Hand Anthropometry Analysis and Construction of Regression Models for a Hong Kong Sample

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***Abstract*—The hand anthropometry of a Hong Kong sample was analyzed in this study. The features of this sample were described and regression models were constructed. Then the results were compared with some other studies and a conclusion was made.**

***Index Terms*—Hand-grip, strength, Hong Kong, anthropometry**

I. Introduction

HAND-grip strength (HGS) is a contemporary topic which has been studied by many researchers in the research area of human factors. Analysis of hand-grip strength can supply useful information for Repetitive Strain Injuries (RSIs) analysis. Workers sometimes encounter with fatigue and safety problems due to Repetitive Strain Injuries. Safety requirements of the workplaces are generally set by consolidated norms. However, local samples do not always have the same features with the consolidated norms. That is why hand anthropometry and hand-grip strength of a Hong Kong sample was analyzed and compared with the results of the other studies in this study.

II. Procedures

A. Participants

49 participants were measured. Six of them have claimed that they might have health problems with their hands i.e. they had accidents before. Therefore, they were not included into the analysis. The analysis was conducted with 43 participants. Most of the participants were university students in Hong Kong. 31 of the participants were male and 12 of them were female. The ages of the participants were between 18 and 33. 6.98% of the sample was left handed.

B. Apparatus and Methods

In the data collection part, this study mainly stayed with the format designed by Chan [1]. The methods used in this study are quite alike as the definitions asserted by Pheasant [9].

Martin type anthropometers and Jamar type dynamometers were used in this study. The participants were asked to remove their wristbands if they had. The hand-grip strength values were measured as the participants standing straight. In order to eliminate measurement errors due to the different inspectors and instable state of human body, each participant was measured twice and the average of the measurements was taken and used.

Lengths were recorded in meters, weight was recorded in kg, and the force was recorded in kgf.

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III. Data analysis And results

Excel 2007 & 2010 and Minitab 16 were used for statistical analysis. Here is the statistical summary of the data:

Variable	Mean	StDev	Minimum	Maximum	Range
Weight	66.12	14.06	42.00	92.75	50.75
Height	170.58	10.18	149.30	189.85	40.55
ThumbL	6.681	4.134	5.300	32.950	27.650
ThumbB	2.066	1.148	1.500	9.350	7.850
IndexL	7.1036	0.5271	6.0750	8.1000	2.0250
IndexB	1.7353	0.1503	1.4500	2.0500	0.6000
HandL	18.002	1.205	15.750	20.200	4.450
PalmL	10.117	0.987	6.250	12.125	5.875
HandB	7.909	0.878	4.650	9.625	4.975
IndexThk	1.827	1.181	1.350	9.350	8.000
HandThk	2.728	1.620	1.850	12.950	11.100
WristL	5.3971	0.5708	3.4000	6.3500	2.9500
BicepsL	11.928	2.307	7.150	16.650	9.500
ShoulderB	41.217	6.417	27.600	71.000	43.400
ArmL	75.68	7.86	37.40	86.30	48.90
Dominant HGS	33.67	10.70	15.00	56.50	41.50
Non-D. HGS	30.33	10.61	13.75	53.75	40.00

One-way ANOVA was also applied after all the assumptions were checked and satisfied. The significant groups were Gender, Training_Background, and Nationality and corresponding p-values were 0.000, 0.014, and 0.019 respectively.

It was also found that there was no significant difference between dominant hand-grip strength values of right handed and left handed participants. But there was a significant difference between overall dominant and non-dominant hand-grip strength values because T-Test for equality of the means resulted in a p-value which was equal to 0.000. The 95% confidence interval for it was (2.495, 4.192).

The correlations were also analyzed. Dominant HGS was found highly correlated to Gender (r=-0.809). The other strong correlations were: ThumbB – ThumbL: 0.990, HandL – IndexL: 0.869, HandL – Height: 0.866, HandL – Weight: 0.817, Non-D. HGS – Dominant HGS: 0.967, Dominant

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HGS – HandL: 0.823.

A. Constructing Regression Models

From ANOVA, it was found that "Nation", "Gender", and "Training" were important factors. From the correlation coefficient analysis, the factors that might have a significant effect on the hand-grip strength were found. Here are these factors and their correlation coefficients with HGS: HandL: 0.823, Weight: 0.788, Height: 0.770, IndexB: 0.742, WristL: 0.731, HandB: 0.715, ArmL: 0.655, BicepsL: 0.612

They all had a relationship with HGS although not all of them were very strong. Also there was another limitation that not all of them were independent. For example, in the correlation analysis, it was found that Height, Weight, and HandL were correlated. But they all were still taken into account for analysis. If this decision was wrong, then Variance Inflation Factor (VIF) values would warn about it because VIF detects if there is a redundant variable or not. Then there would be a chance to revise it. But if some variables were eliminated according to only correlation coefficients, the analysis might be finished with biases.

The best subset regression analysis was used. And two different regression models were developed with these different subsets. One was with 11 variables and the other one was with 2 variables.

Regression Analysis (with 11 variables): Dominant HGS versus Gender, Nation, Training, HandL, Weight, Height, IndexB, WristL, HandB, ArmL, BicepsL

The regression equation was:

Dominant HGS = - 37.2 - 7.63 Gender + 4.51 Nation + 0.124 Training + 1.48 HandL+ 0.115 Weight + 0.113 Height + 5.0 IndexB + 0.15 WristL+ 1.16 HandB + 0.024 ArmL + 0.100 BicepsL

None of the variables in this model had a VIF larger than 10. All the VIF values were smaller than 7. Therefore, all the variables in this model were kept because they all were significant for the model.

The power of this regression model was also checked by ANOVA. p-value was smaller than 0.05. It was 0.000. Therefore, Ho was rejected. And it was claimed that this model was quite good. But still we might find a simpler model which had fewer variables.

Regression Analysis (with 2 variables): Dominant HGS versus Gender, Weight

The regression equation was:

Dominant HGS = 27.1 - 11.9 Gender + 0.329 Weight

VIF values were very small. They both were 2.003. Both variables in the model should be kept because their VIF values were very small.

Although there were only two variables in this model, its power was still very high. p-value of the ANOVA was 0.000. Therefore, this model was also adequate and quite good.

IV. Discussion

Not every population has the same hand-grip strength distributions. Some of them have higher means and some of them have lower means. And other characteristics of the samples also changes. If a company from a country tries to adopt standards of a different country without any analysis, it will be very dangerous for the employees of this company. They must take the national features into account.

The analysis of a Hong Kong sample was made. And it was found that 95% Confidence Interval for Dominant HGS of this sample was 33.67+-3.29. And means for males and females were 37.9826 and 19.9167 respectively.

Other populations were also analyzed by different researchers. A summary of some of these analysis were included into TABLE I.

The difference between means of different populations is obvious. Therefore, every local design should refer to its local studies.

TABLE I
HAND-GRIP STRENGTH STUDIES FROM DIFFERENT LOCATIONS

Source	Location	Occupation types	Sample size	Age range	Mean hand-grip strength in kgf *
Mandahawi et al. [5]	Jordan	Carpenters, vehicle drivers, electrical technician, police,	Male: 115	18 to 59	43.05
		engineers, nurses, students, secretary, teachers, and others	Female: 120	18 to 59	24.21
Silahli [10]	Turkey	Light manual workers, heavy manual workers, university students	Male: 129	18 to 69	44.47
			Female: 79	18 to 68	25.36
Wu et al. [11]	Taiwan	Participants from universities, mountain villages,	Male: 244	20 to 75+	35.0+-1.4
		public parks, markets, community halls, churches and temples	Female: 238	20 to 75+	21.2+-0.8
Xiao et al. [12]	ZheJiang province of China	College students, industrial and clerical workers	Male: 146	under 20 to 39	43.92+-7.14
			Female: 47	under 20 to 39	23.26+-5.47

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V. A LIMITATION TO THIS STUDY

Most of the participants of this study were university students. According to Silahli [10], there is a 4.96 kgf difference between students and heavy manual workers. Xiao et al. [12] also found that mean strengths of industrial workers are higher than students. Therefore, a small adjustment should be done for applying the results of this study to heavy workers.

VI. CONCLUSION

Applying unanalyzed reference values of HGS to Hong Kong population may be very dangerous. The local companies should take the findings of this study as a reference. By doing this, they will prevent Repetitive Strain Injuries and they will have a healthier and safer workplace.

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