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Hand grip strength in the adult Malaysian population

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ABSTRACT

Purpose. To measure the hand grip strength of Malaysians aged 18 to 65 years.

Methods. Between January and April 2003, 412 subjects (200 women and 212 men) were recruited from staff, students, and visitors of the University of Malaya Medical Centre. Socioeconomic, general health, and lifestyle data were collected from each subject using a standard questionnaire. Weight and height were measured prior to testing. Standardised positioning and instructions based on several hand grip protocols were used. Data were collected using the LIDO kinetic work set.

Results. 93% of the subjects were right-hand dominant and 7% were left-hand dominant. Hand grip strength was significantly correlated with hand dominance, gender, occupation, height, and weight, but not body mass index. No significant differences in grip strength

were noted with regard to race or level of income. Men were stronger than women in all age-groups, with a ratio of 1.75:1. In both right- and left-hand dominant groups, the dominant hand was consistently stronger than the non-dominant side, with a ratio of 1.12:1 in the right-hand dominant group and 1.05:1 in the left-hand dominant group. The strongest hand grip strength in the right-hand dominant group occurred in the age-group of 25 to 34 years; in the left-hand dominant group it was in the age-group of 18 to 24 years. In western populations, the mean grip strength can be as much as 1.5 times greater than in the Malaysian population.

Conclusion. Data derived from western populations cannot be applied to a comparable Malaysian population. Gender, hand dominance, age, occupation, weight, and height must be considered when establishing normal values for grip strength.

Key words: *hand strength; kinetics*

INTRODUCTION

A reliable hand grip assessment is important when assessing the results of various surgical treatments. A baseline grip strength value for the normal population is needed. There has been no study of the normal grip strength in the adult Asian population. Most normative data are based on the western literature and may not apply to Asians.¹⁻³

MATERIALS AND METHODS

Between January and April 2003, volunteers were recruited from the staff, medical students, and visitors of the University Malaya Medical Centre. Subjects were excluded if they had a history of upper-limb injury or deformity, or related health conditions. Socioeconomic background, general health, and lifestyle of the subjects were assessed using a standard questionnaire. Weight and height were measured prior to testing.

A LIDO kinetic work set was used; a grip device attached to the rotatory arm of the work set was calibrated for each subject. A dedicated technician operated the machine to ensure consistent results. The hand grip protocol was based on the School of Kinesiology and Recreation of the Illinois State University and the New York State University: the subject was seated upright with shoulder in adduction; the elbow was flexed at 90°. The wrist was in a neutral position facing inwards. The device handle was opened to fit onto the palm with the fingers in 90° flexion at the proximal and distal interphalangeal joints with the thumb in 90° abduction (Fig. 1).

Grip strength, or torque, was measured in Newton meters (Nm). Subjects were instructed to grasp the handle for 5 seconds and rest for 5 seconds, and perform the action a total of 6 times. The contralateral hand was then examined using the same protocol. Data were recorded and analysed using LIDO kinetic work set software. The mean value of the 3 most powerful grips was recorded and used for comparison.

RESULTS

Out of the 412 recruited subjects (200 men, 212 women) aged 18 to 65 years (mean, 34.3 years), 383 (93%) were right-hand dominant and 29 (7%) were left-hand dominant. None was ambidextrous. In right-hand dominant subjects, the highest mean grip strength of both hands was recorded among those aged 25 to 34 years and among left-hand dominant subjects in those aged 18 to 24 years (Table 1). Among men the highest

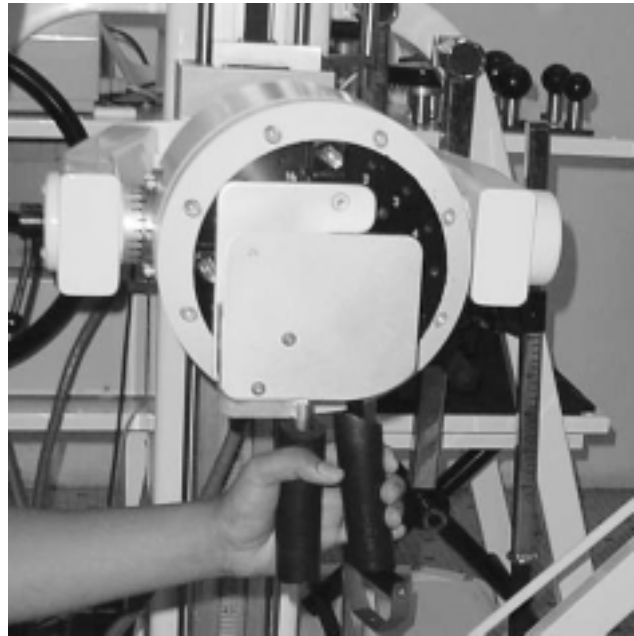


Figure 1 The left hand is being tested. A strict protocol of grip testing is followed: the shoulder is adducted and the arm flexed at 90° with the wrist in neutral position.

mean grip strength was encountered in those aged 25 to 34 years and in women in those aged 18 to 24 years (Table 2). Men were stronger than women in all age-groups, with a ratio of 1.75:1. The dominant hand was consistently stronger than the non-dominant hand, with a ratio of 1.12:1 in the right-hand dominant group and 1.05:1 in the left-hand dominant group (Table 3). The mean difference in grip strength between each side was statistically significant ($p < 0.01$, paired *t*-test) in the right-hand dominant group, but not in the left-hand dominant group ($p = 0.159$, Wilcoxon signed rank test).

There was a clinically and statistically significant difference in the grip strength of the left hand between different dominant hand groups ($p < 0.05$, independent *t*-test), but not of the right hand. Due to the skewed distribution of data and the small number of subjects in the left-hand dominant group, a non-parametric test (Mann-Whitney *U* test) was performed. In comparing the grip strength of the respective hand sides between the different hand dominant groups, the *p* value for the left hand was 0.028 while for the right hand it was 0.642. Only in the right-hand dominant group were there statistically significant differences in mean grip strength of a particular (either left or right) hand side between different age groups (one-way ANOVA test), and between the 2 hands in the respective gender groups (paired *t*-test), with $p < 0.001$ in all tests. There

Table 1
Mean torque (grip strength) of the right and left hand in the different dominant groups

Age-group (years)	Mean torque (Nm)				
	18-24	25-34	35-44	45-54	55-65
Right-hand dominant group	n=138	n=88	n=67	n=63	n=29
Left hand	29.3	33.0	31.8	26.5	23.4
Right hand	32.7	36.7	35.0	29.7	27.5
Left-hand dominant group	n=9	n=5	n=4	n=9	n=0
Left hand	41.3	32.7	41.0	28.7	-
Right hand	39.5	30.5	37.4	29.0	-

Table 2
Mean torque (grip strength) of men and women

Age-group (years)	Mean torque (Nm)				
	18-24	25-34	35-44	45-54	55-65
Men	n=66	n=57	n=43	n=31	n=15
Left hand	38.2	39.5	39.0	34.1	28.5
Right hand	42.0	43.1	43.0	38.5	33.8
Women	n=81	n=35	n=29	n=41	n=14
Left hand	23.4	22.3	22.2	21.2	17.9
Right hand	25.9	25.5	23.5	23.0	20.7

Table 3
Comparison of mean torque (grip strength) of right and left hands between men and women

	Mean torque (SD) [Nm]		Ratio
	Men	Women	
Right-hand dominant group			
Right hand	41.2 (12.0)	24.5 (7.7)	1.68
Left hand	36.9 (11.1)	21.9 (7.2)	1.69
Ratio	1.12	1.12	-
Left-hand dominant group			
Right hand	44.6 (9.0)	24.2 (7.6)	1.84
Left hand	45.9 (11.1)	25.8 (8.0)	1.78
Ratio	0.97	0.94	-

Table 4
Correlation between mean grip strength and age, height, weight and body mass index (BMI)

Variables	Mean grip strength	p value, Pearson correlation test
Age	Left hand	0.002
	Right hand	0.008
Height	Left hand	<0.001
	Right hand	<0.001
Weight	Left hand	<0.001
	Right hand	<0.001
BMI	Left hand	0.178
	Right hand	0.122

were no significant differences noted in the left-hand dominant group using similar statistical tests as well as non-parametric tests (Kruskal Wallis test and Wilcoxon signed rank test, $p>0.05$), possibly due to the small number of left-handed subjects ($n=27$) in our study. However, there were significant differences between different genders in both hands in the left-hand dominant group (Mann-Whitney U test, $p<0.001$).

143 (35%) of subjects were manual workers, 243 (57%) were office workers, and 35 (9%) were retired or pensioners. There was a significant difference in grip

strength between these 3 categories of occupations (one-way ANOVA test, $p=0.005$ in the right hand, $p=0.015$ in the left hand), but not the level of income. There was no statistically significant difference in grip strength between races: 220 (53%) were Malay, 68 (17%) were Chinese, and 124 (30%) were Indian (one-way ANOVA test, $p=0.577$ in the right hand, $p=0.541$ in the left hand).

A multiple regression analysis was used to compare left- and right-hand grip strength, taking into account factors that may influence grip strength such as gender, age, weight, height, body mass index (BMI), race, and occupation. Only age, weight, height, occupation and gender were correlated with grip

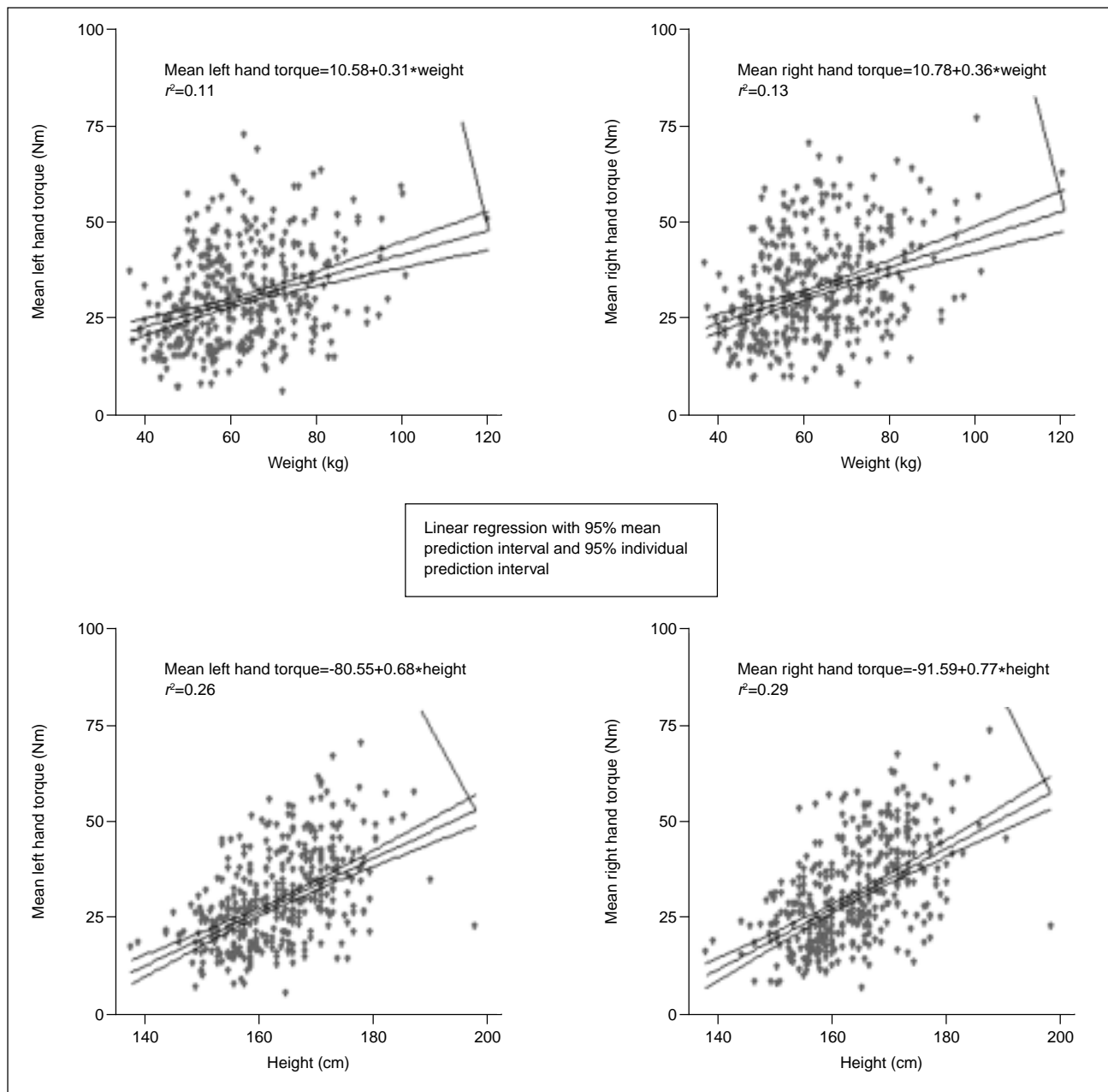


Figure 2 Scatterplots showing the distribution of mean grip strength (torque) of both hands in comparison to height and weight.

strength ($p < 0.01$). Using the Pearson test, significant correlations were noted between grip strength and (i) age, (ii) weight, and (iii) height, but not BMI (Table 4). The regression (r^2) value for height and weight were calculated and a linear model equation suggested that height and weight were predictors of grip strength (Fig. 2): for right- and left-hand grip strength, regression values for height were 0.29 and 0.26, and for weight, 0.13 and 0.11, respectively (Fig. 2).

DISCUSSION

The hand grip strengths of Malaysian subjects were significantly weaker than those reported for American or European populations.¹⁻⁴ Table 5 compares our findings with those of a previous study.² The comparison matches only age, gender and different hand sides. Had other factors (e.g. height and weight) been available, the differences in grip strength between

Table 5
Comparison of hand grip strength between our study and Mathiowetz et al.² study

Age-group (years)	Hand	Grip strength of our study (pounds)									
		Men					Women				
		Mean	SD	SE	Low	High	Mean	SD	SE	Low	High
20–24	R	69.2	18.5	2.3	33.3	115.9	43.2	12.0	1.4	21.5	83.1
	L	63.0	18.9	2.3	17.9	101.3	39.1	11.9	1.4	21.8	76.5
25–29	R	70.9	17.1	2.8	29.2	126.7	37.7	11.1	2.4	18.7	60.0
	L	66.3	15.6	2.6	25.1	98.3	33.0	9.5	2.1	18.2	54.9
30–34	R	72.2	21.4	4.9	30.0	110.1	45.3	13.3	3.0	23.1	65.3
	L	64.7	23.4	5.4	29.5	118.7	40.0	13.5	3.0	11.6	63.3
35–39	R	70.1	21.4	4.6	35.2	108.8	40.0	12.7	3.5	15.1	62.2
	L	62.3	18.8	4.0	23.1	95.8	35.9	10.9	3.0	16.8	52.3
40–44	R	71.8	17.2	3.5	36.9	107.9	37.1	14.3	3.8	13.5	67.5
	L	65.1	18.9	3.9	32.8	112.3	37.1	13.9	3.7	8.5	55.9
45–49	R	64.3	17.0	4.3	41.0	103.8	39.2	12.1	2.6	19.8	64.7
	L	58.6	15.7	3.9	32.5	82.3	36.9	11.5	2.5	20.1	62.5
50–54	R	64.7	22.7	6.5	23.4	91.1	36.9	12.8	3.0	16.2	54.8
	L	56.1	16.0	4.6	31.7	81.0	32.7	12.0	2.8	13.8	54.2
55–59	R	50.2	22.1	6.1	24.5	100.2	34.9	15.3	4.4	15.7	61.4
	L	45.9	14.5	4.0	23.4	68.3	32.0	14.0	4.0	10.5	58.4
60–65	R	43.1	18.2	10.5	40.6	73.9	31.5	6.4	3.7	24.2	36.3
	L	36.9	18.0	10.4	23.5	57.4	23.0	9.9	5.7	11.9	30.8
Overall											
Our study	R	68.4	19.6	1.3	23	127	41.0	12.7	0.9	14	83
	L	61.8	18.2	1.3	18	119	37.1	12.1	0.3	9	76
Mathiowetz et al.² study	R	104.3	28.3	1.6	32	176	62.8	17.0	1.0	25	137
	L	93.1	27.6	1.6	27	160	53.9	15.7	0.9	23	115

the studies might not have appeared so striking. There were no comparative data from previous studies that described important parameters such as subjects' height and weight. Categorical comparison of different factors that could influence grip strength (e.g. occupation) was also not reported in previous studies.

Grip strength has been previously reported to correlate with gender and age⁵ and hand dominance.¹ In this study, grip strength correlated with height and weight (r^2 , 0.11–0.29; Fig. 2). Weight and height proved to be better predictors for grip strength than age. It is therefore important to account for such other factors, not age alone, to predict grip strength. Only one previous study correlated weight and height with grip strength, but details of the relationship between these factors and grip strength were not reported.⁶

Grip strength of the right-hand dominant group increased with age peaking in subjects aged 18 to 34 years, and decreased steadily thereafter. In the left-hand dominant group, maximum strength occurred in age-groups 18 to 24 years and 35 to 44 years. A curvilinear relationship could not be established due to the small number of subjects in the left-hand dominant group. Nevertheless, the overall

data supported such a relationship for grip strength with age, which peaked between the ages of 25 to 50 years. This trend was also described by Mathiowetz et al.² Thus, assumption of a linear regression⁷ to predict adult hand strength scores for normative data, based on a linear inverse relationship was not well supported by our study.

Compared to data from Mathiowetz et al.,² the overall grip strength of their western population is up to 1.5 times greater than in our Malaysian subjects (Table 5). This suggests that grip strength norms from the western populations may not accurately represent the local population and local reference values are needed.

A limitation of our study was that we recruited subjects from a single university, which may not be representative of the whole country. Nonetheless, it is a tertiary university for medical referral and education and the subjects originated from different parts of the nation. Another limitation was the small number of left-hand dominant subjects ($n=27$), resulting in skewed distribution of data. We therefore incorporated the data of the left-hand dominant group into the right-hand group to form a study population as a whole. This practice has also been used in previous studies.^{1–4}

In our analysis of grip strength of left-hand dominant subjects, none of the tests showed any significant results except when comparing the grip strength between male and female subjects. We were only able to detect a statistically significant difference in the left-hand grip strength with respect to the left- and right-hand dominant groups but not for the right hand, which indicates that any difference between the 2 groups may be unimportant or coincidental.

It is advised that future studies recruit more left-handed subjects to ensure greater confidence in estimates of normal values and better predictability of grip strength pattern across different age-groups and genders. To improve the reliability and validity of hand strength evaluations, standardised positioning and instruction, a mean of at least 3 measurements, and a standard dynamometer (or any other measuring device) should be used. Scores should be compared after taking into account of height, weight, hand

dominance, and occupation, not just age and gender. Calibration of the dynamometer should be checked regularly and the same test instrument used for all data collection.

CONCLUSION

Data derived from western populations cannot be applied to a comparable Malaysian population. Local normative data are important for reference and serve as objective values for the purpose of rehabilitation. Grip strength data from a larger sample of representative (especially left-handed) subjects from different regions of the country are required, if they are to be used more widely in the context of Malaysia. Gender, hand dominance, age, weight, height, and occupation must all be considered when establishing normal values for grip strength.

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