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The Comparison of Anthropometry Data of Undergraduate Students and Desk Chairs in the Faculty of Public Health, Universitas Indonesia

Indri Hapsari Susilowati and Chandra Satrya

Department of Occupational Health and Safety, Faculty of Public Health, Universitas Indonesia

Abstract

The objectives of this research were to collect anthropometry data among undergraduate students in the Faculty of Public Health, Universitas Indonesia, and to compare those data with the desk chairs currently in use. There were 146 respondents (113 males and 33 females), aged 20–35 years old. Twelve variables of sitting static data were collected by purposive random sampling. Instruments used included an anthropometer, a carpenter's tape measure, and a ruler bracket. Two types of desk chairs were examined: A and B. When comparing the anthropometric data of undergraduate students, the lower limit backrest of desk chair A was found to be closer to the students' sitting waist height than that of desk chair B. While the width of pedestal desk chair B is closer to the students' anthropometric pelvis width, the difference is not significant with desk chair A. From this research, it is recommended that desk chair A rather than B be used for undergraduate students in the Faculty of Public Health, Universitas Indonesia.

Keywords: Sitting Anthropometry, Desk Chair, University Students, Ergonomics

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1. INTRODUCTION

The learning process is usually carried out in a classroom. Students receive instruction for hours in a sitting position. Certainly, there are some consequences for students' health and fitness from sitting for extended periods of time [1]. This also affects the teaching and learning process.

Disorders resulting from sitting for hours can include muscle stiffness in the neck and shoulders, back pain, and fatigue. These conditions particularly occur in those with poor sitting position (i.e., where the subject's back does not lean on the backrest). Numbness and fatigue in the knees and legs can happen especially to those whose seat position is too high.

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Page 483

To avoid such disorders, the seat must match the user's body dimension or anthropometry [4]. Pheasant (1991) defined anthropometry as a branch of ergonomic science which studies the measurement of human body. Anthropometry is beneficial in appropriately designing furniture to match the dimensions of the users [2, 5].

It is important to have a suitable seat that properly matches with the user's body dimensions. To evaluate whether classroom chairs used in the Faculty of Public Health, Universitas Indonesia (FPH UI) are matched with the students' body dimensions, it was necessary to compare the seats' dimensions and students' anthropometric measurements. This study sought to obtain static anthropometric data on the sitting position of FPH UI undergraduate students and examine whether the current seats used in the classroom appropriately match the static anthropometric dimensions of the students' sitting position.

2. METHODS

A descriptive-comparative study was conducted to compare the static anthropometry of students in the sitting position of with the seat dimensions used in the classroom. The population of this study consisted of FPH UI undergraduate students: 113 male students and 33 female students. Age distribution of this study was limited to 20–35 years old. This study used the purposive random sampling method.
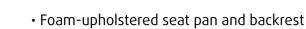
The main instruments used in data collection were an anthropometer, a tape measure and a right-angle ruler. A wooden chair was used as a supporting instrument. The chair was constructed without upholstery on the seat pan and backrest and measured 40 cm x 40 cm x 40 cm. Twelve dimensions were measured for each student: sitting height, sitting shoulder height, sitting elbow height, sitting waist height, knee height, popliteal height, buttock–knee length, buttock–popliteal length, elbow–wrist length, shoulder breadth, hip breadth, and thigh thickness.

Measurements were taken outside of the classroom after the class session was finished. Sample students were asked to remove their shoes, empty their pants pockets, and sit on the wooden chair with the backrest attached to a wall. The measurement was conducted by two people; the first person took the measurements, and the second person recorded the figures. Data processing was performed with Microsoft Excel.

Two types of classroom chairs were used: chair A and chair B.

Characteristics of chair A:

- Stainless steel frame

- Foam-upholstered seat pan and backrest

- Desk made from board and cannot rotate

- Seat can be folded for easy storage

Characteristics of chair B:

- Iron frame

- Fibreglass seat pan and backrest

- Desk made from board and can rotate

- Seat cannot be folded

3. RESULTS

The total sample for this study was 146 students: 113 males and 33 females. All the students were from the undergraduate level in regular and extension programs. Table 1 presents the static anthropometric measurement for the sitting position obtained from the study.

TABLE 1: Results of sitting static anthropometry of FPH UI undergraduate students.

Sitting Static Anthropometry	Male				Female			
	SD	5th percentile	Mean	95th percentile	SD	5th percentile	Mean	95th percentile
Sitting height	0.14	86.78	87.01	87.24	2.51	76.68	80.79	84.90
Sitting shoulder height	0.01	57.62	57.64	57.67	2.59	49.95	54.19	58.44
Sitting elbow height	0.26	23.35	23.78	24.20	2.12	18.91	22.38	25.85
Sitting waist height	0.03	20.77	20.82	20.87	2.32	20.97	24.77	28.58
Knee height	0.04	49.97	50.04	50.11	2.51	41.07	45.19	49.31
Popliteal height	0.19	42.16	42.47	42.77	1.52	37.23	39.73	42.22
Buttock–knee height	0.34	55.33	55.89	56.45	3.60	47.52	53.43	59.34
Buttock–popliteal height	0.25	46.41	46.82	47.24	3.03	41.93	46.90	51.88
Elbow–wrist length	0.02	27.69	27.72	27.76	1.44	23.30	25.66	28.03
Shoulder breadth	0.14	41.78	42.02	42.25	1.81	32.95	35.92	38.89
Hip breadth	0.27	30.10	30.54	30.98	3.15	23.49	28.66	33.83
Thigh thickness	0.16	12.94	13.20	13.46	1.89	9.23	12.33	15.43

Below are the dimensions and diagrams of the classroom chairs studied.

Table 2: Dimensions of chairs A and B in FPH UI classrooms.

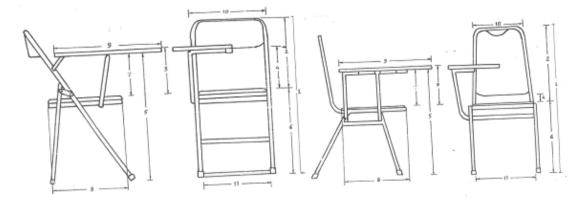| Code number of chair (Figure 1)	Chair A (cm)	Chair B (cm)
1	64	72
2	39	47
3	25	25
4	20.5	5
5	69	67
6	46	44
7	23	23
8	39	40
9	57.5	58
10	40	30
11	36	38

Figure 1: Chairs A and B.

4. DISCUSSION

Soares' study (1990) shows that activities utilizing a classroom chair include sitting, chatting, writing, observing, reading, seeking teachers' attention, handing items to friends, dropping things, and preparing to get up. Body posture during these activities are relaxed sitting (writing and observing), upright sitting (observing), slightly bending forward (writing and reading), and turning around (chatting and handing items to friends). These body postures will affect the classroom seating design.

To use anthropometric data from these measurements, adjustments using correction factors were needed. A shoe height correction factor of 3 cm needed to be added for the sitting knee height and popliteal height variables [7]. A correction factor for clothing was not needed because sample measurement was carried out with clothes on, and it is assumed that those are the usual clothes worn to attend classes. Also, Indonesia is a

tropical country which only has two seasons—dry and rainy season—meaning people wear clothing of relatively the same thickness for the entire year.

This research only compared the anthropometry data of respondents with three parts of the chair dimensions: desk, seat pan, and backrest. Therefore, it was only 9 measurements of sitting static anthropometry that used in comparison with recommendation. The detail can be seen on table 3.

TABLE 3: Comparison between sitting static anthropometry and classroom chairs used by students (cm).

Sitting Static Anthropometry	Percentile	Male	Female	Chair		Recommendation
				A	B	
Sitting elbow height	50	24.2	18.91	25	25	21.56
Sitting shoulder height	5	57.62	49.95	39	47	<49.95
Sitting waist height	5	20.77	20.97	20.5	5	<20.77
Knee height	95	50.11	49.31	69	67	>50.11
Popliteal height	5	42.16	37.23	46	44	<37.23
Buttock–popliteal length Elbow–wrist length	5	46.41	41.93	39	40	<41.93
Hip breadth	95	27.76	28.03	57.5	58	>28.03
Thigh thickness	95	30.98	33.83	36	38	>33.83
	95	13.46	15.43	23	23	>15.43

4.1. Desk

Desk height is considered by the elbow height measurement. This measurement does not describe reach or clearance dimension but is related to comfort. If the desk height is too low, users' bodies will bend too far forward when writing. On the other hand, if it is too high, then users' eyes will be too close to the desk, which may cause eye fatigue and produce excessive pressure on the shoulders.

To overcome these issues, the mean value or 50th percentile (21.56 cm) is used. However, if the desk is adjustable, the lowest possible height should be the 5th percentile of sitting elbow height of a female (18.91 cm) and the greatest height should be the 95th percentile of sitting elbow height of a male (24.20 cm).

Desk design is not only determined by anthropometric variables. Other factors such as students' activities while sitting, items placed on the desk, and students' sitting position when writing also need to be considered. These factors are related to desk length where the applicable anthropometric measurement is elbow–wrist length. To

determine the ideal **desk length**, the 95th percentile value is used so that all elbow–wrist dimensions can reach the desk. Since a female has a longer length compared to a male, the ideal minimum dimension is 28.03 cm. Both types of chairs in the FPH UI classrooms have similar desk lengths, and both are longer than the sample dimensions, which were 57.5 cm for chair A and 58 cm for chair B.

4.2. Seat Pan

Seat depth should be determined by anthropometric measurement of the buttock–popliteal length. If the seat pan is too deep, the front part will create stress on the backs of the knees, which will cause discomfort and affect blood circulation. On the other hand, if seat pan is too shallow, it will not provide adequate support to the thighs while sitting and may cause the user to have the sensation of falling off the chair.

Because seat depth is included in the reach category, it should be measured for the 5th percentile of the buttock–popliteal length. The ideal measurement used is the female anthropometric measurement, which is lower than 41.93 cm. Correction factors included in this research were thickness and elasticity of the seat pan and the users' flexibility.

The uses of two types of chairs in classroom, chair A and B, it found both lower than the ideal dimension. Chair A had a seat depth of 39 cm and chair B had a 40 cm seat depth, both lower than the ideal dimension. However, chair A is the better option when considering the correction factors stated above. Chair A has seat pan upholstered with foam which can reduce the pressure on the thighs and provide the users with more flexibility.

Seat width should be determined by hip breadth. This is a clearance measurement, which describes the space needed to allow users to easily get up from and sit down on the pan. To determine the ideal dimension for seat width, the 95th percentile of hip breadth values is used, which is greater than 33.83 cm from the female sample. Because there is not any standard regulation regarding the additional clearance measurement, the correction factors included in this consideration were users' habits while sitting, users' activities while sitting, and items placed on the chair. Both types of chairs used in the FPH UI classrooms have a wider than ideal seat.

Seat height is determined using the popliteal height measurement. Because seat height is measured as the vertical distance (reach) from the front edge of the seat to the floor, the 5th percentile value is used. By using the lowest seat height, almost all people can use this chair with their feet touching the floor. To achieve the 5th percentile

value, the ideal seat height used in this study is the 5th percentile value for female. With 3 cm addition for the shoe height correction factor, the ideal seat height is lower than 40.23 cm.

Both types of chairs in the FPH UI classrooms have a higher than ideal seat It is best for a seat height design to be adjustable, with shortest value using the 5th percentile of female and the highest value using the 95th percentile of male of the popliteal height measurement.
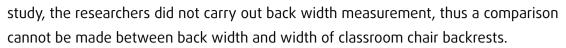
The distance from seat pan to desk is determined using the thigh clearance measurement. Because this is a clearance measurement, the 95th percentile value is used (15.43 cm for females). This measurement is the minimum space from seat pan to desk, as it must allow free movement of users when sitting. Bags placed on the seat pan were taken into consideration.

Given the ideal dimension of 23 cm from seat pan to desk, both types of chairs used in the FPH UI classrooms already accommodate the minimum dimension of thigh clearance for the users.

4.3. Backrest

The main function of a backrest is lumbar support. The lumbar is the part of the spine that curves inward and extends from above the waist to around the middle of the back. To function well, the backrest height needs to be adjusted with the purpose of the seat. Armchair backrest height typically reaches the neck or shoulders while the suitable office chair backrest height need only support the lumbar curve of the back. The classroom chair is considered a multi-purpose chair; thus, the backrest height is in between that of an armchair and an office chair and is approximately as high as the back [6]. When comparing both chairs used in classroom, the backrest is shorter than the sitting shoulder height measurement, which is 49.95 cm for females in the 5th percentile. The mean sitting should height measurement aligns with the ideal backrest measurement. This also supports the ideal backrest height from Grandjean (1997), who recommends 48–50 cm as ideal.

The lower limit of backrest height is reach so the mean value or 5th percentile is used (20.77 cm). The backrest lower limit of chair A was 20.5 cm and chair B was 5 cm. The chair A backrest lower limit was closer to anthropometric measurement than chair B. A chair's backrest width is affected by its backrest height. A chair with a backrest height as high as a shoulder will use shoulder height to determine its backrest width. In this

study, the researchers did not carry out back width measurement, thus a comparison cannot be made between back width and width of classroom chair backrests.

Pulat (1992) stated that ideal backrest width is 33 cm. If this dimension is applied, chair B has a closer measurement, but it is only 30 cm which means that it is narrower than the ideal dimension. On the other hand, the backrest width of chair A is 40 cm, or wider than the ideal dimension. Chair A is preferred because it can provide better support for the body.

5. CONCLUSIONS

When the data obtained from anthropometric measurement of FKM UI undergraduate students are compared with seat dimensions used in the classrooms, the results indicate the desk height of both chairs A and B is higher than students' anthropometric data. The desk's length and clearance in both chairs corresponded with students' measurement data. For the backrest, the height of both chairs is the same as students' anthropometric data, but only chair A has the same lower backrest dimension as students' data. The depth and width of both chairs' seat pans are equal to students' data, while the seat height of both chairs was higher than the students' anthropometric data. In conclusion, the study shows that chair A is preferable chair B because the dimensions of chair A are closer to students' anthropometric data and its seat pan is upholstered with foam, which can reduce the pressure on the thighs and allow users to have more flexibility.

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