# The effect of forearm rotation and handedness on handgrip strength among Malaysian male youth in sitting position

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**ABSTRACT** – Handgrip strength is related to many factors in determining a human's body health. Handgrip strength (HGS) is correlated with the general strength of the body, which are the upper extremity and also some anthropometric measurements. The objective of this paper study is to find the effect of forearm rotation on handgrip strength in youth males during sitting position. Data from a total of 200 subjects aging from 19-30 years old are collected for analysis. The subjects involved in this study were measured using a standardized protocol that is the ASHT protocol where the instrument used is the JAMAR handgrip dynamometer. The data obtained is analyzed using ANOVA statistical method. The finding states that the handedness, the left handed group was found to have slightly greater HGS as compared to right handed subjects. Forearm rotation also was found to have significant effect on HGS. The analysis shows that for both right and left handed subject, the supination and neutral forearm rotation produced greater HGS than the pronation. Handedness has no effect on HGS produced by subject. As for the conclusion, different forearm rotation and handedness group can affect handgrip strength.

## 1. INTRODUCTION

Handgrip strength (HGS) refers to the maximal isometric force that can be mainly generated by the hand and forearm muscles. Several numbers of daily activities require high involvements of the flexor musculature of the forearms and hands. Different positions of body posture or different angles of the arm provides different amount of handgrip strengths. A valid and reliable evaluation of the handgrip strength data will provide an objective index of the upper body strength.

HGS measurements serve many purposes. It also acts as a nutritional marker of the body lean muscle mass. HGS is correlated with the general strength of the body, which are the upper extremity and also some anthropometric measurements. Not only that, handgrip strength also can act as indicator of sport performances.

The force generated by the handgrip is usually measured in pounds and kilogram, but also in Newton or in millimetres of mercury. The grip strength is measured using the dynamometers. There are many types of dynamometers. However, in this study the Jamar dynamometer was used because it is proven to be the most used in other studies. Thus, by using the Jamar dynamometer, the process of comparing the data with other studies will be much more reliable. When accessing the results of various surgical treatments, a much reliable HGS assessment is proved to be very important. A base guideline of the grip strength value for the population is needed.

Handgrip strength is proved to be very important parameter that can indicate a lot of things, including diseases and performance. A reliable or standardised guideline is needed to enable more consistent measurement of the grip strength and for better assessment. Especially in industries, a reliable guideline is much more needed to ensure the worker's productivity and also to prevent injuries at workplace. Thus, a reliable guideline of the maximum handgrip strength in Malaysian is needed.

Forearm rotation affects grip strength. In a study with 40 volunteers an overall decrease of grip strength was observed when the forearm rotated from supination to pronation [1]. During the pronation, the radius finishes over the ulna and a relative shortening occurs. This probably is the cause of the decreased grip in full pronation. Muscle requires an ideal length to develop a maximal contraction power. Changes in length-tension relationships that may occur as the cause of changing the forearm from supination to pronation, weaker grip is predicted in pronated position compared to the supination position [1].

The difference in strength between the three positions was found to be larger for men as compared to women [2]. As for the endurance time, it is found to be significantly decreased with the rotation of the forearms [3]. Not only have that, forearm rotation also had influence on the comfort level of the subject. The rate of discomfort increased with the deviation in the forearm rotation.

The right and left handgrip strength was found to be positively correlated with the BMI (height and weight) and also the body surface area as stated by Chaudhuri & Chatterjee [4]. Besides, the grip strength in the dominant hand with right handed subjects is reported to be higher according to Incel et al. [5]. The results for the strength of different hands showed that, dominant hand obtained greater grip strength than non-dominant hand [6]. Dominant hands possess 10% greater strength compared to non-dominant hand. The significant different existed is probably caused by participants involves their dominant hand in most of the daily activities. Incel et al. [5], found the difference between the non-dominant and the dominant hand were more significant in right-handed subjects.

## 2. RESEARCH METHODOLOGY

A JAMAR handgrip dynamometer was used to measure the maximum handgrip strength of the subjects. The grip handle of the JAMAR dynamometer was adjusted according to the subjects hand size and comfort. The readings were taken for two times for each hand position (supination, pronation and neutral). Each with around 1 minute rest time between readings. Instructions and demonstrations were given by the researcher prior to the assessment.

The study was conducted for youth of age ranging from 19 to 30 years old. All the subjects were selected based on the inclusion and exclusion criteria of the study. The subjects who had experienced injury on the arm whenever during their entire life is excluded from the study. Not only that, the subjects with history of smoking and alcohol also excluded from the study.

A method used to identify the differences in each groups is the Analysis of Variance (ANOVA). ANOVA is probably the most useful technique in the statistical inference. This method is used to analyse the differences that occur among group means. The observed variance in the selected variable is sectioned into different components attributable to different source of variation. Basically, ANOVA provides statistical test for the hypothesis set by the researcher, whether the means of several groups are equal or not. This ANOVA method is often used to compare three or more means of different groups for their statistical significance.

## 3. RESULTS AND DISCUSSION

### 3.1 Forearm Rotation on Handgrip Strength

This section analyses the data and analysis for the effect of forearm rotation on the HGS produced. The total of 200 subjects were asked to grip the JAMAR handgrip dynamometer in three different positions, the supination, pronation and neutral in sitting position.

Table 3.1 Forces recorded for each category

| | Supination (kg) | Pronation (kg) | Neutral (kg) |
|---|---|---|---|
| Mean ± SD | 26.03 ± 7.14 | 21.35 ± 6.85 | 27.38 ± 7.49 |

From the data shown in Table 3.1, the neutral position recorded the highest reading which is 27.38 ± 7.49 kg of force followed by the supination, 26.03 ± 7.14 kg. The least force was found to be in the pronation position which is only 21.35 ± 6.85 kg. To investigate the relation between the rotation of forearm and the HGS produced, the data obtained is analysed using the one-way ANOVA method as there are only one factor considered. First, the null hypothesis is set such that,

$H_o$ = Forearm rotation will have no effect on HGS
H = Forearm rotation have significant effect on HGS

Table 3.2 Determination of F-values and p-value

| | |
|---|---|
| F-critical | 3.03 |
| F-score | 14.16 |
| p-value | $1.63 \times 10^{-6}$ |

Based on the Table 3.2, it can be seen that the F-score (14.16) is much larger than the F-critical value (3.03). It falls on the rejection region. Thus, this indicates that the null hypothesis is to be rejected. The forearm rotation was found to have significant effect on HGS. Another reason to reject the null hypothesis is by looking at the p-value. The p-value calculated in the analysis is much more less than the alpha value, which is $1.63 \times 10^{-6}$ as compared to 0.05. Thus, the null hypothesis is rejected, proving that forearm rotation does have influence on the HGS produced by subjects.

### 3.2 Dominant Hand on Handgrip Strength

As can be observed that the right handed subjects dominates the population of the study with 124 people while the left handed subjects only consists of 76 people. Table 3.3 shows the readings on the HGS recorded and categorized based on the handedness of the subjects.

Table 3.3 Handedness and respective HGS in all forearm rotation

| | Supination (kg) | Pronation (kg) | Neutral (kg) |
|---|---|---|---|
| Right Handed | 26.13±5.31 | 22.13±4.90 | 27.93±5.16 |
| Left Handed | 26.95±7.55 | 21.95±7.26 | 28.26±7.97 |

It can be seen that in supination position, the right handed is lesser than the left handed subjects with 26.95±7.55 kg as compared to 26.13±5.31 kg of HGS. Neutral position also shows the same finding which is the left handed is greater than the right handed subjects with 28.26±7.97 kg compared to 27.93±5.16 kg. However, in pronation position different results is obtained, right handed subjects leads the left handed subjects in HGS reading with 22.13±4.90 kg as compared to 21.95±7.26 kg.

In order for further analysis, the data of handedness correlation with the forearm rotation is analysed using the two-way ANOVA method. All the calculations provided below is auto-generated using SPSS software. For this analysis, the confidence level was set to be 0.95 and 0.0001 tolerance level. The hypotheses are set for the test such as:

Case 1:
$H_o$ = Handedness has no effect on HGS
H = Handedness has significant effect on HGS
Case 2:
$H_o$ = Forearm position has no effect on HGS
H = Forearm position has significant effect on HGS
Case 3:
$H_o$ = Handedness and Forearm position correlation has no effect on HGS

H = Handedness and Forearm rotation has significant effect on HGS

Table 3.4 Two-way ANOVA summary results

| | Sum of squares | Mean squares | F | Pr > F |
|---|---|---|---|---|
| Handedness (Case 1) | 0.495 | 0.495 | 0.009 | 0.923 |
| Forearm Rotation (Case 2) | 929.249 | 464.624 | 8.804 | 0.000 |
| Handedness and Forearm Rotation (Case 3) | 5.033 | 2.516 | 0.048 | 0.953 |

Based on the ANOVA summary in Table 3.4, it can be concluded that the first hypothesis failed to be rejected. The handedness of the subject was found to have no significant effect on the HGS. However, it was found that the second hypothesis is rejected, proving that forearm rotation have significant effect on the HGS produced. For case 3, the correlation between the two, the analysis proved that there exists no correlation between handedness and forearm rotation in the subject's tested.

## 4. SUMMARY

The forearm rotation correlation with HGS is positively significant in the underweight, normal weight and the obese weight category. The finding shows that the amount of maximum HGS produced increases as the forearm changes position from pronation, supination and neutral. In all BMI categories, the neutral position recorded the highest reading while pronation position recorded the least. This agrees with De Smet et al. [1], studies that stated during the pronation position, the radius finishes over the ulna and that leads to the shortening of muscle occurs. It is probably the cause of the decrease in HGS produced. The result of the study is opposite of Farooq and Ali Khan [3] findings that stated the trend was decreasing as forearm changes position from pronation to supination. The current study found that the trend is increasing as the forearm changes from pronation to supination. This study agrees with Nadzalan [6], where the HGS were the weakest in the pronation position.

The findings are important because it identifies the maximum HGS produced in various BMI, forearm rotation and handedness of subjects. Based on the analysis, the objective of the study is achieved. However, the limitation of the study is that the number of participants are quite small, which are only 200. Thus, the data obtained may be less accurate. In the future studies, it is suggested that more subjects may be included in order for the analysis to be more accurate.

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