

## ROLE OF BMI ON HAND GRIP FORCE WITH RESPECT TO GENDER

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### ABSTRACT

*Background and Objectives: Hand Grip Force is due to extreme voluntary force of flexors of fingers. Muscle fatigue causes decline in grip force. We aim to observe the role of Body Mass Index (BMI) in connection to Maximum and Mean Grip Force in young boys and girls of Shalamar Medical & Dental College, Lahore, through Power Lab.*

*Methodology: The duration of this study analytical cross-sectional study was from November 2014 to February 2017. Convenience Sampling Technique was used and thirty participants with equal number of boys and girls were selected. All were between 20-23 years of age and consented after the explanation of the research procedure. They all were with good health and with no history of present illness or on any medication nor involved in any physical fitness training procedures. Power Lab Model 26T along with Hand Grip Transducer as hardware and Lab tutor as software were selected to get Grip Force values for each participant. Direct values in percentages were obtained by following the instructions given on the respective window for recording and calibration. To record weight and height of each subject Adult Weighing Scale ZT-160 was used.*

*Results: Increased Grip Force values was observed in boys compared to girls by > 300% for Maximum Grip Force, > 33% for average grip force and > 58% for maximum grip force just before fatigue. A direct relation was observed between BMI and Grip Force values in boys, although in girls this relation was inverse for Maximum grip force and Grip Force just before fatigue, while direct relation for Average Grip Force values.*

*Conclusion: In boys the BMI was directly proportional to Hand Grip Force. However, in girls, it was in inverse relation with Maximum value and Grip Force values just before fatigue; but directly related with Mean Grip Force.*

*Keywords: Hand Grip Force, Power Lab, Hand Grip Transducer.*

### INTRODUCTION

Hand Grip Force is a unit force exerted by fingers of hand on any object with its contact interface.<sup>1</sup> Anatomically the main players in this pattern of force exertion are flexor digitorum profundus and flexor digitorum superficialis muscles, along with moderate contributions from intrinsic and extrinsic muscles of hand.<sup>2</sup> Maximum Hand Grip Force can be achieved through forceful flexion of all hand digits with their maximum ability to exert voluntary force under normal biokinetic conditions.<sup>3</sup>

Muscle fatigue that caused a progressive loss of maximum hand muscle strength, is primarily denoted to a state of motor insufficiency. Muscle fatigue can also be measured in terms of strength deterioration in muscles of hand<sup>4</sup>. Previously Hand Grip Force was quantified in Newtons<sup>5</sup>, pounds, kilograms and even in milliliters of mercury, while we analyzed and measured grip force on Power Lab in percentages. In the past

Hand Grip Force was measured in terms of entire static force used to compress the traditional dynamometer with hand muscles.<sup>6</sup>

A physiological study based on Australian population, quantified the hand grip strength with standardized technique and positioning of subject through use of conventional hand dynamometer.<sup>5</sup> Power Lab is labelled as a world's first data acquisition system with fast analysis of recorded data, in the all the fields of life sciences including human physiology.<sup>7</sup> This innovative digital technology has two components, a hardware and software containing revised efficient applications for numerous physiological parameters, in which muscle activity is one of them.<sup>8</sup>

The purpose of present physiological study was to compare the Hand Grip Force, in terms of its mean, peak and maximum values just before muscle fatigue, with respect to gender, in young adults via use of Power Lab.

**PARTICIPANTS AND METHODS**

Thirty participants, ranging 20 – 23 years of age, were involved in this study with 15 boys and 15 girls, selected through convenience sampling. Before further proceedings written consent was taken from each participant, also the study was approved from Institutional Review Board. All the volunteers belonged to Shalamar Medical & Dental College.

**Inclusion Criteria**

- Young adults of MBBS Second year Batch 2014-15.
- Boys and girls both.
- With no present medical problem.
- Healthy willing students.
- Right handed dominance volunteers.

**Exclusion Criteria**

- Subject with any medical issue.
- Subject currently doing any endurance fitness exercise.
- Subjects on medication.
- Left handed dominance Subjects.
- Unwilling students.

Power Lab 2005-2007, Model 26T, made by AD Instruments as depicted in Fig. 1, with its Software “Lab Tutor” was used as application tool for recording and calibration of sample record. For height and weight measurements, the Adult Weighing Scale ZT-160 (Fig. 1b) was used.

Muscle Exercise “Grip Force Calibration” was

further followed and the wire of MLT004/ST “Grip Force Transducer” showed in Fig. 2a, was plugged to Input 1 of the main Hardware of Power Lab. Volunteer was asked to hold the transducer in his/her right fist as given in Fig. 2b.

Grip Strength was shown in percentage (%) on y-axis and Time in seconds on x-axis, in the digital graph on the window, when volunteer was asked to squeeze the dynamometer as hard as possible as presented in Fig. 2a, unless and until he/she was fatigued. The values of Maximum Grip Force and also the fatigue point after which the grip force value begin to decline, of each participant was directly obtained from the plotted digital graph. To get Mean Grip Force value, we chose the selected area between two points on wave tracing via cursor then the Mean Grip Force value was automatically appeared on small calibration window.

**Statistical Analysis**

After getting the recorded waves on the digital graph, the labeling was done for the identity of the volunteer as shown in Fig. 2c, also on both axis the adjustment of the scale was done, where required to get accurate values. To calculate BMI of each participant, height in centimeters and weight in kilo grams was also noted.

For more than two groups one way ANOVA (analysis of variance) was applied on the data, using SPSS version 16. Alpha was taken as 0.05 or it could be said that all the values were calculated with 95% confidence. Then finally correlation between the different groups was expressed as p-value (Probability value).



**Fig. 1a:** Power Lab 2005-07, Model 26T, made by AD Instruments. **Fig. 1b:** Adult Weighing Scale ZT-160.



**Fig. 2a:** Volunteer squeezing the MLT004/ST Grip Force Transducer



**Fig. 2b:** Sitting position of the Subject holding Grip Force Transducer



**Fig. 2c** Digital graph showing Mean Grip value on calibration window

**RESULTS**

- We compute the data of only those boys and girls, who are same with respect to their BMI, in order to see any gender difference, we observed raised Maximum Grip Force up to > 300% in boys in comparison to their counterpart girls, all with high level of statistically significant difference (Figure: 3).
- Also the average grip force is said to be 33% high in boys compared to girls with same BMI, and again the difference is proved statistically sound (Figure: 3).
- Similarly the values of maximum grip force just before start of muscle fatigue is 58% high in boys as compared to girls with same BMI (Figure: 3).
- In boys we found a direct relation of BMI and Hand Grip Force i.e. with 12.8% rise in BMI, we observed a 10.6% rise in Maximum Hand Grip Force, a 5.56% rise in Mean Hand Grip Force, while a 9.1% rise in hand Grip Force just before fatigue.
- On the other hand in girls we observed somewhat

different relation between BMI and Hand Grip Force, i.e. a rise of 12.8% in BMI, lead to reduction in Maximum Hand Grip Force by 14.6%, but increase in Mean Hand Grip Force by 6.15% and again reduction of 4.76% in value of Hand Grip Force just before fatigue.

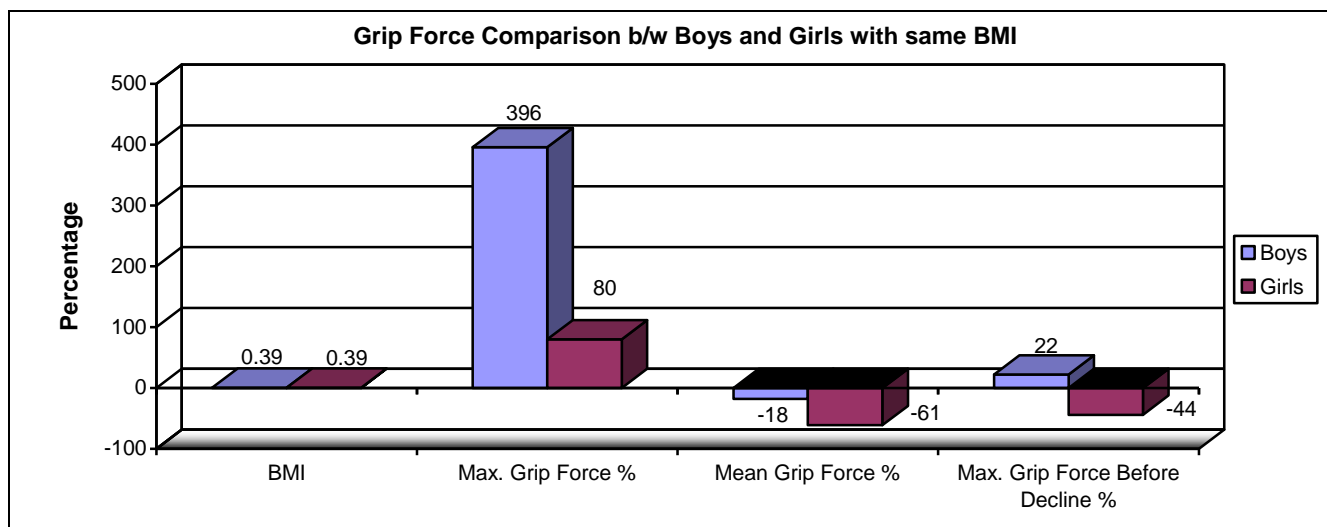
**DISCUSSION**

There are two groups of muscles present in human hand called intrinsic and extrinsic muscles, which extend to digits of each hand<sup>2</sup>. Anatomically when we talk about the origin and insertion of these muscles, specifically the bellies of intrinsic muscles are placed in hand and bellies of extrinsic muscles are present in the forearm. The anatomical structures in digits of hand that may act as a major contributor to their mechanical functioning under tension included as connective tissue in between the fingers<sup>9</sup>, multi-tendon hand musculature especially the extrinsic muscles and overlapping neural cortical projections in respective digits. All of them have a vital connection in isometric hand muscle strength<sup>10</sup> and isometric force can be

**Table 1:** Hand Grip Force Values in Both Gender with same BMI

Variables	Statistical Values	Gender Comparison Groups		P
		Boys	Girls	
BMI (Taken only those boys and girls who have same BMI)	N	09	11	0.0001*
	Mean (± S.E.M)	0.39 ± 0.018		
Max. Grip Force (%)	Mean (± S.E.M)	-18 ± 102	-61 ± 36.2	
Mean Grip Force (%)	Mean (± S.E.M)	396 ± 29.5	80 ± 21.3	
Max. Grip Force just before Fatigue (%)	Mean (± S.E.M)	22 ± 45.6	-44 ± 27	

\*p < 0.05



**Fig. 3:** Gender Based Comparison of Hand Muscle Grip Force, with Same BMI of Boys & Girls on Power lab (p=0.0001).

defined as a static effort against a constant resistance.<sup>11</sup>

Muscle strength also has an influential role in defining hand grip force and it is expressed in terms of complex connectivity between flexors and extensors in each muscle unit of hand.<sup>9</sup> Other contributors of hand grip strength may include age, sex, ethnic background, muscle fatigue, diurnal changes, diet, pain or any anomaly and right or left hand dominance<sup>12</sup> and even change in gravitational forces may change in Hand Grip Strength in both genders along with changes in hemodynamics.<sup>13</sup> Our results also found consistent with the previous studies as BMI showed its own impact with respect to Hand Grip Force in both genders, though there was scarcity in terms of specific values in percentages that showed a numerical number to the degree of BMI in relation to increase in Mean Hand Grip Force value in both Genders. Our study confirmed a positive link with a numerical values, which was a strength of present study. A supportive study concluded that about 10% raised strength was found in dominant hand versus non-dominant one. Another view of researchers said that this value was even more i.e. 12.7% increased hand grip force was found in dominant hand in comparison to non-dominant hand.<sup>3</sup> In the same lines another study concluded that there was an inverse relation between age and Grip Strength<sup>14</sup> and also an inverse relation was present in between age and dexterity<sup>15</sup>. More specifically a survey was reported that in late adult life there was seen a decline in muscle strength in both genders.<sup>16</sup>

Old research also analyzed the same view point that grip strength has been a raised phenomenon in males of all ages in comparison to females. However we also came across a pivotal study that announced fourth decade of life as the age for maximum grip strength in both males and females, afterword it begin to deteriorate in a gradual fashion.<sup>17</sup> Decrease in muscle grip force also connected with depression that was observed by a study on Korean adults.<sup>18</sup> Literature showed disparity in terms of association between hand grip force and BMI (Body Mass Index), as many studies from different ethnicities, ages, genders, work nature and eating habits; announced a positive link between the Hand Grip Force and BMI in both genders and in all age groups, while others explored no relationship between the two variables.<sup>19</sup> Researchers also stated that Hand Grip Force owned a positive connection with the cognitive abilities and a negative connection with BMI.<sup>20</sup>

It is **concluded** that BMI has a direct relation with Average Hand Grip Force in both genders. As with 12.8% increase in BMI, the Boys showed a rise of 5.56% in Average value of Hand Grip Force and 6.15% rise in the Girls.

**Conflict of Interest:** No conflict found amongst authors.

### Authors' Contribution

AS: Design the work, along with its statistical analysis and article Drafting. FM: Critically reviewed the content before submitting. RM: Involved in construction of research work. MA: Assisted in data collection and its tabulation. ZA: Assisted in the organization and tabulation of data. NF: Contributed in compilation of Results.

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