

INVESTIGATION ON YOUNG ADULT HAND GRIP STRENGTH

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ABSTRACT

It is believed that exposure to whole-body vibration (WBV) may increase seated occupant drowsiness and seated. The purpose of this paper is to investigate the strength of the hand grip among the young adults in Malaysia. Also, to examine the correlation between anthropometry factors such as hand length (HL), hand breadth (HB), wrist circumference (WC) and body mass index (BMI) with average full hand grip strength of young adults. 40 Malaysian young adults with equal females and males and the range age of 23 to 28 years old voluntarily basis participated in this study. Three experiments were conducted in sitting position according to American Standard Hand Therapist (ASHT) with 45°, 90° and 135° of hand flexion using dynamometer. The results show the significant different full hand grip strength between Malaysian young adult females and males, the difference full hand grip strength for different hand flexion angles in sitting position and difference correlations between anthropometry factors and full hand grip strength for both young adult males and females.

Keywords: Hand grip, hand muscle, young adults

INTRODUCTION

Human hand grip strength is measured by the amount of static force that a hand can squeeze around a dynamometer commonly being quantified in kilogram, pounds, and millilitres of mercury or Newton. Hand grip strength is interpreted as a reliable measurement by using a standard and appropriate method with calibrated equipment. Repeated measures with standard positioning, instruction and hand grip strength calculation were executed.

Published normative data for hand grip strength are available from many regions such as West Bengal, India¹, Kartaka, India², South Africa, Africa³, Turkey⁴ and Australia⁵. The existing data from previous studies are classified into age and gender subgroups. Analysis of hand grip strength by gender shows higher grip by male at all ages, and analysis by age group demonstrate a peak of grip strength among 40 years old, then gradually decline for both gender⁵. Grip strength is a predictive value to other health condition, although it is not a causative reconciliation. However, proved existing studies relating to the hand grip strength focused on gender groups in wider range of age classification which open the opportunity to study the hand grip strength for smaller range of age group such as young adults. The study on small age range would produce significant effect for product design considerations.

A disparity occurs in the literature over a correlation of hand grip strength and BMI whereby many researchers claimed a positive

correlation upon hand grip strength and BMI such as reported by Dhananjaya et.al⁷ and Günther et.al⁸ while some researchers found no correlation such as reported by Luna et. al⁹ and Lad et.al¹⁰. Hand grip strength is found to have no correlation to physical frailty although the body mass index (BMI) and arm muscle circumferences were eliminated such as reported by Masy et.al⁶, Roberts et.al¹¹. There are many studies of hand grip strength for adults in Malaysia such as from Keevil et.al, Kamarul et.al, Moy et.al and Shahid et.al¹¹⁻¹⁴ but difficult to search and almost none on correlation between hand grip strength and other anthropometry data such as hand length (HL), hand breadth (HB) and wrist circumference (WC) among Malaysian young adult population.

The aim of this study is to investigate and analyse the recent data of hand grip strength among the young adults population in Malaysia. Next is to describe normative data of hand grip strength for Malaysian young adult population by establishing grip strength parameters such as HL, HB, WC and BMI correlation upon full hand grip strength performance using a dynamometer. The study also will investigate the full hand grip strength using different types of hand flexion angles in sitting position.

STATE OF THE ART

Hands are important body part to conduct various handling, pushing, pulling, gripping, carrying and lifting activities. Lam et.al reported that poor handling interaction between product or workstation and human could lead to low

operation performance, risk the individual health and contribute to accident and poor safety as well¹⁵. There are many factors that influencing the hand grip strength such as health status, gripping time, age, gender, dietary status, hand movement, muscle activities and torment as suggested in Swanson et.al¹⁶.

Hand grip strength data is important in medical field such as indicator for body healthy, diagnose disease activity, proposing suitable treatment according to hand and recording muscle movements as studied by De et.al¹. In addition, Putz found that hand grip strength also shows the fatigue seriousness¹⁷. In engineering application, Abdullah found that hand grip strength data is important to be accounted in developing and designing product, workstation, process and the related system to ensure the zero-working risk during machine- human interaction¹⁸.

The grip strength according to the posture and body joint angles and the maximum grip strength for optimal body posture and joint angle among 156 males and 224 females Bengalee adults with age range of 20 to 60 years old was examined by De et.al¹. The study found that Bengalee males had a significantly greater ($p < 0.001$) grip strength compared to that of Bengalee females. Also, the maximum grip strength was obtained in standing posture with elbow angle of 90° in both Bengalee adult males and females. While Salam et.al² conducted an investigation to search the correlation between grip and pinch strength with body mass index among dental professionals in Karnataka, India. The study among 150 Indian professional dentals with range age of 22 to 40 years belong to both genders showed that there was a significantly weak positive correlation of body mass index with grip strength with r was equal to 0.233. Next, Ramlagan et.al³ examined the hand grip strength in associated with social and health differences among 50 years old and above of 3840 South Africans.

The results from the study showed the mean overall of hand grip strength for African men with mean age 61.1 years old was 37.9 kgs while 31.5 kgs for African women with mean age 62.0 years old. It also reported that greater grip strength among African men was associated to greater height, not being underweight and lower functional disability while among African women, the greater grip strength was associated to greater height, better cognitive functioning, and lower functional disability. In another research, Ekşioğlu⁴ studied the gender and age specific reference values for isometric hand grip strength of 128 males and 83 females' age between 18 to 69 years of Turkey population with special regard to occupational demand. The study found that mean and standard deviation of maximum static grip strength values for dominant and non-

dominant hands respectively were 455.2 ± 73.6 N and 441.5 ± 72.6 N for Turkey males, and 258 ± 46.1 N and 246.2 ± 49.1 N for Turkey females. The mean Turkey female strength was about 57% of the Turkey mean male strength value for both dominant and non-dominant hands. There was a curvilinear relationship of grip strength to age, significant differences between genders, hands, and some age-groups, and a correlation to height, body-mass, BMI and hand dimensions depending on the gender. The similar scope of study also conducted by Shahida et.al¹⁴ to determine the relationship between anthropometric dimensions and hand grip strength among elderly Malaysians with mean age was 66.98 years.

The results showed that there was a significant correlation between the anthropometric dimensions such as stature, sitting hip breadth, wrist circumference, hand circumference and heel ankle circumference and hand grip strength. Finally, Massy et.al⁵ reported a normative data of hand grip strength among 20 years and above of 1314 Australian men and 1315 women. The results showed that participants with range age of 20 to 29 years produced 28 to 45 kg hand grip strength with the strength variations based on gender, right hand and left hand. After examined the previous studies, there is opportunity to emphasize a study of hand grip strength among young adults because the existing and current investigations examined wider range of adult age i.e. 18 to 70 years old which produce the general results instead of specific data for target age sample and adult group. Even the study by Nicola produced results for young adult hand grip normative data for the age of 20 to 29 years, but the physical difference between Australian and Malaysian would give significant different between two studies.

According to Neugarten et.al¹⁹ young adults are classified to 18 to 22 years for males and 18 to 24 for females while Petry²⁰ referred young adults as people in group age of 18-35 years. Walder²¹ reported in his study that young adults were belonging to 17 to 40 years based on conception of adults' development. Therefore, this study considered the group age of 23 to 28 years as young adult according to thus researchers.

METHODS

This investigation was conducted among 20 young adult males and 20 young adult males. This small sample is enough to produce significant study as supported by Jason et.al²² and Fagarasanu et.al²³. The range age of the participants is between 23 to 28 years old. All participants are belonging to Asian people and Malaysian citizenship. The participants also free from musculoskeletal-related medical history in

order to obtain the results that free influenced by health factor. All participants are voluntarily basis.

An electronic handgrip dynamometer with the maximum measurement for isometric forces up to 90kg/200lb and its sensitivity 0.1kg/0.2lb was used in this study to measure the hand gripping strength. An electronic weighing scale was used to measure the weight of participants and height measuring scale to measure the participants' height in order to calculate their body mass index (BMI). The hand length, breadth and wrist circumferences of the participants were measured by using tape measurement.

Participants were briefed regarding the study objectives and the investigation procedures. Then, participants were instructed to take a full meal before participating the experiment as conducted by Ekşioğlu⁴.

Next, participants were interviewed by facilitator in order to obtain the demographic and health information followed by data collecting activities on participants' weight, height, hand breadth, hand length and wrist circumference as shown in Figure 1.

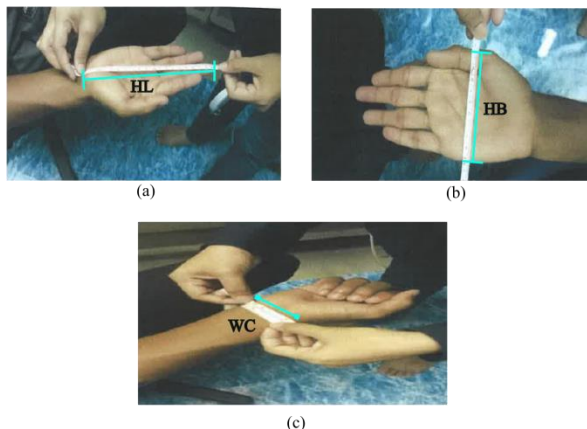


Figure 1: Measurement on (a) Hand length, (b) Hand breadth, (c) Wrist circumference

BMI for each participant was calculated according to Hutasukut and Ryoto²⁴ based on participant's weight and height. The measurement of participant's hand breadth was obtained by measuring the length between radial and ulnar metacarpals where the metacarpal heads from the second to fifth metacarpal while the hand length was measured from the line of middle finger to styloid process as referred to Shurrab et.al²⁵. The wrist circumference was measured at the styloid process of the radius and ulna, with outstretch of the hand using the measurement tape as referred to Shurrab et.al²⁵.

Next, before the maximum hand gripping strength was investigated, the temperature of the experiment room had been set up to 22°C with normal humidity (40- 60%) for all

participants to avoid disturbance factors such as demotivated, outperform, competition, noise and spectators as conducted by Ekşioğlu⁴. The experiment was conducted in three modes of hand postures angles which were in 45°, 90° and 135° as shown in Figure 2. For every experiment mode, the participants was asked to be sit on a provided chair that was set up according to American Standard Hand Therapist²⁵ to avoid the awkward sitting posture as shown in Figure 2. Then, the participants were asked to grip the handgrip dynamometer according to their comfortable griping to calibrate the dynamometer.

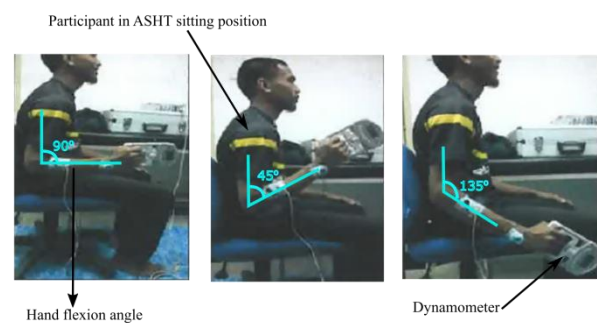


Figure 2: Experimental setup in investigating the hand grip strength among young adults

Next, the participants were instructed to grip the dynamometer using maximum strength to obtain the maximum hand gripping strength data for each determined hand posture angles. Two minute rest time was given to participant in between tested gripping modes. Generally, the experiment was taken approximately one hour per participant to be completed.

Finally, the hand grip strength data was recorded in commercial software and correlation analysis was conducted by using Minitab 17 software to study the significant correlation between the hand gripping strength for every hand flexion angles and the HL, HB and WC.

RESULTS

Figure 3 illustrates the results of average full hand grip strength for young adults. The results show that the full hand grip strength among young adult males for all hand flexion angles are higher than young adult females full hand grip strength for almost twice with 15.7 kg for 45°, 22.3 kg for 90° and 19.1 kg for 135°. Highest hand grip strength produced by young adult males during 90° hand flexion with 49.6 kg and the lowest is during 45° hand flexion with 43.8 kg. However, young adult females' highest hand grip strength is 28.3 kg during 135° hand flexion and the lowest hand grip strength is 27.3 kg during 90° hand flexion.

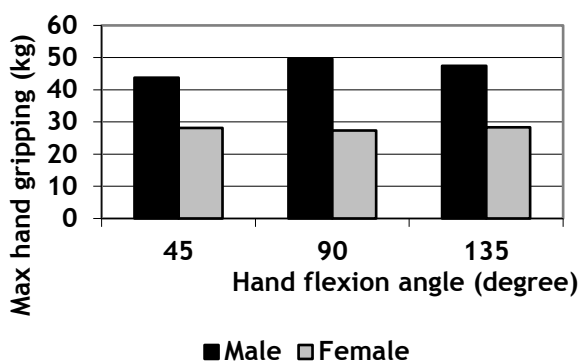


Figure 3: Results of full hand grip strength of young adults male and females

Table 1 summarizes the correlation coefficient, R between hand length (HL), hand breadth (HB) wrist circumference (WC) and body mass index (BMI) and the average full gripping strength of different hand flexion angles among young adults. The results for 45° of hand flexion shows that the full gripping strength for the young adult male participants are moderately correlated to the HL and the WC with the R-value is 0.5881 and 0.5085 each while for the young adult females, the full gripping strength is associated to the HB with R-value is 0.5456. The BMI factor is contributed to the weak correlation to the hand grip strength of young adults both for males and females with the R-value is 0.1884 and 0.2254 each.

The correlation results between HL, HB, WC and BMI and the full hand grip strength of 90° hand flexion shows the same pattern as 45° of hand flexion angle for both young adult males and females.

The correlation results for 135° of hand flexion angle shows that HL, HB and WC has weak correlation to the young adult males' full hand grip strength while HB has moderate correlation to the young adult females' full hand grip strength with R-value is 0.4903. However, most participants claimed that 135° hand flexion is the simplest posture among three postures. The BMI factor also has weak correlations with the full hand grip strength in this 135° hand flexion result.

Table 1: Results of correlation coefficient(R) between hand length (HL), hand breadth (HB) wrist circumference (WC) and body mass index (BMI) and the average full gripping strength of different hand flexion angles of young adults

Anthropometry / Gender	R-value	
	Male	Female
	45°	
HL	0.5881	0.1448
HB	0.2829	0.5456
WC	0.5086	0.2444
BMI	0.1884	0.2254
	90°	
HL	0.5881	0.1448
HB	0.2829	0.5456
WC	0.5086	0.2444
BMI	0.1884	0.2254
	135°	
HL	0.2923	0.1700
HB	0.1146	0.4903
WC	0.1326	0.3329
BMI	0.1795	0.2637

DISCUSSION

This first aim of this study is to investigate and analyse the recent data of hand grip strength among the young adults population in Malaysia. The results in this study found in agreement with other studies [1,2,3,4] that males produce 35 % to 40% more full hand grip strength than females in general. This study also proves that the different hand flexion angle does affect the full hand grip strength value in the range of 2.2 to 5.8 kg for young males and 0.2 to 1.0 kg for young females. However, the highest full hand grip produced by females in different hand flexion angle i.e. 90° compare to the females i.e. 135° which require further study on the factors that effect this finding.

The second aim in this study is to describe normative data of hand grip strength for Malaysian young adult population. The results in this study considered novel because the previous studies did not conduct the similar correlation investigation. It is found in this study that HL and WC moderately influences the young males' full hand grip strength during 45° and 90° while the different anthropometry factor i.e. HB moderately influences the young females' full hand grip strength. In the other hand, BMI almost does not influence the full hand grip strength for both gender and both hand flexion angles. It is also found in this study that different hand anthropometry influences the full hand grip strength value for both males and females in 135° hand flexion angle. The full hand grip strength almost unrelated to the HL, HB, WC and BMI of young Malaysian males. However, HB moderately influences the Malaysian females' full hand grip in this study. Further investigation is recommended to investigate this finding in

order to understand in detail the reasons behind the data and finding.

The results in this study are significant in the human factors and ergonomics field by contributing the technical data for designing a product such as lifting mechanism²⁶ and working activities such as controlling a joystick to operate remote container crane¹⁸. Hand grip strength data also important in engineering application and product design and development because gripping activity is common and frequent action in handling objects and operations. Proper amount of hand grip strength will contribute many benefits to operators' health condition and safeties i.e. avoiding upper and lower body pains, reduce awkward posture risk, reduce working hazard, increases working performance and increase task ease¹⁷.

CONCLUSION

The objective of this study is to examine the hand grip strength among the young adults in Malaysia. 40 participants with range age of 23 to 28 years old had been voluntarily participated in the experiment. The experiments were conducted in sitting position with three different hand flexion angles i.e. 45°, 90° and 135° using the handgrip dynamometer to obtain the hand grip strength data. The first results show that young adult males produced higher hand grip strength during all hand flexion angles in sitting position compare to young adult females. Young adult males produced highest hand grip strength which is 49.6kg during 90° of hand flexion while young adult females produce highest hand grip strength which is 28.3 kg during 135° of hand flexion. The second results show that HL and WC has moderate correlation to the young adult males' hand grip strength during 45° and 90° hand flexion while HB has moderate correlation to the young adult's females' hand grip strength during all hand flexion angles. Finally, BMI has weak correlation with both young adult males and females hand grip strength during all hand flexion angles in sitting position. Further investigation on muscle activities related to the hand grip strength in multiple hand flexion angles should be conducted in future in order to understand the relationship between the hand grip strength and the related muscle activities.

ABBREVIATIONS

HL-Hand length, HB-hand breadth, WC-wrist circumference, BMI-body mass index, ASHT-American Standard Hand Therapist.

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COMPETING INTERESTS

There is no conflict of interest.

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