumference and maximum grip strength in both genders while, strongest correlation was found between maximum grip strength and hand circumference. This conclusion was related to the report from survey which revealed strong relationship between MGS and hand-circumference[13].

Conclusions:

It can be concluded that MGS is influenced by gender, BMI, forearm and hand circumference. Hand circumference is a best predictive of Maximum Grip Strength (MGS) in males and females for right and left hands than forearm circumference and BMI. Males have higher body mass index, hand and forearm circumference and grip-strength than females.

Recommendations:

As there is no published data available on present study in Lahore so further studies should be conducted to find the correlation of MGS and other anthropometric variables to support the present study results.

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