

# Hand Anthropometry of Bangladeshi University Students Aged 18-25 Years

**Md. Eanamul Haque Nizam\***

PhD (Fellow), Faculty of Textile Science and Technology, University of Zagreb, Croatia  
Assistant Professor, Department of Textile Engineering, Southeast University, Tejgaon, Dhaka, Bangladesh  
[\*Corresponding author]

**Darko Ujevic**

Emeritus Professor, Faculty of Textile Technology, University of Zagreb, Croatia

**Bristy Rani Roy**

Textile Student, Department of Textile Engineering, Southeast University, Tejgaon, Dhaka, Bangladesh

**Rasel Rana**

Textile Student, Department of Textile Engineering, Southeast University, Tejgaon, Dhaka, Bangladesh

**Badhan Chandra Roy**

Textile Graduate, Department of Textile Engineering, Southeast University, Tejgaon, Dhaka, Bangladesh

**Anas Rari**

Graduate, Department of Agricultural Economics, Sher-E-Bangla Agricultural University, Dhaka, Bangladesh

## Abstract

This study represents the findings of hand anthropometry conducted on 58 males and 13 females in the 18–25-year age group of Bangladeshi university students. 25 (twenty-five) dimensions of each hand were measured together with body height, weight, and BMI. An analysis of the mean, standard deviation, and 10th, 50th, and 90th percentile values are provided in this article. This study provides information regarding gender differences, right-handed versus left-handed individuals, age groups, and so on. Due to a lack of information regarding the dimensions of openings for hand access into machines in the Bangladeshi tools. A potential comparison with anthropometry data from other world populations was performed to evaluate the effective difference.

## Keywords

Hand anthropometry, Bangladesh, Hand tools design, Age relation

## INTRODUCTION

Hand tools have been used by humans since the beginning of time, according to research into human history. The hand axes and flints that Neanderthal Man used for his work were made of stones or bones that had been altered to fit the anthropometry of the human hand. This issue's importance has not diminished with time, on the contrary. Additionally, the physical characteristics of the workers should be compatible with the modern equipment. Measurements of the length, width, and height of the human body are the subject of the science known as anthropometry (T. Kanchan, K. Kirshan, 2011), is appropriate for this optimization. It is well recognized that mismatches between the anthropometric measurements of humans and the dimensions of equipment can lead to reduced productivity, discomfort, mishaps, injuries, and cumulative traumas (Loslever & Ranaivosoa, 1993; Imran et al., 1993). The use of hand anthropometric data is essential for engineers designing any hand tool; without it, the product may not be ergonomically sound. The design of handles, grip options, and operation button distances all depend on hand anthropometry data. Applications of the findings in the following paper are not limited to hand tool design. The dimensions needed for hand access openings

in machinery (for automation in assembly or safety purposes, for example) can be ascertained using the data that is provided. There are a lot of factors to consider, like age group, dominant hand, gender of the operating person, and nationality. But not every task calls for a particular hand tool, and not every user benefits from having the same tool (Y.A.A. Mohammad, 2005). People who will be using the tool daily should be involved in the testing process as new ergonomic designs are being tested. This study set out to measure Bangladeshis' hands precisely and compared the results with those of other studies involving different populations. The purpose of selecting hand dimensions was based on their intended use, mainly in the design of firearms (Sekulova et al., 2015). The data are used more widely in hand tool design in general, though. The aging factor received special attention as well. Unlike other recently published studies on hand anthropometry, this one:

**Table 1** Cluster analysis of the population

Division's	Populations	
	Male	Female
Dhaka	12	2
Chattogram	2	1
Barishal	7	4
Khulna	7	0
Mymensingh	11	1
Sylhet	6	1
Rangpur	9	3
Rajshahi	4	1
<b>Total</b>	<b>58</b>	<b>13</b>

Bangladeshi uses European standards for workplaces and tool design however this standard is not sufficient.

## METHODOLOGY

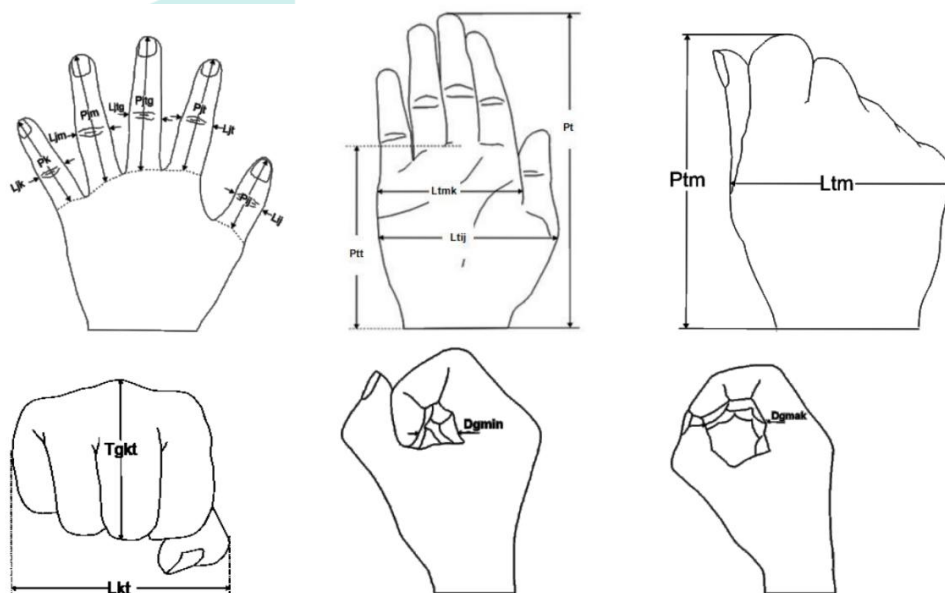
### Subjects

A total of 71 people were measured, including 58 men and 13 women. The study was mainly attended by students. Sampling was based on subjects' ability and willingness to participate without compensation or coercion. All subjects were physically fit by self-report. Statistical analysis excluded all types of hand injuries. The age range of all participants was between 20 and 25 years. Of all sample members (male and female), 90% were right-handed and 10% left-handed.

### Apparatus and measurements

Twenty-five hand measurements were taken, along with height and weight. The size was chosen to match the design of the handpiece.

1. Thumb width (Lij),
2. Index finger width (Ljt),
3. Middle finger width (Ljtg),
4. Ring finger width (Ljm),
5. The width of the little finger (Ljk),
6. Thumb length (Pij),
7. Index finger length (Pjt),
8. Middle finger length (Length),
9. Ring finger length (Pjm),
10. The length of the little finger (Pjk),
11. Metacarpal hand thickness (Ttm),
12. Thumb hand thickness (Ttij),
13. Thumb thickness (Tij),
14. Finger thickness (Tj),
15. Hand gripping length (Ptm),
16. Hand gripping width (Ltm),
17. Hand length (Pt),
18. Palm length (Ptt),
19. Metacarpal hand width (Ltmk),
20. Width of hand to thumb (Ltij),
21. Little thumb distance (Jjk),
22. Maximum grip diameter (Dgmax),
23. Minimum grip diameter (Dgmin),
24. Fist width (Lkt),
25. Fist height (Tgkt).



**Fig. 1** Palm measurements dimension in different positions (Website)

### Statistical Analysis

The data were statistically analyzed by Statistics Toolbox MATLAB version 7.3 software to determine the normality assumption of the data and the percentile values. The descriptive values were summarized in terms of mean, standard deviation (SD), coefficient of variation (CV) and 10th, 50th and 90th percentiles. A statistically significant paired and unpaired t-test for determining the difference between male and female, right hand and the left hand and other correlations

between body dimensions and age, body mass, stature or dominant hand were performed. Statistical evaluation was carried out on a participants sample aged from 20-25 years. This group of participants was divided into single group which is identical with DIN 33402-2 (Database, 2006) for subsequent comparisons. The summary of all measurements is described in Table 3. This table contains percentile values (5th, 50th and 90th), means and standard deviations for all measurements according to genders. In table 2 the cluster of individual age groups has stated here for clear understanding about the age variations.

**Table 2** Cluster of individual age groups

Age groups	Male	Female
18-25	58	13

## RESULTS & DISCUSSION

Few hands anthropometric survey of various nationalities such as India, Jordanian, Singaporean, and Nigerian as well as Bangladeshi female population were shown in Table 3. Here, age range and sample population size for different nationalities' population are quite similar with the present study. Mean stature and standard deviation of different population can be compared from this Table.

**Table 3** Sample Population Features of Various Works on Different Population

Studies	Nationality	Range of age	Sample populations	Mean ±Standard Deviation
Present study	Bangladeshi	18-25	Male: 58	171.5±6.1
			Female: 13	161.15±3.17
Nag et.al 2003	Indian	18-60	Male: 37	157.22±8.76
			Female: 51	149.88±6.28
Mandahawi 2008	Jordanian	18-59	Male: 120	162.19±5.20
			Female: 24	132.77±7.71
Saengchaiya and Bunternghit 2004	Singaporean	18-59	Male: 120	149.88±6.28
			Female: 150	116.19±4.64

**Table 4** Comparisons of measurements for Bangladeshi male and female university students

Dimension	Age group		Male				Female			
	18-25	10 <sup>th</sup>	50 <sup>th</sup>	90 <sup>th</sup>	Mean	SD	10 <sup>th</sup>	50 <sup>th</sup>	90 <sup>th</sup>	Mean
Height	164.2	172	180.3	171.5	6.1	155.6	162	165.07	161.5	3.17
Weight	53.8	64	83.2	66.6	11.4	46.6	57	66.8	56.6	6.83
BMI	17.46	20.2	25.26	20.58	2.79	17.5	21.5	25.96	21.65	2.81
(L.H) Thumb width (Lij) [cm]	1.88	2.4	3	2.41	0.42	1.83	2.5	2.91	2.4	0.36
(R.H) Thumb width (Lij) [cm]	1.9	2.5	3	2.45	0.40	1.73	2.5	2.91	2.39	0.37
(L.H) Index finger width(Ljt) [cm]	1.5	2.3	2.8	2.25	0.44	1.8	2.2	2.67	2.18	0.29
(R.H) Index finger width(Ljt) [cm]	1.6	2.3	2.82	2.29	0.43	1.8	2.2	2.67	2.19	0.28
(L.H) Middle finger width(Ljtg) [cm]	1.8	2.2	2.92	2.26	0.43	1.63	2.25	2.7	2.27	0.33
(R.H) Middle finger width(Ljtg) [cm]	1.7	2.2	3	2.3	0.45	1.63	2.4	2.87	2.33	0.42
(L.H) Ring finger width(Ljm) [cm]	1.68	2.1	2.7	2.19	0.43	1.63	2.3	2.6	2.19	0.37
(R.H) Ring finger width(Ljm) [cm]	1.7	2.3	2.8	2.23	0.43	1.6	2.35	2.64	2.15	0.4
(L.H) Width of little finger[cm]	1.3	2	2.6	1.98	0.44	1.33	2	2.2	1.88	0.28
(R.H) Width of little finger[cm]	1.4	2.1	2.72	2.05	0.47	1.33	2.1	2.2	1.88	0.35
(L.H) Thumb length(Pjt) [cm]	5.58	6.4	7.66	6.46	0.71	5.5	6.45	7.1	6.46	0.55
(R.H) Thumb length(Pjt) [cm]	5.6	6.5	7.44	6.53	0.69	5.65	6.7	7.07	6.57	0.47
(L.H) Index finger length(Pjt) [cm]	6.5	7.3	8.16	7.4	0.72	6.49	7.35	7.5	7.18	0.33
(R.H) Index finger length(Pjt) [cm]	6.8	7.4	8.32	7.49	0.67	7.13	7.4	8.04	7.48	0.29
(L.H) Middle finger length[cm]	7.58	8.2	9.08	8.35	0.69	7.25	8	8.58	7.96	0.38

(R.H) Middle finger length[cm]	7.58	8.3	9.12	8.37	0.71	7.2	8.05	8.64	8.03	0.45
(L.H) Ring finger length[cm]	6.46	7.5	8.76	7.63	0.81	6.86	7.4	8.27	7.38	0.43
(R.H) Ring finger length[cm]	6.88	7.6	8.8	7.70	0.77	5.9	7.3	8.46	7.20	0.76
(L.H) Length of little finger(Pjk) [cm]	6	6.5	7.8	6.69	0.72	5.83	6	6.62	6.06	0.25
(R.H) Length of little finger(Pjk) [cm]	6	6.6	7.72	6.75	0.68	5.8	6	6.41	6.03	0.19
(L.H) Metacarpal hand thickness[cm]	1.5	1.9	2.22	1.90	0.30	1.3	1.9	2.07	1.83	0.25
(R.H) Metacarpal hand thickness[cm]	1.4	2	2.3	1.96	0.33	1.2	1.95	2.14	1.82	0.31
(L.H) Thumb hand thickness(Ttj) [cm]	6	6.8	7.32	6.69	0.55	5.59	6	6.07	5.93	0.15
(R.H) Thumb hand thickness(Ttj) [cm]	6	6.9	7.42	6.75	0.6	5.59	5.9	6.2	5.94	0.19
(L.H) Thumb thickness(Tij) [cm]	4.18	4.7	5.5	4.75	0.54	2.33	3.5	4.23	3.43	0.58
(R.H) Thumb thickness(Tij) [cm]	4.2	4.8	5.6	4.82	0.55	2.25	3.55	4.26	3.47	0.58
(L.H) Finger thickness[cm]	4.68	6.2	6.92	6.11	0.84	5.5	5.65	5.97	5.71	0.18
(R.H) Finger thickness[cm]	4.6	6.2	7.12	6.2	0.87	5.5	5.75	6	5.75	0.18
(L.H) Hand gripping length(Ptm) [cm]	11	11.8	12.92	11.82	0.95	11.06	12.5	12.9	12.19	0.72
(R.H) Hand gripping length(Ptm) [cm]	11	12	13.02	11.95	0.98	11.2	12.6	13	12.33	0.66
(L.H) Hand gripping width(Ltm) [cm]	9.88	10.4	12.18	10.58	0.98	8.7	10	10.41	9.74	0.61
(R.H) Hand gripping width(Ltm) [cm]	9.24	10.5	12	10.63	1.00	8.7	10	10.37	9.78	0.59
(L.H) Hand length(Pt) [cm]	17.08	18	21	18.46	1.35	17.15	17.9	18.07	17.82	0.29
(R.H) Hand length(Pt) [cm]	17.38	18.2	21.04	18.48	1.26	17.43	17.9	18.14	17.83	0.21
(L.H) Palm length(Ptt) [cm]	8.1	10.5	12	10.35	1.24	7.13	7.95	9.39	7.98	0.66
(R.H) Palm length(Ptt) [cm]	8.18	10.7	11.9	10.36	1.29	7.1	8	9.42	8	0.68
(L.H) Metacarpal hand width(Ltmk) [cm]	7.5	8.2	8.74	8.23	0.59	7.2	7.6	8.91	7.12	0.52
(R.H) Metacarpal hand width(Ltmk) [cm]	7.58	8.3	8.7	8.29	0.60	7.16	7.8	8.98	7.83	0.54
(L.H) width of hand to thumb(Ltlj) [cm]	6.56	7.8	10.06	8.19	1.27	5.9	6.45	6.64	6.31	0.27
(R.H) width of hand to thumb(Ltlj) [cm]	6.56	7.9	9.96	8.30	1.25	5.73	6.5	6.71	6.32	0.33
(L.H) Little thumbs distance(Jjk) [cm]	5.3	6.1	6.6	6.04	0.49	4.9	5.2	5.5	5.19	0.19
(R.H) Little thumbs distance(Jjk) [cm]	5.5	6.2	6.72	6.18	0.5	5.06	5.35	5.57	5.34	0.14
(L.H) Maximum grip diameter(Dgmak) [cm]	3.68	4.2	5	4.33	0.67	3.5	4.25	4.85	4.25	0.41
(R.H) Maximum grip diameter(Dgmak) [cm]	3.6	4.4	5.1	4.43	0.69	3.4	4.4	5	4.28	0.49
(L.H) Minimum grip diameter(Dgmin) [cm]	1.78	2.1	2.52	2.06	0.38	1.7	2.6	2.7	2.4	0.38

(R.H) Minimum grip diameter(Dgmin) [cm]	1.78	2.2	2.72	2.15	0.39	1.6	2.6	2.9	2.45	0.44
(L.H) Fist width(Lkt) [cm]	8.88	10.8	12.04	10.59	1.2	8.4	8.45	11.19	8.93	0.95
(R.H) Fist width(Lkt) [cm]	8.9	10.9	12.3	10.64	1.24	8.23	8.55	11.33	8.93	1.01
(L.H) Fist height(Tgkt) [cm]	5.38	6.1	6.76	6.01	0.59	5.2	5.65	6.44	5.71	0.38
(R.H) Fist height(Tgkt) [cm]	5.48	6.2	6.84	6.09	0.55	5.5	5.6	6.37	5.74	0.31

### Difference between Male and female value with statically

#### Treatment 1

N1: 53  
 $df1 = N - 1 = 53 - 1 = 52$   
M1: 11.09  
SS1: 30661.98  
 $s21 = SS1/(N - 1) = 30661.98/(53-1) = 589.65$

#### Treatment 2

N2: 53  
 $df2 = N - 1 = 53 - 1 = 52$   
M2: 10.23  
SS2: 26694.46  
 $22 = SS2/(N - 1) = 26694.46/(53-1) = 513.3566666$

### T-value Calculation

$s2p = ((df1/(df1 + df2)) * s21) + ((df2/(df2 + df2)) * s22) = ((52/104) * 589.65) + ((52/104) * 513.35) = 551.5$   
 $s2M1 = s2p/N1 = 551.5/53 = 10.41$   
 $s2M2 = s2p/N2 = 551.5/53 = 10.41$   
 $t = (M1 - M2)/\sqrt{(s2M1 + s2M2)} = 0.86/\sqrt{20.81} = 0.19$   
The t-value is 0.18814. The p-value is .425565. The result is not significant at  $p < .05$ .

### Single Sample T-Test

United fans reported higher levels of stress ( $M = 83, SD = 5$ ) than found in the population,  $t(48) = 2.3, p = .026$ .  
Coffee drinkers spent more time awake ( $M = 17.8, SD = 1.4$ ) than the population norm,  $t(28) = 2.6, p < .05$ .

### Independent T-Test

The 25 participants who received the drug intervention ( $M = 480, SD = 34.5$ ) compared to the 28 participants in the control group ( $M = 425, SD = 31$ ) demonstrated significantly better peak flow scores,  $t(51) = 2.1, p = .04$ .  
There was no significant effect for sex,  $t(3--8) = 1.7, p = .097$ , despite women ( $M = 55, SD = 8$ ) attaining higher scores than men ( $M = 53, SD = 7.8$ ).

### Dependent T-Test

The results from the pre-test ( $M = 13.5, SD = 2.4$ ) and post-test ( $M = 16.2, SD = 2.7$ ) memory task indicate that the presence of caffeine in the bloodstream resulted in an improvement in memory recall,  $t(19) = 3.1, p = .006$ .  
There was a significant increase in the volume of alcohol consumed in the week after the end of semester ( $M = 8.7, SD = 3.1$ ) compared to the week before the end of semester ( $M = 3.2, SD = 1.5$ ),  $t(52) = 4.8, p < .001$ .

**Table 5** Comparison of hand anthropometric data of selected world nationalities (Bures et al., 2015)

Nationality	Values	Male (18-25 years)				Female (18-25 years)			
		Hand length	Palm length	Hand breadth	Middle finger length	Hand length	Palm length	Hand breadth	Middle finger length
Vietnamese	Mean	177	98.8	79.2	78.2	165	92.7	71	72.3
	SD	12	--	6.9	4.5	9	--	4.3	4.6
Bangladeshis [cm]	Mean	18.48	8.19	1.96	8.37	17.82	6.31	1.82	8.03
	SD	1.26	1.27	0.33	0.71	0.29	0.27	0.31	0.45
Filipinos	Mean	197.5	--	98	--	179.5	--	92.3	--
	SD	7.82	--	4.07	--	3.44	--	6.97	--
Jordanians	Mean	191.2	109.9	87.7	81.3	171.3	96.1	77.8	75.2
	SD	10.2	--	4.82	7.14	7.44	--	3.92	3.62
Turkish	Mean	190.4	108.5	87.3	81.9	172.2	97.8	76.1	74.4
	SD	9.69	--	4.67	5.15	8.14	--	4.66	3.91
Mexicans	Mean	185.5	107	85.3	78.5	--	--	--	--
	SD	7.1	--	4.9	4.4	--	--	--	--
Czechs	Mean	192	110	89	82	176	100	79	76
	SD	9.83	6.1	5.63	5.29	8.01	4.82	4.11	4.73

## CONCLUSION

The study described in this article aims to collect up-to-date data on manual measurements in Bangladeshis aged 18–25 years and use these data for potential design of hand tools and human-machine interaction. The statistical evaluation of the measured values was compared with six countries around the world to find differences.

**Age relation** – The results of this study showed that age had little effect on the relevant hand measures. Differences were found only in height and weight. The hypothesis that height decreases with age was confirmed. On the other hand, all weight-related diseases tended to increase with age. Overall, a small increase was seen for women.

**Males vs. females** – Our study found that women's hand sizes were about 3% to 5% smaller, depending on their size. Of course, larger differences were found in arm length and girth, and smaller differences were found in finger length.

**Right vs. left hand** – The differences in measurements between the two arms were not found to be significant. In the longitudinal measurements, the differences were shifted by about 1 mm, resulting in high agreement. A relatively large difference of approximately 5–6 mm was observed in the right large limb.

**Comparison with other nationalities** – This comparison was conducted across five nationalities (Vietnamese, Filipino, Jordanian, Turkish and Mexican men). The Czech, Turkish and Jordanian hands were very similar in size due to their relative geographic proximity. With all these statistical evaluations and comparisons, we have enough information and up-to-date data for all applications that require human (manual) intervention.

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## DECLARATION OF CONFLICT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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