

# **Anthropometric Database for the Learning Environment of High School and University Students**

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*This paper presents an anthropometric database of high school and university students from Kuala Lumpur, Malaysia. Forty-one high school participants (21 males and 20 females), 13–17 years old, and 143 university students (74 males and 69 females) took part in the study. Twenty-one static body dimensions were measured. The greatest mean differences in the anthropometric data between male and female high school students were found in the sitting elbow height. In addition, a comparison of anthropometric data of male and female university students showed that data for males and females were significantly different, except for buttock–popliteal length, sitting elbow height and thigh clearance. The primary aim of this study was to develop an anthropometric database that could be used as a primary reference in designing products, devices and equipment for ergonomic learning environments.*

anthropometry   high school students   university students   computer workstation

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## **1. INTRODUCTION**

Fast advancement in technology has led to a greater development in the production of machines and equipment. As the world population is growing rapidly [1], the demand for better and more efficient products is increasing. As the human factor cannot be separated from the production process, ergonomics is one of the most important aspects that need to be addressed in the process of designing high quality products. An ergonomic design would help to increase comfort, work productivity and performance. The number of work-related injuries would also be reduced [2, 3].

Anthropometry is the branch of the human sciences that deals with body measurements: measurements of body size, shape, strength and working

capacity [4]. It deals with the physical characteristics of a person, particularly with individual variations, ontogenesis and generic development. Anthropometric data on the general population is essential in ergonomics to specify the physical dimensions of workspace, equipment, furniture and clothing to fit the user and to avoid a physical mismatch between the dimensions of products and equipment and corresponding user dimensions [5]. In ergonomic anthropology, a person is a basic unit in the human–machine system. The primary guideline of ergonomic design is to design the workplace to accommodate most individuals with regard to the structural size of the human body [6]. Human diversity such as gender, age, ethnicity, social status, health and occupation must also be considered in defining a target population for anthropometric pur-

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poses [4]. This clearly has implications for the way products and devices are designed. The application of ergonomic research in this aspect would produce optimum conditions for the proper functioning of the human-machine system. This, in turn, results in adequate information for the design and ergonomic assessment of this system [7].

Several researchers studied anthropometric data [7, 8, 9, 10, 11, 12]. It is acknowledged that different populations from different countries differ in their anthropometric dimensions [8, 12]. Researchers studied the anthropometric dimensions of Asian populations, e.g., Jordanian [12], Thai [3], Bahraini [13] and Indian [14]. However, there is very limited research on the anthropometric data of the Malaysian population.

A number of complaints, e.g., musculoskeletal stress and back pain, were reported as caused by the dimension misfit between a machine or equipment and the workers [8, 12]. Gouvali and Boudolos reported difficulties experienced by most students in finding school chairs and tables appropriate for their body dimensions [2]. In general, researchers suggested the need for ergonomically designed school furniture to meet school students' needs and to ensure comfort [2, 10, 15].

Computers have become important in people's life, both for work and leisure. Hence, computer use in education is growing rapidly [16]. Nowadays, the learning and teaching processes at the university require students to use information technology facilities more often [17]. Therefore, further study on computer workstations in educational institutions is essential.

As anthropometric dimensions of humans widely vary across the age range [19, 20, 21], it is crucial to investigate the effect of age on anthropometric characteristics. Thus, the aim of this study was to examine the anthropometric comparison of high school and university students in Malaysia in the context of designing a computer workstation.

## 2. METHODS

### 2.1. Study Participants

Students from junior and senior high schools and university students from different fields of study in Kuala Lumpur, Malaysia, participated in this

study on a voluntary basis. Of the total number of participants, 41 were high school students (21 males and 20 females, 13–17 years old), with the mean age (*SD*) of 15.02 (1.34) years. Most of them were Malay. Of the 143 university students (74 males and 69 females), 69.93% were Malay, 22.38% were Chinese and 7.69% were Indian. Their mean age (*SD*) was 22.85 (3.64) years. They came from different fields of study at the University of Malaya. The participants were paid for their time and participation.

Sociodemographic data (occupation, family background and past medical history) were obtained with a self-administered questionnaire. The sample was representative of various socioeconomic strata in Malaysia. Anthropometric data were collected on site: in schools and at the university.

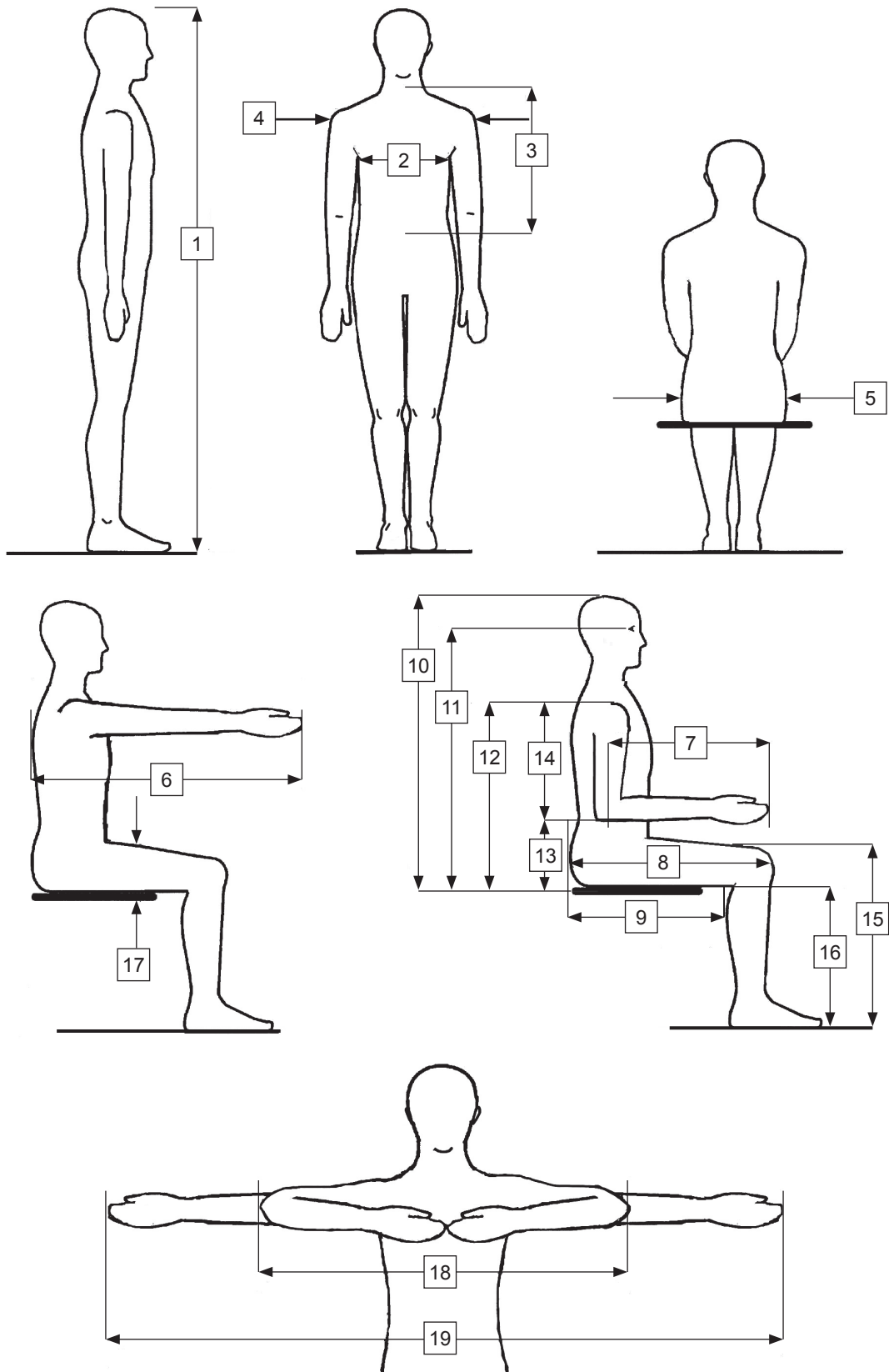
### 2.2. Dimensions

Twenty-one static body dimensions were selected for measurement. Four trained research assistants took the measurements during the day. One participant was measured three times by the same person; intrareliability was  $r = .86$ .

All anthropometric measurements were based on Pheasant's protocol [4]. These dimensions are essential for designing a computer workstation. The measurements, with the exception of stature, span and elbow span, were taken with the student sitting on a seat with a horizontal surface, with knees bent at 90° and with bare feet placed flat on an adjustable horizontal step. Figure 1 shows the dimensions of the human body measured in this study.

### 2.3. Measuring Equipment

Standard, calibrated tools for anthropometric measurements were used in the study. The measuring equipment consisted of a standard professional anthropometry measuring set, a scientific Martin pelvimeter and TTM bone caliper (TTM Martin's human body measuring kit; Mentone Educational Centre, Australia), a weighing scale and a measuring chair. During the measurement, participants wore only light clothing and no shoes.



**Figure 1. Anthropometric dimensions.** Notes. 1 = stature; 2 = interscye breadth; 3 = back waist length; 4 = shoulder breadth; 5 = hip breadth, sitting; 6 = arm reach forward; 7 = forearm–hand length; 8 = buttock–knee length; 9 = buttock–popliteal length; 10 = sitting height; 11 = sitting eye height; 12 = sitting shoulder height; 13 = sitting elbow height; 14 = shoulder–elbow length; 15 = knee height; 16 = popliteal height; 17 = thigh clearance; 18 = elbow span; 19 = span.

## 2.4. Statistical Analysis

SPSS for Windows version 16.0 was used in the following statistical analysis. Extreme outliers, results that were unreasonable and probably resulted from errors in measurement or recoding, were carefully identified and eliminated. Normality was examined with the Shapiro–Wilk method. Descriptive statistics, including arithmetic means (*M*), standard deviations (*SD*), and percentiles (5th, 50th and 95th) of the measurements were calculated for both male and female participants. Variation was also expressed with coefficient of variation (*CV*) values. In addition, an independent *t* test was used to compare data between male and female participants and between ages.

## 3. RESULTS

### 3.1. Data for Male and Female High School Students

Tables 1–2 present anthropometric data for male and female high school students. The dimensions

include *M*, *SD*, *CV*, and 5th and 95th percentile values. The average age, weight and stature of the male participants were  $15.00 \pm 1.25$  years,  $52.13 \pm 13.02$  kg and  $160.04 \pm 7.32$  cm, respectively. The average age, weight and stature of the female participants were  $14.85 \pm 1.42$  years,  $47.40 \pm 7.84$  kg and  $152.54 \pm 6.83$  cm, respectively.

### 3.2. Data for Male and Female University Students

Tables 3–4 present anthropometric data for male and female university students. The dimensions include *M*, *SD*, *CV*, and 5th and 95th percentile values. The average age, weight and stature of the male participants were  $22.55 \pm 5.09$  years,  $67.28 \pm 13.52$  kg and  $170.49 \pm 5.40$  cm, respectively. The average age, weight and stature of the female participants were  $23.15 \pm 2.20$  years,  $54.17 \pm 11.31$  kg and  $157.29 \pm 5.74$  cm, respectively.

**TABLE 1. Anthropometric Data for Male High School Students (*n* = 21)**

No.	Anthropometry <sup>a</sup>	<i>M</i>	<i>SD</i>	<i>CV</i>	5th Percentile	95th Percentile
1	weight (kg)	52.13	13.02	.25	37.20	76.40
2	stature	160.04	7.32	.05	150.00	169.60
3	interscye breadth	29.47	3.68	.12	25.00	37.00
4	back waist length	44.86	4.69	.10	38.50	53.25
5	shoulder breadth	39.28	3.71	.09	34.40	44.80
6	hip breadth, sitting	32.98	4.68	.14	27.00	42.40
7	arm reach forward	75.65	17.86	.24	31.20	87.75
8	forearm–hand length	44.77	2.06	.05	42.00	48.05
9	buttock–knee length	53.00	3.09	.06	49.70	57.85
10	buttock–popliteal length	42.54	2.07	.05	39.25	45.55
11	sitting height	82.37	14.41	.17	71.40	87.00
12	sitting eye height	70.64	13.85	.20	58.20	76.05
13	sitting shoulder height	55.51	12.69	.23	47.50	59.25
14	sitting elbow height	24.75	23.05	.93	13.75	66.50
15	shoulder–elbow length	35.25	5.08	.14	32.00	38.50
16	knee height	51.05	2.55	.05	47.00	54.75
17	popliteal height	41.14	1.86	.05	39.30	44.60
18	thigh clearance	11.58	2.36	.20	9.70	15.45
19	span	163.11	8.04	.05	154.00	175.05
20	elbow span	86.09	9.19	.11	77.25	94.55

Notes. a = adapted from Pheasant [4], measured in centimeters; *CV* = coefficient of variation.

**TABLE 2. Anthropometric Data for Female High School Students (n = 20)**

No.	Anthropometry <sup>a</sup>	M	SD	CV	5th Percentile	95th Percentile
1	weight (kg)	47.40	7.84	.17	35.95	62.00
2	stature	152.54	6.83	.04	142.24	161.60
3	interscye breadth	25.02	1.55	.06	22.75	27.24
4	back waist length	36.22	3.26	.09	31.44	40.34
5	shoulder breadth	36.48	2.38	.07	33.19	39.72
6	hip breadth, sitting	32.62	3.67	.11	27.33	37.94
7	arm reach forward	77.04	4.51	.06	70.74	84.20
8	forearm–hand length	42.20	1.92	.05	39.64	44.68
9	buttock–knee length	51.25	5.18	.10	44.85	55.81
10	buttock–popliteal length	44.23	7.56	.17	39.75	48.85
11	sitting height	77.56	14.90	.19	67.22	85.49
12	sitting eye height	68.11	12.06	.18	60.80	74.28
13	sitting shoulder height	52.55	11.87	.23	42.95	62.33
14	sitting elbow height	17.48	3.17	.18	12.44	23.07
15	shoulder–elbow length	33.20	1.98	.06	30.43	35.75
16	knee height	47.26	3.65	.08	40.66	51.85
17	popliteal height	39.03	2.51	.06	34.74	41.79
18	thigh clearance	11.71	1.82	.16	8.47	14.29
19	span	155.02	7.85	.05	144.84	163.46
20	elbow span	81.26	14.64	.18	70.71	86.62

Notes. a = adapted from Pheasant [4], measured in centimeters; CV = coefficient of variation.

**TABLE 3. Anthropometric Data for Male University Students (n = 74)**

No.	Anthropometry <sup>a</sup>	M	SD	CV	5th Percentile	95th Percentile
1	weight (kg)	67.28	13.52	.20	53.00	95.00
2	stature	170.49	5.40	.03	162.07	179.10
3	interscye breadth	30.73	3.22	.10	26.29	35.70
4	back waist length	46.15	4.72	.10	38.07	53.55
5	shoulder breadth	42.36	2.83	.07	38.63	47.31
6	hip breadth, sitting	33.59	4.25	.13	25.69	40.35
7	arm reach forward	81.88	10.33	.13	70.00	94.62
8	forearm–hand length	46.11	2.20	.05	42.57	49.27
9	buttock–knee length	54.27	3.79	.07	48.79	59.94
10	buttock–popliteal length	43.09	4.48	.10	34.27	49.71
11	sitting height	89.31	4.31	.05	81.86	95.98
12	sitting eye height	77.55	4.62	.06	71.64	85.04
13	sitting shoulder height	60.48	3.85	.06	54.65	67.24
14	sitting elbow height	17.91	2.86	.16	15.08	21.08
15	shoulder–elbow length	35.31	2.94	.08	31.86	39.11
16	knee height	52.01	5.24	.10	47.65	57.18
17	popliteal height	42.54	5.66	.13	37.00	47.07
18	thigh clearance	13.85	1.97	.14	11.75	15.92
19	span	173.31	7.89	.05	162.04	185.49
20	elbow span	86.96	7.28	.08	74.30	97.79

Notes. a = adapted from Pheasant [4], measured in centimeters; CV = coefficient of variation.

**TABLE 4. Anthropometric Data for Female University Students ( $n = 69$ )**

No.	Anthropometry <sup>a</sup>	<i>M</i>	<i>SD</i>	<i>CV</i>	5th Percentile	95th Percentile
1	weight (kg)	54.17	11.31	.21	41.63	73.38
2	stature	157.29	5.74	.04	150.38	167.77
3	interscye breadth	27.44	3.26	.12	22.06	32.84
4	back waist length	39.32	4.56	.12	32.92	48.78
5	shoulder breadth	37.21	3.39	.09	32.85	41.74
6	hip breadth, sitting	35.10	3.63	.10	30.19	40.91
7	arm reach forward	76.03	7.05	.09	68.65	82.34
8	forearm–hand length	42.44	4.73	.11	37.95	46.55
9	buttock–knee length	51.79	5.04	.10	46.65	56.69
10	buttock–popliteal length	42.14	3.87	.09	36.55	48.24
11	sitting height	82.08	5.89	.07	76.12	88.97
12	sitting eye height	71.35	5.74	.08	64.72	78.20
13	sitting shoulder height	54.91	4.32	.08	48.58	61.13
14	sitting elbow height	19.35	0.21	.01	19.22	19.49
15	shoulder–elbow length	33.02	4.14	.13	29.29	36.01
16	knee height	47.96	4.23	.09	39.73	52.68
17	popliteal height	39.95	3.93	.10	33.83	45.14
18	thigh clearance	12.05	1.48	.12	11.11	13.00
19	span	154.54	13.06	.08	140.10	165.70
20	elbow span	81.38	11.79	.14	74.04	85.05

Notes. a = adapted from Pheasant [4], measured in centimeters; CV = coefficient of variation.

### 3.3. Gender and Anthropometric Data for High School and University Students

An independent *t* test was used to analyze the differences in anthropometric data between genders. Tables 5–6 show that there were significant differences in some anthropometric data between male and female high school students, and between male and female university students. There were significant differences between male and female high school students in stature, weight, interscye breadth, back waist length, shoulder breadth, forearm–hand length, knee height, popliteal height and span measurements. All data for males for these measurements were higher than for females.

The comparison of anthropometric data for male and female university students showed that they differed significantly, except for buttock–popliteal length, sitting elbow height and thigh clearance. All data for males were higher than for females except for hip breadth sitting and sitting elbow height.

### 3.4. Data for High School and University Students

There were only few significant differences in anthropometric data for male high school students and male university students. Weight, stature, shoulder breadth, arm reach forward, forearm hand length, sitting height, sitting eye height, sitting shoulder height and span were different (Table 7).

Like males, female high school students and female university students differed significantly in weight, stature, interscye breadth, back waist length, hip breadth sitting and sitting height (Table 8).

## 4. DISCUSSION

### 4.1. Anthropometry of High School Students

Table 6 shows that male and female high school students significantly differed in stature, interscye breadth, back waist length, forearm–hand length, knee height, popliteal height and span. To main-

TABLE 5. Anthropometric Data for Male and Female High School Students

No.	Anthropometry	Gender	N	M	SD	p
1	weight (kg)	male	19	52.13	13.02	.175
		female	20	47.40	7.84	
2	stature	male	21	160.04	7.32	.002
		female	20	152.54	6.83	
3	interscye breadth	male	21	29.47	3.68	<.001
		female	20	25.02	1.55	
4	back waist length	male	21	44.86	4.69	<.001
		female	20	36.22	3.26	
5	shoulder breadth	male	21	39.28	3.71	.007
		female	20	36.48	2.38	
6	hip breadth, sitting	male	21	32.98	4.68	.784
		female	20	32.62	3.67	
7	arm reach forward	male	21	75.65	17.86	.739
		female	20	77.04	4.51	
8	forearm–hand length	male	21	44.77	2.06	<.001
		female	20	42.20	1.92	
9	buttock–knee length	male	21	53.00	3.09	.194
		female	20	51.25	5.18	
10	buttock–popliteal length	male	21	42.54	2.07	.330
		female	20	44.23	7.56	
11	sitting height	male	21	82.37	14.41	.299
		female	20	77.56	14.90	
12	sitting eye height	male	21	70.64	13.85	.537
		female	20	68.11	12.06	
13	sitting shoulder height	male	21	55.51	12.69	.446
		female	20	52.56	11.87	
14	sitting elbow height	male	21	24.75	23.05	.170
		female	20	17.48	3.17	
15	shoulder–elbow length	male	21	35.25	5.08	.099
		female	20	33.20	1.98	
16	knee height	male	21	51.05	2.55	.000
		female	20	47.26	3.65	
17	popliteal height	male	21	41.14	1.86	.004
		female	20	39.03	2.51	
18	thigh clearance	male	21	11.58	2.36	.840
		female	20	11.71	1.82	
19	span	male	21	163.11	8.04	.002
		female	20	155.02	7.85	
20	elbow span	male	21	86.09	9.19	.210
		female	20	81.26	14.64	

tain comfort at the workstation, individual body part measurements should be considered in the design. Generalizing those measurements would result in discomfort and stress in those body parts.

The greatest mean differences between male and female high school students were found in

sitting elbow height, followed by back waist length and interscye breadth. A study of secondary school students in Hong Kong revealed an opposite result as the mean values of sitting elbow height for male and female students were approximately similar [22]. The difference in

TABLE 6. Anthropometric Data for Male and Female University Students

No.	Anthropometry	Gender	N	M	SD	p
1	weight (kg)	male	73	67.28	13.52	<.001
		female	68	54.17	11.31	
2	stature	male	74	170.49	5.39	<.001
		female	69	157.29	5.74	
3	interscye breadth	male	74	30.73	3.22	<.001
		female	69	27.44	3.26	
4	back waist length	male	74	46.15	4.72	<.001
		female	69	39.32	4.56	
5	shoulder breadth	male	74	42.36	2.83	<.001
		female	69	37.21	3.39	
6	hip breadth, sitting	male	74	33.59	4.25	.024
		female	69	35.10	3.63	
7	arm reach forward	male	74	81.88	10.33	<.001
		female	69	76.03	7.05	
8	forearm–hand length	male	74	46.11	2.19	<.001
		female	69	42.48	4.73	
9	buttock–knee length	male	74	54.27	3.79	.001
		female	69	51.79	5.04	
10	buttock–popliteal length	male	74	43.09	4.48	.179
		female	69	42.14	3.87	
11	sitting height	male	74	89.31	4.31	<.001
		female	69	82.08	5.89	
12	sitting eye height	male	74	77.55	4.62	<.001
		female	69	71.35	5.74	
13	sitting shoulder height	male	74	60.48	3.85	<.001
		female	69	54.91	4.32	
14	sitting elbow height	male	4	17.91	2.86	.539
		female	2	19.35	0.21	
15	shoulder–elbow length	male	74	35.31	2.94	<.001
		female	69	33.02	4.14	
16	knee height	male	74	52.01	5.24	<.001
		female	69	47.96	4.23	
17	popliteal height	male	74	42.54	5.66	.002
		female	69	39.95	3.93	
18	thigh clearance	male	4	13.85	1.97	.327
		female	2	12.05	1.48	
19	span	male	52	173.31	7.89	<.001
		female	49	154.63	12.80	
20	elbow span	male	52	86.96	7.28	.004
		female	49	81.36	11.55	

these results may result from the limited number of participants involved in the present study, which gave a poor representation of the anthropometric measurements of secondary students in Malaysia.

Generally, all dimensions of male high school students were greater than those of female students except for arm reach forward, buttock–popliteal length and thigh clearance. At 10–14 years old, there is an increase in growth rate of females. At this stage, there is an increase in fat in some



**TABLE 7. Anthropometric Data for Male High School Students and Male University Students**

No.	Anthropometry	Age (years)	N	M	SD	p
1	weight (kg)	13–17	19	52.13	13.02	<.001
		18–35	73	67.28	13.52	
2	stature	13–17	21	160.04	7.32	<.001
		18–35	74	170.49	5.39	
3	interscye breadth	13–17	21	29.47	3.68	.127
		18–35	74	30.73	3.22	
4	back waist length	13–17	21	44.86	4.69	.269
		18–35	74	46.15	4.72	
5	shoulder breadth	13–17	21	39.28	3.71	<.001
		18–35	74	42.36	2.83	
6	hip breadth, sitting	13–17	21	32.98	4.68	.573
		18–35	74	33.59	4.25	
7	arm reach forward	13–17	21	75.65	17.86	.044
		18–35	74	81.88	10.33	
8	forearm–hand length	13–17	21	44.77	2.06	.015
		18–35	74	46.11	2.20	
9	buttock–knee length	13–17	21	53.00	3.09	.164
		18–35	74	54.27	3.79	
10	buttock–popliteal length	13–17	21	42.54	2.07	.586
		18–35	74	43.09	4.48	
11	sitting height	13–17	21	82.37	14.41	<.001
		18–35	74	89.31	4.31	
12	sitting eye height	13–17	21	70.64	13.85	<.001
		18–35	74	77.55	4.62	
13	sitting shoulder height	13–17	21	55.51	12.69	.004
		18–35	74	60.48	3.85	
14	sitting elbow height	13–17	21	24.73	23.05	.566
		18–35	4	17.91	2.87	
15	shoulder–elbow length	13–17	21	35.25	5.08	.947
		18–35	74	35.31	2.94	
16	knee height	13–17	21	51.05	2.55	.418
		18–35	74	52.01	5.24	
17	popliteal height	13–17	21	41.14	1.86	.269
		18–35	74	42.54	5.66	
18	thigh clearance	13–17	21	11.58	2.36	.085
		18–35	4	13.85	1.97	
19	span	13–17	21	163.11	8.04	<.001
		18–35	52	173.31	7.89	
20	elbow span	13–17	21	86.09	9.19	.672
		18–35	52	86.96	7.28	

body parts, including buttocks and legs. The size of the body increases, too, as a result of the growth of feet, arms, legs and hands. However, the differences in this study were so small that they can be neglected.

The body mass index (BMI), which is defined as weight (in kilograms) per height (in square meters), was calculated for each participant. In general, mean BMI for female high school students was greater than for male high school students; 20.33 and 18.24, respectively. However,

**TABLE 8. Anthropometric Data for Female High School Students and Female University Students**

No.	Anthropometry	Age (years)	N	M	SD	p
1	weight (kg)	13–17	20	47.40	7.84	.014
		18–35	68	54.17	11.31	
2	stature	13–17	20	152.54	6.83	.002
		18–35	69	157.29	5.74	
3	interscye breadth	13–17	20	25.02	1.55	.002
		18–35	69	27.44	3.26	
4	back waist length	13–17	20	36.22	3.26	.006
		18–35	69	39.32	4.56	
5	shoulder breadth	13–17	20	36.48	2.38	.369
		18–35	69	37.21	3.39	
6	hip breadth, sitting	13–17	20	32.62	3.67	.009
		18–35	69	35.10	3.63	
7	arm reach forward	13–17	20	77.04	4.51	.548
		18–35	69	76.03	7.05	
8	forearm–hand length	13–17	20	42.20	1.92	.827
		18–35	69	42.44	4.73	
9	buttock–knee length	13–17	20	51.25	5.18	.675
		18–35	69	51.79	5.04	
10	buttock–popliteal length	13–17	20	44.23	7.56	.098
		18–35	69	42.14	3.87	
11	sitting height	13–17	20	77.56	14.89	.044
		18–35	69	82.08	5.89	
12	sitting eye height	13–17	20	68.11	12.06	.096
		18–35	69	71.35	5.74	
13	sitting shoulder height	13–17	20	52.55	11.87	.172
		18–35	69	54.91	4.32	
14	sitting elbow height	13–17	20	17.48	3.17	.424
		18–35	2	19.35	0.21	
15	shoulder–elbow length	13–17	20	33.20	1.98	.856
		18–35	69	33.02	4.14	
16	knee height	13–17	20	47.26	3.65	.499
		18–35	69	47.96	4.23	
17	popliteal height	13–17	20	39.03	2.51	.324
		18–35	69	39.95	3.93	
18	thigh clearance	13–17	20	11.71	1.82	.802
		18–35	2	12.05	1.49	
19	span	13–17	20	155.02	7.85	.899
		18–35	49	154.63	12.80	
20	elbow span	13–17	20	81.26	14.64	.975
		18–35	49	81.36	11.55	

both values remained in the normal range of BMI. These results contradict Gouvali and Boudolos, who reported anthropometric data for students in Athens, Greece [2]. The data collected from that study revealed that the BMI of male

students was greater than that of female students due to male students' much greater weight. On the other hand, mean BMI of females was approximately the same as our data for Malaysian students.

## 4.2. Anthropometry of University Students

There were 16 anthropometric measurements with significant differences between male university students and female university students. There were no significant differences in hip breadth sitting, buttock popliteal length, sitting elbow height and thigh clearance. The body structure of the two genders is different. In general, men are taller and have greater arm and leg length relative to body length than women. Women tend to have wider hips; their shoulders are more narrow [23]. Adult men and women consistently differ in body size and in physical capability [24].

The results show that males have a larger upper body than females. In general, upper and lower limbs are proportionally as well as absolutely longer in men. Thus, the ratio of sitting height to stature is greater in women than in men. The only limb dimension that is proportionally greater in women is buttock knee length. This is due to the differences in the form of male and female buttocks [4]. Females and males also differ in terms of the composition of their body. Fat represents a greater proportion of body weight in the adult female than in the male. Female have a propensity to accumulate fat in breasts, hips, thighs and upper arms.

## 4.3. Comparison and Workstation Design

A comparison between genders and ages showed differences in body dimensions. There were significant differences in anthropometric data between genders for both high school and university students. The differences were found mainly in university students. There were no significant difference in three dimensions only: buttock–popliteal length, sitting elbow height and thigh clearance.

A comparison of anthropometric data for high school and university students showed there were significant differences between ages. Significant differences in males were found in weight, stature, shoulder breadth, arm reach forward, forearm–hand length, sitting height, sitting eye height, sitting shoulder height and span. In contrast, females differed in weight, stature, intersyce

breadth, back–waist length, sitting hip breadth and sitting height.

These differences need to be considered in designing computer workstations for high school and university students. The design of a workstation should be based on the users' anthropometric characteristics. If the users are high school students, the computer workstation must fit their anthropometry. A mismatch can lead to lost productivity and injury [25].

In summary, the current study suggests that important factors need to be considered in designing computer workstation for high school and university students. Providing various sizes of workstation so that students can select proper ones could reduce musculoskeletal pain. Hence, this study helps to understand the multifaceted problems associated with any population-based anthropometric study.

## 5. CONCLUSION

In conclusion:

- The greatest mean differences in anthropometric data between male and female high school students were found in sitting elbow height, followed by back waist length and intersyce breadth.
- Anthropometric data of male and female university students show they differ significantly, except for buttock–popliteal length, sitting elbow height and thigh clearance. All data for males were higher than for females except for hip breadth sitting and sitting elbow height.
- The primary significance of this study is that it provides data for an anthropometric database, which can be used as a reference in designing an ergonomic learning environment.

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