ORIGINAL ARTICLE

The Hand – The Basic Anthropometry

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Abstract: This study focuses on hand anthropometry data which should be the most important parameters in handheld devices and many other products that are handled with hands, however is not well-addressed. Currently, there are few Malaysian anthropometry data established, but none is specific on hand anthropometry. Therefore, it is aimed that if the basic hand anthropometry data collected for this study is congruent with the old data, more advanced hand parameters could be generated even though the subjects are limited. Thirty males and females basic hand data were measured and compared to a 10-year-old Malaysian database. Results showed the current data are similar to the existing local hand anthropometry data with the average hand length for males being 20cm and 17.65cm for females. However, a comparison based on a confidence interval of male hand length revealed that the current data has 95% [15, 24] whilst the elderly data 95% CI [16, 18], the workforce data 95% CI [18, 19] and the adult data 95% CI [18, 19]. It shows that the anthropometry data from the current subjects can be used to represent Malaysian hand anthropometry, based on the agreement of the basic hand anthropometry confidence interval with previously established data.

Keywords: handheld device, design, palm length, handbreadth

1.0 INTRODUCTION

A horizontal mouse is arguably still the best option for productivity if that is the most important consideration. When it comes to ergonomic mice, no one form factor will fit everyone. The first step to picking a comfortable mouse however is to be aware of choices. Mouse, is just an example of perhaps the most widely used handheld device in this modern world. The wrong design and dimensions could easily become a risk factor for the prevalence of carpal tunnel syndrome (CTS).

An ergonomic product would focus on the human-machine interaction first before anything else. Product design is built on dimensions that are decided based on its function, aesthetics and

performance. And a safe, as well as efficient design, is determined by the anthropometry of the human, specifically the potential user of the product. In order to narrow down the discussion to design and anthropometry, a refined search of literature review for the topic of hand anthropometry was carried out using the combination of keywords "hand anthropometry" with "engineering" "design" and "NOT medical". The search revealed nine most recent papers published in 2021, but none are for Malaysian anthropometry. When included the keyword "Malaysia" and the year's range was not restricted, there were 107 papers listed by Google Scholar. Sixty-eight were published within the past 5 years, but when scrutinised, some papers are foreign studies that were compared with some Malaysian data.

From the searched local studies, most did not focus on hand anthropometry but included a few hand parameters in their data collection. Dawal, Ismail, Abdul-Rashid et al [1] for example studied anthropometry dimensions for design purposes focusing on specific users, the elderly. The hand anthropometry measured were the basic hand length, palm length and handbreadth. Later, Abdul Rahman, Dawal and Yusoff et al. [2] measured and compared the working middle-aged population between 18 – 45 years old Malaysians with another 3 Asian countries focusing on seated and stand workstations design. This study only considered two hand parameters, the hand length and handbreadth. Mohamad et al. [3] have the most extensive data with more than 1000 subjects, hence the database is a good reference for this study.

Rigorous linear hand anthropometry would be like the 56 dimensions' study [4] or the 33 dimensions [5] or as illustrated by Dreyfuss [6] as shown in Figure 1.

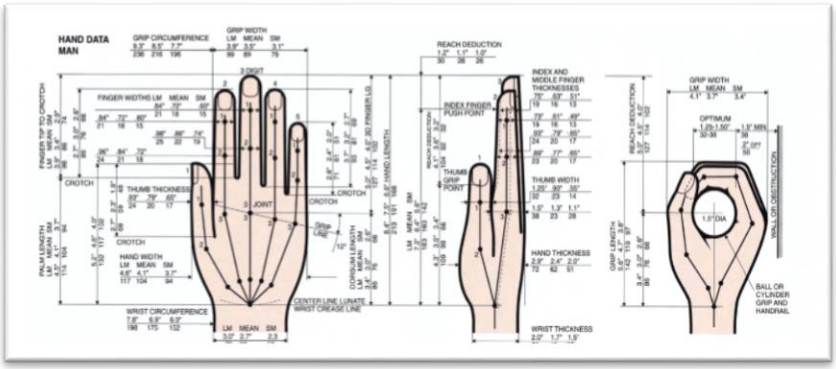

Figure 1 Hand measurement from Tilley [6]

Many tools and devices are specific for the hands; however, it is such a revelation that not many researchers focused on hand anthropometry. More so, that today's environment is dependent on handheld devices, and the long and static exposure to these devices could cause musculoskeletal disorders such as the infamous carpal tunnel syndrome.

Recruiting a large number of subjects for anthropometry data collection could be costly and is impossible without support from any sponsor. Therefore, this study aims to look at the Malaysian hand anthropometry data available in published studies and to compare recently collected data with those data. It is aimed that if the basic hand anthropometry data collected for this study is in agreement with the previously established data, more advanced hand parameters could be generated from these limited subjects and yet it could still be representing the Malaysian population.

2.0 METHODOLOGY

Dominant hands of thirty working adult male and thirty female subjects were measured. Anthropometric data of each respondent were obtained by using a standard 30mm ruler since the parameters involved were only the basic hand data. Subjects were adult students aged between 25-45 years old from a master's program at the National University of Malaysia (UKM). Anthropometric data measured includes:

- length of hand (distance between the distal wrist crease and the tip of the middle finger in extension, A).
- length of palm (distance between the distal wrist crease and the proximal digital crease of the middle finger, B).
- length of index finger (distance between the upper top of the proximal digital crease of the thumb and the fingertip of the index finger, C).
- width of hand (distance from the radial side of the proximal palmar transverse crease to the ulnar side of the distal palmar transverse crease, D).

The data collection process was carried out with close supervision among team members and the diagram as shown in Figure 2 was referred to. As the normal data collection procedure, each parameter was measured three times and then averaged.

All data acquired were recorded and later analysed using Microsoft Excel 2016 to obtain the means, relevant percentiles and standard deviations. The normality of the data was tested using a histogram. Data kurtosis and skewness were also tested.

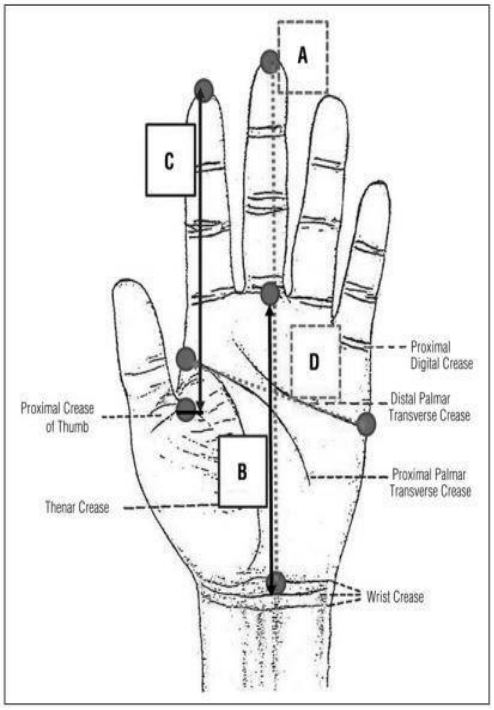

Figure 2 Anthropometric measurements. A length of hand; B length of palm; C length of index finger; D width of hand [7]

3.0 RESULTS

Data were first tested for its normality, kurtosis and skewness. Figure 3 shows the 4 distributions for parameter A; the hand length, parameter B; the palm length, parameter C; the Index finger to proximal crease of thumb or for an easy write-up, the Index finger length and parameter D; the width of the hand. Table 1 shows for example for the male, two parameters A and B have positive kurtosis but skewed to the left, whilst C and D have negative kurtosis and are not that skewed.

Table 2 shows the results of the hand anthropometry measured, the means, the 5th and 95th percentile and its standard deviation. Anthropometric dimensions for each population are ranked by size and described as percentiles. It is a common practice to design for the 5th percentile (5th%) female to the 95th percentile (95th%) male.

The 5th% female value for a dimension (e.g. length of hand) usually represents the smallest measurement for design in a population. On the other hand, a 95th% male value may represent the largest dimension for which one is designing.

It is widely used and common that 5th% to 95th% percentile range is used in design; however, it only accommodates approximately 90% of the population. To design for a larger portion of the population, one might use the range from the 1st% female to the 99th% male.

Table 1 Data kurtosis and skewness

	MALE				FEMALE			
	A	B	C	D	A	B	C	D
Kurtosis	0.74	0.45	-0.37	-0.63	-0.22	-0.47	1.65	0.15
Skewness	-0.54	-0.69	0.01	0.29	-0.85	-0.51	-1.07	0.41

Table 2 Hand Anthropometric Data of 30 Sample Results (unit in cm)

	30 Male				30 Female			
	5th %tile	50th %tile	95th %tile	SD	5th %tile	50th %tile	95th %tile	SD
Hand Length	17.73	20.00	20.97	1.03	15.23	17.65	18.56	1.07
Palm Length	9.92	11.70	12.67	0.96	9.00	10.40	11.31	0.80
Index finger length	11.09	12.20	13.28	0.64	8.73	10.50	11.30	0.82
Hand width	8.34	9.10	10.27	0.65	7.00	8.00	9.11	0.63

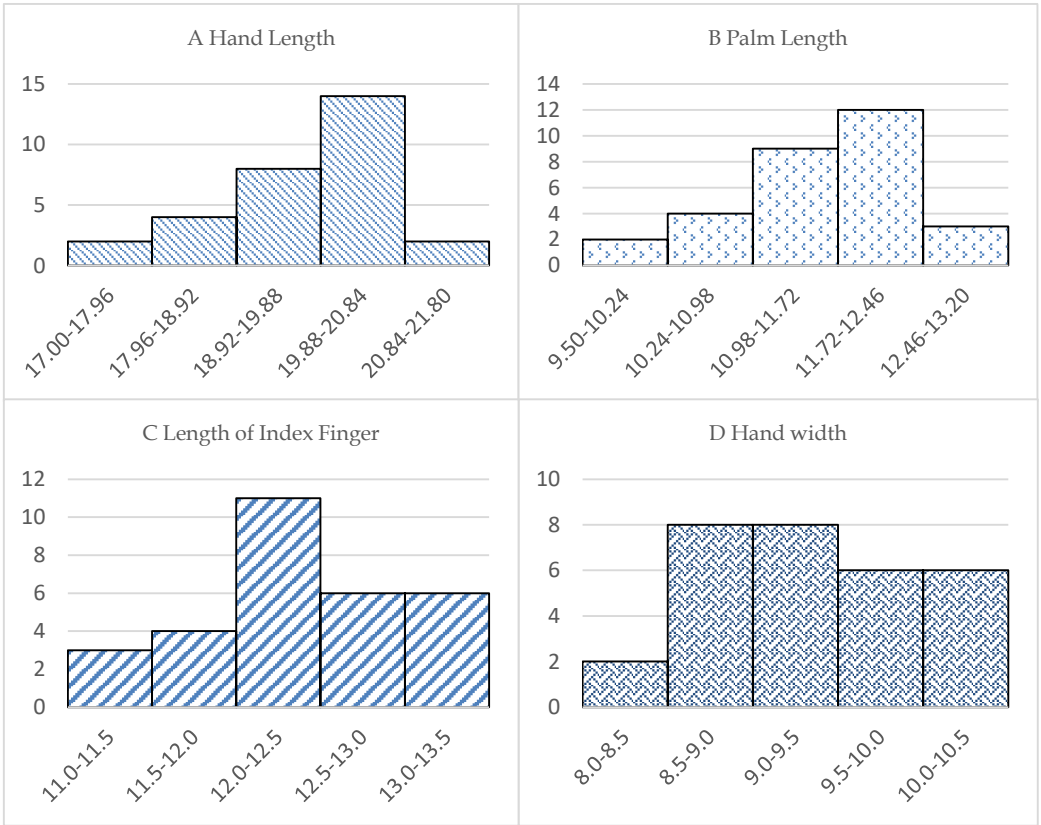

Figure 3 Example of normality test on the 30 samples data (male)

Table 3 Malaysian hand anthropometry data

	ELDERLY[a]						WORKFORCE[b]						ADULT[c]					
Gender	MAlE (46)			FEMALE (61)			MAlE (146)			FEMALE (168)			MALE (512)			FEMALE (491)		
	50th	SD	CV	50th	SD	CV	50th	SD	CV	50th	SD	CV	50th	SD	CV	50th	SD	CV
Hand length	17.02	2.21	0.12	16.30	1.17	0.07	18.30	1.10	0.06	17.0	0.80	0.05	19.0	1.01	0.05	17.20	1.07	0.06
Palm length	10.19	2.28	0.22	9.16	0.60	0.06	-	-		-	-	-	11.0	0.85	0.08	10.00	0.80	0.08
Handbr eadth	7.99	0.73	0.09	7.28	0.48	0.07	8.10	0.80	0.10	7.2	0.50	0.07	9.0	0.64	0.07	7.60	0.63	0.08

[a]Dawal et al. 2015, [b]Abdul Rahman et al. 2018, [c]Mohamad et al. 2010

It was found that Malaysian hand length and had breadth are slightly smaller as compared to Indonesian, Filipinos and Thailand data (Abdul Rahman et al., 2018). Therefore, the data presented here are insufficient to determine the complete design parameters of a mouse or any common handheld device. More data are required such as the complete database by Mansour (2016) or Cakit et al. (2012).

Data from Table 2 and Table 3 can be compared by calculating the confidence interval of each data. However, just like statures and the length of hands or legs, the human body is usually proportionate. Table 4 depicts 1 comparison of the confidence interval for the current data and the other three older hand anthropometry as shown in Table 3.

Table 4 Confidence Interval of Hand Length for Male

Male Hand Length Confidence Interval				
	Current	Elderly	Workforce	Adult
Mean	20.00	17.02	18.30	19.00
$t^*(s/\sqrt{n})$	4.12	0.66	0.18	0.09
CI min	15.88	16.36	18.12	18.91
CI max	24.12	17.68	18.48	19.09

The current data seems to have the highest maximum confidence interval and the lowest minimum confidence interval. Although all the data are for Malaysians, however, the range of each sample somewhat varies.

4.0 CONCLUSION

This study managed to produce sample data for hand anthropometry that can represent the Malaysian population. This was concluded based on the calculation of the 95% confidence intervals of male hand length for this study and three other previous studies. The mean data for males' hand length, palm length, index finger length and hand with are 20cm, 11.7cm, 12.2cm and 9.1cm respectively. For female data, 17.65cm, 10.4cm, 10.5cm and 8cm, respectively.

From the hand length parameter, it is shown that the confidence interval for all the data as such; the current data at 95% CI [15, 24], elderly data 95% CI [16, 18], workforce data, 95% CI [18, 19] and adult data 95% CI [18, 19].

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