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Originals

ANTHROPOMETRIC POSITIONAL DIMENSIONS OF DENPASAR JUNIOR HIGH SCHOOL STUDENTS IN 2016

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ABSTRACT

Ergonomic aspects, especially anthropometric measures, are essential factors indesigning a workstation. The most facilities in junior high schools often remain unchanged or not adjusted for new students. Those facilities include tables, chairs, boards, etc. The study aims to know about anthropometric dimensions of students in junior high schools in Denpasar in 2016. The research is descriptive (anthropometric survey) involving junior high school students amounting to 901 at ten junior high schools in Denpasar as a sample determined by random cluster sampling. These 901 volunteered test subjects are divided into 480 male and 421 female students. Among 15-dimensional indicators in a standing position, only 3 dimensions did not show significant results between the two genders, namely lower leg length, chest circumference and buttocks circumference. In a sitting position, among 21 dimension indicators, only 7 dimensions did not show significant results between the two genders. Anthropometric measurements of junior high school students in Denpasar had significantly different results in the sitting and standing dimensions for both genders.

Keywords: Ergonomic aspects; anthropometry; student posture

INTRODUCTION

Ergonomic aspects, especially anthropometry in work facility design, are an important factor in supporting the improvement of production services. Attention to this in the present decade is something that cannot be delayed any longer. Anthropometry thus has many uses, such as conducting tool/work facility design. The suitability of the size of a tool against people who will use it will provide satisfaction in the form of comfort and health viewed from the point of view of anatomy, physiology, psychology, occupational health and safety, design and management and preventing complaints due to the size of the anthropometrical device of people who use it (Grandjean, 1997; Nurmianto, 2004).

In junior high schools, the facilities available are still facilities that have been around for a long time and have not been replaced. These facilities include benches, seating, blackboards, and so on. Many of these facilities may not be suitable for use. Even if they can still be used, the size is not necessarily suitable for junior high school students nowadays, because as to the anthropometric measures of students now and those that have changed again until now in Indonesia there are no definitive anthropometric measures of Indonesian people (Sutjana and Susila, 2010). So far, we still use estimated anthropometric measures (Pederson and Gore, 1996; Norton, 2004). For this reason, to plan the procurement of facilities as substitutes for existing facilities and the procurement of new facilities, it is very necessary to pay attention to the anthropometric aspects of the people who will use them, in this case, junior high school students.

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METHODS

This research was conducted in July-September 2016 in the Municipality of Denpasar. The design of this study was an anthropometric survey (descriptive) to measure the anthropometric measurements of junior high school students in the Municipality of Denpasar. The study population was Denpasar City junior high school students, and the sample determination was taken by random cluster sampling, and the number of schools used was at least 20% of the total number of junior high schools (40 × 20% = 8 schools). Of the 40 junior high schools in Denpasar City, there are 11 public middle schools and 29 private junior high schools and 10 junior high schools (4 public middle schools and 6 private middle schools) are used in this study. Of all the schools selected as samples, 901 students were taken apart as measured samples.

The study was conducted after receiving approval from the Research Ethics Committe, Medical Faculty, Universitas Udayana/Sanglah General Hospital. We then described the characteristics of study participants. Before starting this study, all participants gave informed consent. Prior to measurements, we first asked for permission from the respective head of school to measure some anthropometric measurements of the students. After obtaining the approval from each school principal, we made measurements following the agreement, namely at certain lesson hours we informed each school student to do measurements of several anthropometric dimensions, and at that time measurements were taken directly on 1st, 2nd and 3rd-year students. The tools used were an anthropometer and a metal meter. The measurements were carried out on each sample in standing and sitting positions (Abernethy et al., 2004; Kamal, 2004). Data in each position were then analyzed by the Mann-Whitney test (significance, $p<0.05$). This revealed the comparable data between male and female students.

RESULTS

Of the 40 junior high schools (Sekolah Menengah Pertama, SMP, in Indonesian) in Denpasar, there are 11 public middle schools (27.5%) and 29 private middle schools (72.5%) with 23,576 students, consisting of 12,271 male students (52 %) and 11,305 female students (48%) (Denpasar City Education Office data, 2005). Anthropometric measurements have been carried out on 10 SMPs (4 public middle schools and 6 private middle schools) with a sample of 901 people with details such as in Table 1.

Table 1. Characteristics of the samples

No.	Class/Gender	Number	Percentage (%)
1	1st Class		
	-Male	170	56.1
	-Female	133	43.9
	Subtotal	303	100
2	2nd Class		
	-Male	134	48
	-Female	145	52
	Subtotal	279	100
3	3rd Class		
	-Male	176	55.2
	-Female	143	44.8
	Subtotal	319	100
4	All participants		
	-Male	480	53.3
	-Female	421	46.7
	Total	901	100

Table 2 shows aco mparison of the anthropometric dimensions of male and female students in Denpasar junior high schools in 2016. These results indicate are results divided into 15 standing position dimensions and 21 sitting position dimensions. In the standing position, the dimensions of lower leg length, buttocks circumference and chest circumference did not show a statistically significant difference between the two genders (p>0.05). On the other hand, in the sitting position, stature, sitting eye height, sitting shoulder height, elbow-elbow distance, buttock-knee length, buttock-popliteal length, and hip thickness also did not show a statistically significant difference between the two genders (*p*>0.05).

Table 2. Denpasar junior high school students' anthropometric standing dimensions

No	Dimension	Male					Female					*p*
		Mean	SD	5th	50th	95th	Mean	SD	5th	50th	95th	
1	OHR	183.54	12.74	163.11	183.9	204	178.26	8.14	165.72	178.4	191.45	0.000*
2	ST	154.81	10.11	139.01	155.45	170	151.63	6.69	141.52	151.6	161.7	0.000*
3	EYH	142.25	10.84	125.34	143.1	157.6	139.31	8.5	128.51	140	149.29	0.000*
4	WH	97.22	8.6	84	75.5	109.6	97.03	10.15	87	96.5	105.69	0.016*
5	EBH	92.43	9.87	80.52	93.15	104.19	91.31	8.16	82.51	91.5	99.8	0.000*
6	HFH	66.18	7.18	57.5	66.2	74.98	65.06	6.83	57.32	64.8	72.78	0.000*
7	LLL	87.76	8.28	75.62	88.5	99	87.53	6.03	77.71	88	96.39	0.481
8	FR	56.03	4.25	49	56	62.49	54.65	4.29	49.11	54.8	60.56	0.000*
9	SR	55.09	4.36	48.2	55.4	61.99	53.48	4.2	47.71	53.6	59	0.000*
10	NC	31.36	3.06	26.71	31.1	36.7	29.66	2.46	26.7	29.6	33.8	0.000*
11	SC	92.43	10.59	77.31	91.5	111.48	89.41	8.61	77.82	89	102	0.000*
12	CC	76.33	9.43	63.3	75	94	76.5	7.75	65.45	76	88.18	0.252
13	WC	66.85	10.58	56.04	66.35	91.98	66.83	8.95	56	65.5	82.2	0.022*
14	BC	80.6	10.54	66.7	80	99.95	80.54	8.21	68	80	94.9	0.618
15	HC	45.14	7.25	35	44	57.99	43.89	6.4	34.53	43.8	53.3	0.042*

*Note: * significance < 0.05; SD, standard of deviation*
OHR, Overhead reach; ST, Stature; EYH, eye height; WH, Waist height; EBH, elbow height; HFH, Handfist height; LLL, Lower leg length; FR, Forward reach; SR, side reach; NC, Neck circumference; SC, Shoulder circumference; CC, Chest circumference; WC, Waist circumference; BC, Buttocks circumference; HC, Hip circumference.

No	Dimension	Male					Female					p
		Mean	SD	5th	50th	95th	Mean	SD	5th	50th	95th	
1	OHR	153.93	9.32	141.52	154	166.6	151.53	6.54	142.01	152.1	159.8	0.000*
2	ST	124.04	7.62	116.2	124	133.6	124.37	5.74	116.6	124.4	131.18	0.539
3	EYH	111.83	8.78	102.72	112.1	121.5	111.58	7.15	103.31	112.4	117.8	0.933
4	SH	96.41	6.01	89.81	96.8	104.4	96.54	6.11	89.12	96.8	102.38	0.507
5	WH	68.67	6.63	63.31	68.8	75.3	70.14	5.65	65	70	75.97	0.000*
6	EBH	63.6	5.72	58.91	63.6	69.39	64.49	5.13	59.5	64.4	69.5	0.000*
7	KH	48.12	5.2	41.11	48	54.2	45.99	3.53	40.3	46	50.78	0.000*
8	PH	40.62	3.93	36	40.5	45	39.35	2.39	35.4	39.4	42.7	0.000*
9	SSD	37.15	4.95	31	36.85	43.6	35.57	3.03	31	35.4	40	0.000*
10	EED	36.82	7.73	29	35.35	47.5	36.15	5.05	29.7	35.5	44.49	0.87
11	WW	22.52	4.16	17.61	21.7	29.8	21.88	5.54	17.21	21	29.2	0.002*
12	BW	29.75	3.65	24.61	29.3	36.5	30.3	4.49	25.51	30	35.66	0.044*
13	BKL	52.17	5.4	44.31	52.15	59.6	51.75	4.79	45.41	52.3	57.5	0.281
14	BPL	43.12	4.18	37.21	43	49.5	43.42	4.81	37.8	43.5	49.58	0.099
15	HT	12.78	2.68	9.2	12.2	17.5	12.98	4.75	9.41	12.6	16.99	0.378
16	CT	17.75	3.2	14.21	17.2	23.19	18.72	2.61	14.91	18.5	22.79	0.000*
17	AT	18.12	3.73	13.81	17.3	25.39	17.57	3.46	13.3	17	23.8	0.047*
18	DEL	32.05	2.87	27.5	32.05	36.5	31.13	2.4	27.11	31.4	34.4	0.000*
19	EWL	29.33	4.22	22.8	29.2	36	28.77	3.44	23.5	28.6	34.3	0.037*
20	EFL	43.31	3.54	37.6	43.5	48.7	41.65	2.7	37.01	41.9	45.4	0.000*
21	ETL	37.45	3.17	31.7	37.5	42.5	36.09	2.56	32.51	36	39.49	0.000*

Note: * *significance < 0.05; SD, standard of deviation*

OHR, Overhead reach; ST, Stature; EYH, eye height; SH, shoulder height; WH, Waist height; EBH, elbow height; KH, knee height; PH, Popliteal height; SSD, Shoulder-shoulder distance; EED, Elbow-elbow distance; WW, Waist width; BW, Buttock width; BKL, Buttock-knee length; BPL, Buttock-popliteal length; HT, Hip thickness; CT, Chest thickness; AT, Abdominal thickness; DEL, Deltoid-elbow length; EWL, Elbow-wrist length; EFL, Elbow-finger length; ETL, Elbow-thumb length.

As from 15-dimensional indicators in the standing position, only three dimensions did not show significant results between the two genders, namely lower leg length, chest circumference and buttocks circumference. In contrast, in the sitting position, from 21 dimension indicators, only seven dimensions were not significantly different between the two genders ($p>0.05$). In the dimensions of eye height and stature, the standing position had significant results as compared with the sitting one ($p<0.05$).

DISCUSSION

The observation technique has been used in many studies, including the evaluation of the anthropo-

metric dimensions of students in the classroom. In this study, 901 volunteered test subjects are recruited, and they are divided as 480 male and 421 female students. They were observed while they are sitting on the arrangement seat and standing for approximately in a one minute duration. The observations are representable reflecting the standard technique applied as usual in the Department of Physiology, Medical Faculty, Universitas Udayana.

The result of the comparison showed that all average male's body dimensions of male students are mostly higher than those of female ones. However, in several sitting dimensions, while not significant, the average results of woman are slightly higher than those of men (Fuster et al., 1998). Those dimensions are mostly measured in sitting shoulder height, buttock-popliteal length and hip thickness dimensions. The similar results had been showed by Chuan et al. (2010) when twenty-four body dimensions were evaluated for comparison. It was shown that more than 50 percent of the dimensions were significantly different, including weight, stature, eye height, sitting height, sitting eye height, sitting shoulder height and others.

However, thus focused on health status, e.g., body mass index, of the students as well as gender was the only socio-demographic characteristic used to compare the differences in health status of the students. Lack of discipline and time, self-control and social support were reported as important influencing factors of students' eating behaviour (Amin and Negm, 2017). Younger female students in Bali generally receive close supervision from their parents regarding their discipline in maintaining health by not playing outside to waste their energy at all. The tendency of the female students' metabolism also affects the fat deposits in their bodies, especially the buttock and thigh area. The fact whether this trend makes sitting anthropometric measurements appear to be women who have a higher value is also not yet clearly known.

Lower leg length (LLL), chest circumference (CC) and buttocks circumference (BC) had insignificant p-value within this study. The measurements of standing dimensions are performed statically. Khamis and Carmeli (2017) accentuated that more comprehensive evaluations such as gait analysis can enhance accuracy and provide a detailed valid and reliable evaluation of deviations and the resultant change in the effective leg length. There are still differences of opinions as to the situation of LLL plays in musculoskeletal disorders and the recognized extent of LLL necessary to warrant corrective support such as a heel or shoe lift.

Yang et al. (2013) had stated that BC were anthropometric measurements that show greater correlation with visceral adipose tissue thickness than BMI. That statement is in accordance with the real situations among the junior high school's students involved within the study. Nowadays, Indonesian teenagers are faced with a shifting in nutritional intake problem. It was reflected by Sari and Sartika (2019) that mentioned the proportion of the nutritional status of teenagers in Indonesia (2007) was malnourished (90.8%), while 9.2% of them had better nutritional status. Besides, it showed a significant relationship between sex, education, protein intake, smoking, exercise and parental nutritional status with them.

Sexual dimorphism is apparent for height and weight as well as for the remaining anthropometric variables, reflecting a greater body size for males and more adiposity for females. This data can be adjusted in designing ergonomic workplaces according to students. This data is also the useful concept of the morphological posture of both males and females and should be considered comfortable set for learning (Davoudiantalab et al., 2013).

Reis et al. (2012) presented that teenagers used school tools that did not meet their ergonomic standards, which favored the adoption of incorrect postures and contributed to the emergence of musculoskeletal problems that can interfere with their educational process. It basically occurred while they were in sitting positions. The significant results affected by the unusual sitting positions included sacro-popliteal length, popliteal height, hip width, lumbar support height and elbow and thigh height. In contrast, in the present study, buttock-knee length, buttock-popliteal length and hip thickness had insignificant meaning in both genders.

The elbow height in standing positions for the human is used for designing work levels. Sitting position dimensions are important for designing office workstations, desks and chairs and are also used for determining the sitting workspace as well as are important dimensions of chairs such as chair height and length of seat (Marfell-Jones, 2004). But, that is not commonly found in the case of the elbow height dimension even though the difference is equally significant between the two genders. In a standing position, the height

is 1.1 cm different from the males. Conversely, the mean elbow height of females has a higher value of 0.8 cm than that of males in the sitting dimension. However, the distance between the two elbows is indeed not significant with the greatest value in men.

Although, Reis et al. (2012) still demonstrated these dimensional growths cannot be considered as linear. During the growth phase, the body segment grows faster than the head, followed by the trunk and, after six years of age, lower limbs grow more significantly, continuing to grow faster than other body segments until the onset of puberty, which, in turn, the trunk grows faster again. This indicates that at the different school phases until the beginning of puberty, they should pay

more attention to the height of the seat. The popliteal height has an essential participation in defining the seat height. According to the results of the present study, the average of both genders approached the 95th percentile, which means that the growth patterns around the limbs in both genders are in the same habituation at their age. The stature appeared to be a similar value in the 50th percentile. It seems that the posture while sitting in both genders was similar. But, the following phase of growth would change their stature apparently as the 95th percentile had not been achieved that time (Abdrahman et al., 2018).

In relation to the evaluation of human posture, the establishment of the postures can be conducted through the observation method. In this study, the common postures of students while both standing and sitting on the environment will be used in the ergonomics assessment to indicate whether the current movement, seat and desk design is suitable in adapting to these different dimensions (Romli and Aminian, 2018). The resulting posture will tend to improve performance, efficiency and children's well-being (Gonçalves and Arezes, 2012).

A basic rule of ergonomics is that there is no such thing as an "average" person. However, providing a chair specifically designed for each individual is not practical. The only solution is to provide everyone with fully adjustable chairs that can accommodate a maximum range of people. Nonetheless, the chair and its adjustment remain constant for the majority of setups in a typical office environment (Jung, 2005). The adjustable range is normally from the 5th to 95th percentile of measurements (typically around 90% of the population; workers falling in the ranges of 5% of the shortest and the tallest will need custom-made chairs). In students, desks and chairs with inappropriate dimensions can cause poor sitting posture, neck and back pain, and increased stress at 5th lumbar vertebrae, resulting in a loss of interest in learning (Wang et al., 2018). In addition, this limiting study did not present the feedback from both students and teachers about the comfortable use of their equipment in the school to optimize the measurements.

CONCLUSION

Anthropometric measurements in junior high school students in Denpasar mostly have reliable dimensions while sitting and standing. Both genders have thinly significantly different results. Both dimensions provide significance values that are easy enough to determine how comfortable students will be when learning in the classroom later. Moreover, ergonomic workspaces need to be stressed early on in order to create an effective and efficient learning ecology.

CONFLICT OF INTEREST AND AUTHORSHIP

The authors stated that there is no conflict of interest with regard to this study. There is no funding used in the process of this research. IMM has contribution in the idea, structure, editing and measurements, while GW has contribution in analytical process, data sinthesis and format.

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