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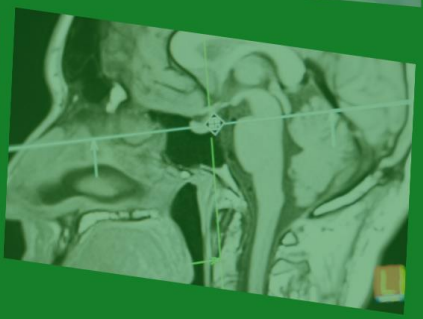

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Preliminary Study on Normal Grip Strength Values among Selected Healthy Filipinos in Batangas City: A Pilot Study

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Abstract

Grip strength is recommended as a simple measurement of hand muscle strength and is an important predictor of physical outcomes. However, there is no study about normative values for grip strength among Filipinos. The objective of this study is to conduct a pilot study in establishing grip strength value of selected healthy Filipino individuals in the localities of Batangas in the event of bilateral affectation of the upper extremity. This study used Jamar Analogue Hand Dynamometer which is considered as the gold standard assessment tool for grip strength measurement with good reliability (ICC = 0.94 – 0.98) to test grip strength among 720 healthy Filipino individuals (362 males and 358 females), aged 12 to 65 in Batangas City. Proportional stratified sampling was used to analyze the data. The results demonstrated consistent results with other studies in trends observed as for age, gender, hand dominance, height, weight, and BMI. An average grip strength value was obtained within the sample however, it cannot adequately represent the norm for the community being studied considering the high variability of the data. The researchers recommend further research using larger sample to limit the variability of data.

Keywords: grip strength, hand dynamometer, healthy Filipinos

INTRODUCTION

Health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity as defined by the World Health Organization (WHO) (Sartorius, 2006). Hand grip strength is used as a functional measure of the integrity of upper extremity (El-Sais & Mohammad, 2014). It is suggested as an effective and simple means to measure the strength of muscle in standard conditions and it is proven that the dominant hand compared to the non-dominant hand is 10% stronger (Roberts et al., 2011). According to Kubota and Demura (2011), maximal handgrip is found in young dominant hand than non-dominant hand as to laterality and gender differences. Moreover, it is significantly greater in the dominant hand at all ages consistently (Lam et al., 2016; Kubota & Demura, 2011). Regardless of gender and age, muscle strength of grips in the dominant hand exhibited higher mean values than those of the non-dominant hand (Kubota & Demura, 2011). Several studies revealed a significantly higher value obtained from the dominant hand, especially those in right-handed participants, although one study documented that there is no significance with left-handed individuals (Bansode, Borse, & Yadav, 2014; Incel et al., 2002). Grip strength is sensitive to age-related changes (Forrest et al., 2012; Gerodimos, 2012), height and weight (Simmonds et al., 2015; Hemberal, Doreswamy, & Rajkumar, 2014; Roberts et al., 2013; Inskip et al., 2007). Age is one of the vital factors to consider in grip strength value. Grip strength is at its peak during early adult life and gradually declines as the age increases for both genders with the youngest age group having the greatest hand strength. Both males and females have an increase of age-dependent handgrip strength and were found to have a strong association with the muscle mass changes during their childhood. (Gerodimos, 2012; Massy-Westropp, Gill, Taylor, Bohannon, & Hill, 2011; Incel, Ceceli, Durukan, Erdem, & Yorgancioglu, 2002). Hand grip strength increases directly proportional to height and weight (Inskip et al., 2007). The standard weight and BMI typically changes and varies with the race of an individual. The WHO sets the BMI of >25kg/m² to be overweight and >30kg/m² as obese while 18.5 – 25 kg/m2 is said to be the normal range for the general population. Both genders and ages claimed a positive relationship between grip strength and BMI according to several researchers. Increased grip strength were associated with greater body mass index. (Forrest et al., 2012). Testing positions can affect the results of hand grip testing (El-Sais & Mohammad, 2014; Liao, Wang, Yu, Chen, & Wang, 2014). Fully extended elbow shows significantly greater grip strength

compared with the elbow fully flexed to 90° (Liao et al., 2014). Roberts et al. (2011), cited that the American Society of Hand Therapists (ASHT) recommends standardized positioning in which the participant is comfortably seated, with shoulders adducted and neutrally rotated, elbow flexed at 90°, forearm in neutral and wrist between 0 and 30° extension. This standard protocol will likely increase the validity of the assessment procedure. Dodds et al. (2016) mentioned that the average grip strength measurements among emerging countries such as Africa, America (except for North America), and Asia (excluding Japan) were considerably lower as compared with developed world regions such as Australia, Europe, Japan and Northern America. Creating baseline measurements, appropriate treatment plan and evaluation of effectiveness of treatment can be determined through grip strength measurement (Meek, 2015). Hand grip strength is measured by producing a static force directed to dynamometer (Hemberal et al., 2014). Hand dynamometer is used to investigate the accuracy of estimation of grip forces used during hand tool tasks (McGorry, Dempsy, & Casey, 2004). It uses a mean value on the strength of three consecutive measurements, thus, obtaining a quantitative measure of the maximal isometric muscle strength of the hand (Ferreira et al., 2011). Majority of the studies conducted about establishing baseline grip strength is mostly from the Western and American countries (Hogrel, 2015). Western countries have already established their baseline for the measurement of grip strength. Since Filipino individuals have a smaller body size, cell mass, decrease total body potassium, excrete less creatinine and fewer amount of fat free weight as compared to Western individuals, there will be difference in terms of hand grip due to the above factors (Novak, 1970). This study aimed to investigate the normal grip strength of healthy Filipinos in local communities in Batangas

MATERIALS AND METHODS

Research Local

The research study was conducted in the local communities of Batangas City particularly Barangay Kumintang Ibaba, Balagtas, and Alangilan. The said communities were chosen secondary to the number of healthy individuals found in the feasibility study.

Research Design

This study utilized a proportional stratified sampling study since it utilized the factors affecting grip strength and grip strength measurement.

Sampling Design

This study used proportional stratified sampling design to ensure the equal distribution of the participants according to age bracket within the sample of 720 participants.

Participants

A total of 720 healthy Filipino participants were selected. It was divided into two groups namely: male (n=362) and females (n=358), aged 12 to 65 years were recruited in the communities of Batangas. The participants were randomly selected and categorized into age groups specifically the following: adolescent (10-19 years old), early adult (2-40 years old), middle adult (41-60 years old), and late adult (61-65 years old). Prior to the conduct of the study, a feasibility study was made among 100 participants in the following barangays: Kumintang Ibaba, Balagtas and Alangilan. After gathering all the participants, the researchers conducted proportional stratified sampling. All the participants were asked to sign an informed consent explaining the benefits and possible risks of the study. Later, they were asked to fill up the demographic sheet provided by the researchers in order to determine if they were able to meet the inclusion criteria. Those who met the inclusion criteria were considered qualified participants.

Participants were chosen based on the following inclusion criteria (Liao et al., 2014): within the accepted standard body mass index (18.5 – 25 kg/m2); no significant medical diagnosis affecting both upper extremities such as carpal tunnel syndrome, rheumatoid arthritis, and fracture; no history of psychiatric or neurological dysfunction; can independently ambulate; and can follow commands.

The following were considered exclusion criteria: failure to give written informed consent; failure to hold the dynamometer; those who have terminal phase of illness such as cancer; with known history involving the neurologic or orthopedic systems that may possibly affect the grip strength, with present pathology or injury to the upper limb or cervical region; those that had discomfort or reports of aching in their shoulder, arm or hand in relaxed state or when moving which last for several days or at the minimum of a month; and have sensory or cognitive impairments.

Instruments

The materials used include researchers-made survey questionnaire and Jamar Analogue Hand Dynamometer (Fig. 1). The

survey questionnaire consists of demographic data of participants' profile as to age, gender, height, weight, hand dominance, and pertinent medical history related to the upper extremities. The Jamar hand dynamometer is considered the gold standard and most widely used as compared to other dynamometers (Hogrel, 2015; Roberts et al., 2013). The Jamar displays grip force in both pounds and kilograms, with a maximum of 200 lbs (90 kg) with an interval of 2 kg or 5 lbs which allow the assessment to the nearest 1 kg or 2.5 lbs. To make the indicator move it requires 3–4 pounds of force, which may be inappropriate when measuring grip strength in very weak patients. It has a peak-hold needle that retains the maximal reading automatically until reset. The handle is adjustable in order to fit for individuals with different sizes (Hogrel, 2015). It is relatively small and portable but heavy with 1.5 lbs. It reads force in both kilograms and pounds and has good inter-rater reliability (reliability; ICC = 0.94 – 0.98) and test-retest reliability (r>0.80) (Peolsson, Hedlund, &Öberg, 2001).

Figure1. Jamar Analogue Hand Dynamometer

Procedure

The procedure utilized the recommended testing position by ASHT. Prior to the actual testing procedure, the correct position in holding the handle of the dynamometer was demonstrated by the examiner. The participants were seated on a standard chair without armrest and backrest which allowed the participants to have their shoulders in adduction and neutral rotation, elbow flexion at 90^0, neutral position of forearm and the wrist in slightly extended position ($0\text{-}30^0$ of wrist extension) with neutral radioulnar deviation (Roberts et al., 2013). The hips, knee and ankle joints were also positioned to obtain a right angle with legs upright and the feet flat on the floor (Fig. 2). After placing into the designated position, the participants were given instructions verbally to induce their grip strength maximally by squeezing the handle as much as they can and maintain the grip for

3-5 seconds and with 15-20 seconds rest interval between measurements. The same instructions were given for three trials (El-Sais, & Mohammad, 2014). Both hands were tested and the means of the three trials of grip strength of each hand were obtained using the ASHT protocol (Roberts et al., 2013).

Figure 2. Proper position in assessing grip strength

Ethical Consideration

The study was conducted upon the approval of Mary Mediatrix Medical Center Ethics Review Board. Prior to evaluation, participants were asked to sign an informed consent (if the participant is an adult) and assent form (if minor) with stated purpose, benefits and the possible risks of the study. The participants may withdraw anytime during the assessment proper.

Statistical Analysis

The data were analyzed using SPSS version 20.0. Frequency and percentage were used to analyze the profiles of the participants. Descriptive statistics was utilized to determine the correlation of factors affecting the grip strength such as age, gender, and hand dominance; and also for the factors affecting the grip strength like hand circumference. Lastly, mean and standard deviation for the range of grip strength (in kgs) for each age bracket and gender were also determined.

RESULTS AND DISCUSSIONS

Table 1
Profile of the Participants

Gender	N	Percentage
Female	359	49.9
Male	361	50.1
Total	720	100.0
Age Range		
11 - 20 years old	165	23%
21 - 30 years old	197	27%
31 - 40 years old	134	19%
41 - 50 years old	95	13%
51 - 60 years old	98	14%
61 years old and above	31	4%
Hand Dominance		
L	166	23%
R	554	77%
Age Range		
11 - 20 years old	R – 150	20.8%
	L – 15	2.1%
21 - 30 years old	R – 154	21.2%
	L – 43	5.9%
31 - 40 years old	R – 86	11.9%
	L – 48	6.7%
41 - 50 years old	R – 74	10.3%
	L – 21	2.9%
51 - 60 years old	R – 72	10%
	L – 26	3.6%
61 years old and above	R – 18	2.5%
	L – 13	1.8%

Table 1 shows the profile of the participants. Based on the data, participants were almost equally represented in terms of gender, majority belongs to ages 21-30, and are right handed. This age group has the highest population that leads to highest number of right handed individuals. Both genders were tested without any variance regardless of hand dominance.

Table 2
Means of Grip Strength Based on Gender

Gender	**Right Hand (kg)**	**Left Hand (kg)**
Male	30.93±9.18	26.59±9.56
Female	19.84±5.53	16.19±5.49

Table 2 shows the average mean of grip strength based on gender. Males tend to have higher grip strength compared to females because males are heavier, taller and have a higher BMI. The observed pattern for grip strength was similar with the findings of Kubota and Demura (2011) which stated that males have higher grip strength than females due to higher muscle strength and difference in muscle mass.

Table 3
Means of Grip Strength Based on Hand Dominance

Dominance	Right Hand (kg)	Left Hand (kg)
Right	25.32± 9.17	18.31±7.18
Left	19.15± 9.21	24.01± 9.79

Table 3 shows the means of grip strength based on hand dominance. Based on the data obtained, dominant hand has greater grip strength as compared to the non-dominant hand. Right-sided person has a higher value on the right, whereas left-sided has a greater value on the left. According to Kubota and Demura (2011) and Incel et al. (2002), difference in grip strength particularly in dominant hand is due to frequent use of dominant hand, its function and strength typically develops overtime.

Table 4
Means, Median and Mode of Grip Strength Based on Height

Height (cm)	N	Right Hand (kg)	Left Hand (kg)
147	5	21.27 ± 3.77	15.67 ± 3.78
150	9	16.96 ± 2.64	15.30 ± 6.68
152	18	19.37 ± 3.96	16.44 ± 5.33
155	42	19.97 ± 7.00	17.06 ± 6.57
157	70	21.74 ± 8.09	18.31 ± 7.12
160	79	22.59 ± 9.21	18.61 ± 8.64
163	106	24.83 ± 7.96	20.07 ± 9.82
165	96	25.54 ± 8.32	21.37 ± 9.87
168	88	28.20 ± 9.43	22.67 ± 9.18
170	53	27.27 ± 8.76	22.35 ± 8.88
173	61	29.07 ± 10.25	23.52 ± 6.91
175	49	27.95 ± 9.80	25.14 ± 7.74
178	32	33.49 ± 12.02	32.44 ± 10.34
180	4	30 ± 12.77	31.50 ± 7.98
183	3	28.11 ± 12.58	37.33 ± 2.89
185	2	31.50 ± 11.08	44.50 ± 21.44
		Right Hand	**Left Hand**
Median		26.41	21.86
Mode		16.96[a]	15.30[a]

Table 4 shows the means, median and mode of grip strength based on height. Majority of the participants are 163 cm in height. The highest grip strength for the right-hand was found among 178 cm height whereas for the left-hand it belongs to 185 cm. The findings are similar to that of Inskip et al., (2007), Forrest et al., (2012), and Chandrasekaran et al., (2010) where the efficient amount of force is generated if there is greater height due to longer arms thus, greater lever arm of force is generated.

Table 5 Means, Median and Mode of Grip Strength Based on Weight

Weight (lbs)	N	Right Hand (kg)	Left Hand (kg)
100	24	16.83 ± 3.97	15.96 ± 5.85
105	50	19.74 ± 6.11	16.13 ± 6.13
110	60	20.40 ± 6.38	16.44 ± 6.19
115	72	21.97 ± 7.16	19.23 ± 9.22
120	118	24.70 ± 8.40	20.20 ± 7.89
125	87	27.93 ± 10.47	24.55 ± 12.10
130	71	28.72 ± 9.83	21.65 ± 7.76
135	68	26.14 ± 7.84	20.71 ± 6.58
140	43	25.91 ± 9.29	22.40 ± 8.07
145	48	29.37 ± 10.56	26.23 ± 10.97
150	40	29.27 ± 9.03	26.07 ± 9.78
155	20	30.02 ± 11.30	27.07 ± 6.75
160	14	35.95 ± 9.52	29.95 ± 11.34
165	5	28.80 ± 10.60	34.20 ± 16.71
		Right Hand	**Left Hand**
Median		27.04	22.03
Mode		17[a]	16[a]

Table 5 shows the mean, median and mode of grip strength based on weight. Majority of the participants weighed 120 lbs. The highest grip strength for the right-hand was found among 160 lbs whereas for the left-hand it belongs to 165 lbs. This shows that grip strength increases accordingly with an increase in body weight. The result is similar with the study of Inskip et al. (2007) and Forrest et al. (2012) which stated that grip strength is strongly associated with the weight of the individual thus, varies with weight accordingly.

Table 6 Means, Median and Mode of Grip Strength Based on BMI

BMI	Right Hand (kg)	Left Hand (kg)
18.5	18.85 ± 6.82	16.68 ± 6.43
19	24.92 ± 10.45	20.31 ± 7.47
19.5	26.15 ± 8.89	21.45 ± 8.83
20	24.13 ± 8.87	20.37 ± 10.36
20.5	26.48 ± 9.40	21.35 ± 7.42
21	25.89 ± 8.64	23.31 ± 10.51
21.5	28.80 ± 9.35	23.99 ± 8.75
22	26.09 ± 9.50	20.59 ± 8.41
22.5	27.90 ± 11.28	23.60 ± 9.61
23	24.92 ± 9.67	21.16 ± 10.46
23.5	27.36 ± 7.46	23.23 ± 10.07
	Right Hand	**Left Hand**
Median	26.09	21.35
Mode	24.92	16.68

Table 6 shows the mean, median and mode of grip strength based on BMI. Majority of the participants for both groups fall on 21.5 BMI. Weight and height were also higher in this group thus, contributing with higher BMI grade. The results are in contrast with the study of Forrest et al. (2012) which stated that grip strength declines with an increase of BMI.

Table 7.1
Means of Grip Strength in Males Based on Age Range

Age Range	Right Hand (kg)	Left Hand (kg)
11 - 20 years old	26.71 ± 7.70	21.86 ± 7.37
21 - 30 years old	29.96 ± 8.08	24.20 ± 7.22
31 - 40 years old	36.60 ± 9.35	33.62 ± 11.93
41 - 50 years old	37.83 ± 5.72	31.98 ± 8.34
51 - 60 years old	28.23 ± 8.68	25.31 ± 7.15
61 years old and above	21.67 ± 6.07	23.75 ± 8.34

Table 7.1 shows the average mean of grip strength in males based on age range. For the right-hand, individuals between 41-50 years old have the highest grip strength while individuals between 31-40 years old for the left-handed. This implies that grip strength is higher and peaked among young adults which have higher muscle mass, height, weight and BMI, as compared to other age groups, which are associated in contributing to higher grip strength. This is in contrast with the study of Dodds et al. (2016) which stated that the peak of grip strength among male is between ages 29 and 39 years old. However, according to Sternäng et al. (2014), men's grip strength level decreases faster with increasing age than women.

Table 7.2
Means of Grip Strength in Females Based on Age Range

Age Range	Right Hand (kg)	Left Hand (kg)
11 - 20 years old	17.1 ± 4.47	13.1 ± 4.63
21 - 30 years old	20.82 ± 5.40	18.12 ± 5.61
31 - 40 years old	21.71 ± 4.64	19.28 ± 4.56
41 - 50 years old	22.98 ± 3.89	17.77 ± 4.17
51 - 60 years old	19.31 ± 6.59	14.52 ± 4.53
61 years old and above	12.73 ± 2.02	9.11 ± 1.46

Table 7.2 shows the average mean of grip strength in females based on age range. For the right-hand, individuals between 41-50 years old have the highest grip strength while individuals between 31-40 years old for the left-handed. This implies that grip strength is higher and peaked among young adults which have higher muscle mass, height weight and BMI as compared to other age groups. This is in contrast with the study of Sternäng et al. (2014) which stated that the peak of grip strength among female is 30-40 years old and then decreases with increasing age. However, according to Forrest et al. (2012), grip strength increases before 50 years old and decrease beyond 50 years old. Grip strength in older age group tends to decline secondary to loss of muscle mass and likely the contributing factor to the decline in muscle strength. This is similar to the study of Oliveira and Araujo (2007) which stated that grip strength declines secondary to contractile changes and biomechanical changes.

CONCLUSION

An average grip strength value was obtained within the sample and the results were consistent with the findings of other studies as for age, gender, hand dominance, height, weight, and BMI. However, it cannot adequately represent the norm for the community being studied considering the high variability of the data due to a small number of participants thus, representing only a minimal percentage of target population.

RECOMMENDATION

The researchers recommend the utilization of larger sample population to limit the variability of data and to establish a baseline for grip strength measurements of healthy Filipino individuals in different localities of Batangas and in our country for future research.

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