Body Measurements (Anthropometry): A Case Study of Male Students in Qom University of Technology

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Received: 16 Oct. 2018, Revised: 01 Dec. 2019, Accepted: 28 Dec. 2019

ABSTRACT

The existence of ergonomic training tools and devices improves the educational quality and convenience of students. Non-ergonomic training tools also cause musculoskeletal disorders in students and as a result, they will be less efficient. The purpose of this study was to examine the suitability of the seats available with the body dimensions of the male undergraduate and master's students of Qom University of Technology. In this research, 60 male undergraduate and master's male students of Qom University of Technology were selected randomly and 18 physical dimensions of them were measured by an anthropometric calliper with an accuracy of 0.1, 0.05 meter, and also seven important parts of the seat affecting on the body's posture were measured by the meter. Also, feeling or not feeling pain in the 8 parts of the bodies of these students and their feelings about the cause of the pain were asked by questionnaires and for data analysis, was used the SPSS version 22. The height of the seating area was almost appropriate. The length and width of the seat area and the width of backing was smaller than the optimal sizes. The height of the chair elbow was shorter than the optimal amount. The length of chair elbow was suitable, and the backing height from the seat area was not suitable. Only the height of the seat area and the length of chair elbow are somewhat appropriate and the rest of the seat parts are not proportionate to the students' physical sizes. There was a significant difference between the parameters of undergraduate students and the master's students.

Key words: Ergonomics, Posture, Anthropometry, Statistics and Data Analysis, Body dimensions, Product Design

INTRODUCTION

Nowadays, musculoskeletal disorders are one of the most important work environmental problems all over the world [1]. As in the workplace, using the equipment should match the physical dimensions of the users, the equipment used in the university should also be proportionate with the physical dimensions of the students. University chairs are one of the most frequently used items by students.

According to Ansari *et al.*, the appropriate sitting position reduces the pressure on various parts of the body, improves blood flow and as a result, it can reduce stress and increase the efficiency of the students and they feel comfortable [2].

The wrong sitting position increases the pressure on the body and causes neck pain, back pain and musculoskeletal disorders, and as a result, it can reduce the efficiency of students. But the appropriate sitting position is possible when the chair design is fit to student's physical dimension or so-called ergonomic. In recent years, much attention has been paid to design of ergonomic desks and benches in schools, but paying attention to the design of ergonomic chairs for students is not enough.

Especially in Iran, the chairs in most universities used, are using in high schools, given that the average physical dimensions of high school students differ from undergraduate and master's students. So it is non-ergonomic. By individual assessment and examination of musculoskeletal disorders and body posture, comfortableness could be measured [3].

Sadeghzadeh (2006) studied accordance between physical dimensions of 52 students aged 18-26, Faculty of Health and Paramedical, Qazvin University of Medical Sciences, and the dimensions of the chairs in the faculty. Some studies on anthropometric variables such as popliteal height, length of the elbow to wrist, hip-width, popliteal-hip length, abdominal depth, thigh thickness, shoulder width, the width of backing to elbow showed that there was a big difference between the shoulders width of male and female students with the backing length, popliteal-hip length and the depth of the seat area. So it is necessary to design classrooms for girls and boys based on their size and physical dimensions [4].

Mirza'ei *et al.* studied anthropometric parameters of 1184 male students aged 6-18 with a comparison of the dimensions of the schools' desks, and benches in Sistan and Baluchestan Province. In this study, static

anthropometric characteristics of height, weight, popliteal height, knee height, sitting height, thigh depth, and shoulder height, the height of backing to the elbow, limit access to forward, elbows width and hip width were evaluated. This is done, according to the two principles of determining the percentiles and the height criteria. Research literature mainly discussed tables and benches used in schools for their analysis and did not consider the size of the body of students. It is worth mentioning that, this disproportion causes of neck and back injuries and early fatigue [5].

Institute of Tsing-Hue University studied the student's anthropometry and dimensions of Taiwan's elementary and secondary schools benches and desks. The results showed that the anthropometric dimensions of the height of popliteal, the width of the hip, the hip-popliteal length, the width of the shoulder and the height of the elbow-sitting in different age groups vary with each other. Hence, they proposed adjustable training desks and benches to improve the pattern [6].

Kelamklay *et al.* studied the anthropometric indices of height, weight, the height of the seat area, the height of popliteal, depth of abdomen, thickness of the thigh, shoulder width, backing width in 300 girls and boys aged 18-25 years old. The results showed the significant differences in weight, structure and physical dimensions of the groups, and these differences should be noticed in the design of school equipment [7].

Fatemeh Zarei *et al*, in a similar study, concluded the dimensions of the chair and dimensions of students matched only in the length of chair elbow parameter [8].

Sakineh Varmazyar *et al.* stated in a study that all dimensions of the tables and chairs excepting height of the surface of the tables are different from the standard point of design [9].

At the study of Ramin Zare *et al.* in Primary Schools of Markazi Province, results showed that 53.2% of schools, desks and benches of students did not match with the principles of ergonomics [10].

The Parselz study in 1999 measured the disparity between the physical dimensions of children and the school equipment by measuring the child's anthropometric characteristics, their tables and chair's dimensions of Americans children aged 11-13[11].

The results of the research by Panagiotopoulou *et al.* on elementary school students aged 7-12 in Greece showed that a large number of students used high and deep benches with high desks. On the other hand, only free space below the table is acceptable for most students. The number of students whose physical dimensions are proportional to the depth, the height of the benches and the desks, are elder, and the lack of physical proportionality of children and school equipment is often not negligible in younger children [12].

Akbari *et al.*, introduced the HSE-S questionnaire as an evaluation tool to check the status of health, safety, and environment based on an audit system. As an important factor students' health and safety can impact their learning capacity [13].

In the next section, we first provide a description of our analysis, and information about how data are going to process. Then, in the findings section, we will elaborate on the short brief of the data we gathered. In the results, we will compare the actual and standard of the value measured on the previous parts. In the end, in the discussion section, we will provide a conclusion and propose future directions.

MATERIALS AND METHODS

In this research, 60 undergraduate and master's male students of Qom University of Technology were randomly selected and 18 physical dimensions were measured by an anthropometric calliper with an accuracy of 0.1, 0.05 in the meter. And also the seven most influential parts of the chair on the body's posture were measured by the meter. Also feeling or not feeling pain in 8 parts of the body of these students and their feelings about the cause of pain were asked by questionnaires. And for analyzing the obtained data, it was used SPSS version 22 software. T-test was used to show existence or not existence of differences between physical dimensions of two groups of undergraduate and master's students.

RESULTS

The present study is a descriptive study. The studied population include male undergraduate and master's students of Qom University of Technology. The samples are 60 people and sampling is random. In this research a set of anthropometric parameters that is required to design a chair, measured by an anthropometric caliper with accuracy of 0.1 and 0.05 millimeters.

The measurements were made with no shoes and minimum clothes. 18 Parameters required to design a chair were measured. These parameters are based on the standard definition of the Pheasan in 1996 [14].

The results analyzed by using SPSS version 22 software. Also, t-test was used to compare the two groups of undergraduate and master's students, which as a result shows a significant difference between the parameters of undergraduate and master's students. Fig. 1 shows the studied anthropometric parameters.

In this section, first, we are going to compute the mean, maximum, minimum, standard deviation, 5th percentile, 50th percentile and 95th percentile for the measured data which the result is shown in Table 1.

Also, the number of students who felt pain in different parts, the regarding percentage of them based on the total number of students, and the most important reasons for these pains are demonstrated in Table 2. Fig. 2 is shown the comparison of musculoskeletal disorders in the present study with a represented similar study.

In the same study that was carried out in 2010, authors examined the proportion of wooden and plastic chairs available in the university with the body size of students at the Faculty of Health [8], these results are as Table 3.

Students feeling about the cause of pain:

The discomfort of the students studied is presented in Table 4. The values for the same study are also given in Table 5. Fig.3 is shown the comparison of students' feeling of discomfort with the same studied students.

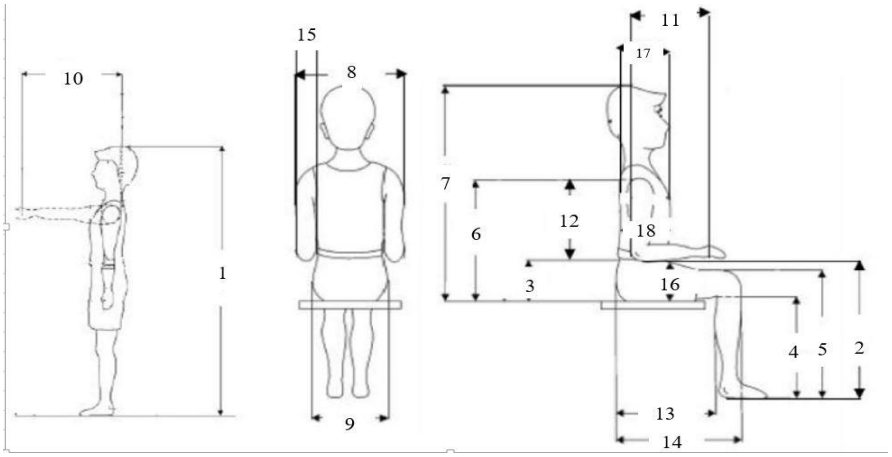

Fig. 1: The studied anthropometric parameters.

Table 1: Anthropometric Indicators of Students

Dimensions	Max	Min	Standard deviation	Mean	95 Percentile*	50 percentile*	5 percentile*
1- Height	184	170	3.4538	177.9333	183	178	172
2- Elbow height in sitting posture	85	72	3.4128	78.95	84.05	79	73
3- Height of elbow support	34	26	1.9821	29.7333	33.05	30	27
4- Height of popliteal	52	46	1.6841	49.2166	52	49	46
5- Height of knee	64	53	2.8009	58.5666	63	59	54
6- Height of shoulder	73	60	3.1773	66.2666	72	66.5	61.95
7- Height of sitting posture	103	63	5.4598	95.4166	101.05	96	90
8- Width of shoulder	54	46	1.9924	49.6166	54	49	47
9- Width of hip	52	42	3.1906	46.0333	50.05	46	42.95
10- Limit of front access	90	76	3.4538	83.9333	89	84	78
11- Length of the elbow to fist	40	28	3.2579	34.05	39	34	29
12- Length of elbow to shoulder	40	34	1.3597	36.5333	39	36.5	34
13- Length of hip - popliteal	55	41	3.4538	48.9333	54	49	43
14- Length of hip - knee	68	55	3.3984	62.0166	67	62	56.9
15- Width of elbow	12	8	0.7808	10.0833	11	10	9
16- Depth of thigh	34	23	2.2499	27.0666	31	27	24
17- Depth of chest	27	15	2.2647	20.0666	24	20	17
18- Depth of abdomen	24	13	2.3033	17.1666	21.5	17	14
19- Weight	75	60	3.4597	68.1166	73**	68**	62.95**

The numbers are in centimetres* and kilogram.**

Table 2: Students feeling pain in different areas of their bodies

Area	Neck	Shoulder	Upper back	Lower back	Forearm	Wrist	Thigh	knee

Number	28	14	32	6	4	16	22	23
Percentage	46.66%	23.33%	53.34%	10%	6.66%	26.66%	36.66%	38.33%

Table 3. Feeling pain in the same study

Area	Neck	Shoulder	Upper back	Lower back	Forearm	Wrist	Thigh	knee
Plastic chair	77.4%	63.5%	90.4%	84.4%	-	46.1%	61.8%	61.7%
Wouden chair	80%	67%	83.4%	82.6%	-	45.2%	47.8%	56.6%

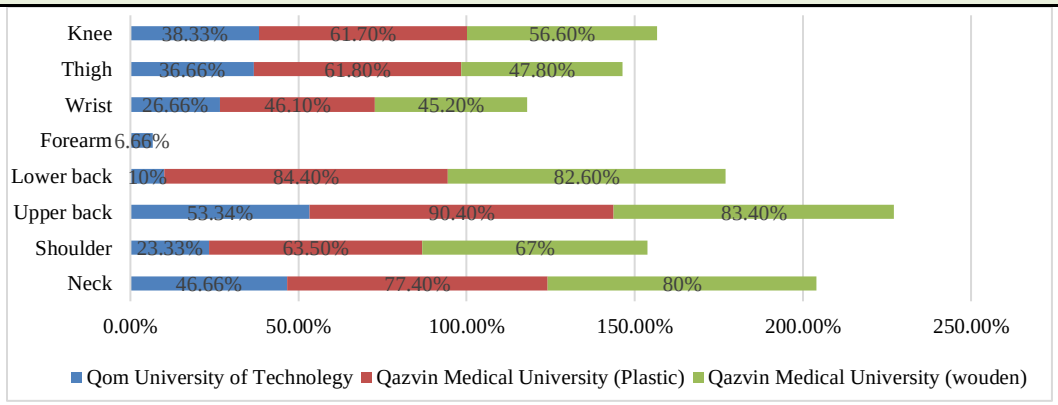

Fig. 2: Comparison of musculoskeletal disorders in the present study with a represented similar study

Table 4. Perceived discomfort of the students

Feeling of students	Number	Percentage
Chair discomforting	55	91.66%
continuous changing of sitting posture	42	70%
Improper sitting posture because of wrong design	45	75%
Improper fabric of seat arae	50	83.33%
Improper width of seat area	23	38.33%
Improper backing	37	61.66%
Improper chair elbow	46	66.66%

Table 5: Perceived discomfort of the same studied students

Feeling of students	Plastic chair (Percentage)	Wooden chair (Percentage)
Chair discomforting	76.8%	93%
continuous changing of sitting posture	47.8%	62.6%
Improper sitting posture because of wrong design	39.1%	42.6%
The improper fabric of seat area	52.2%	88.7%
Improper width of seat area	40%	65.5%
Improper backing	38.3%	45.2%
Improper chair elbow	42.6%	74.8%

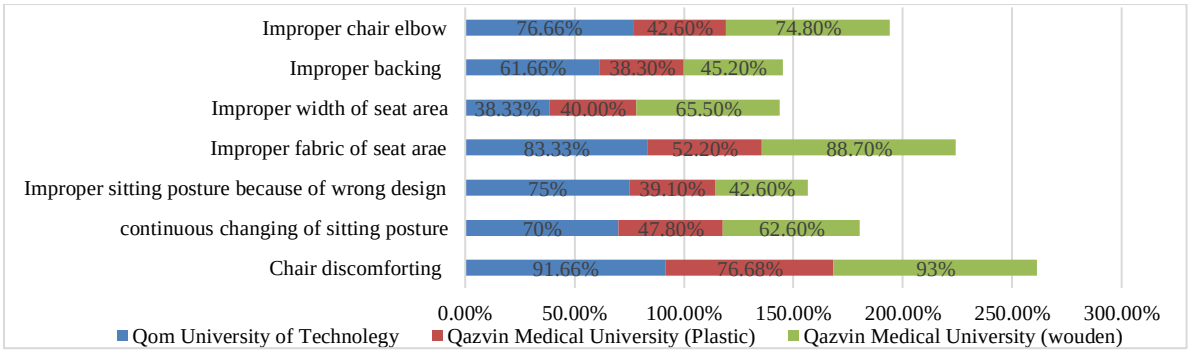

Fig. 3: Comparison of students' feeling of discomfort with the same studied students.

Separate parts of the chair

The important parts of the chair, which have a great impact on students' sitting posture, are shown in Fig.4.

In this section, we want to compare the size of different parts of the chair with the appropriate percentile of the corresponding dimensions.

For example, with regard to seat area height, mostly, researchers believe that when it comes to values less than acceptable limits, are less crucial than values more than acceptable limit [15]. We also compare this size with the 5th percentile of popliteal height. We have used the 50th percentile of hip-popliteal length for length of the seat area, the 95th percentile of popliteal width for the seat area width, the 95th percentile of the shoulder width for backing width, the 50th percentile of elbow support height for the chair elbow height from the seat area, the 95th percentile of elbow height to fist for the chair elbow height, and ultimately the 95th percentile shoulder height for the backing height for the comparison analysis. Table 5 shows these comparisons.

Fig 4 is shown the important parts of chair.

Fig. 4: Important parts of a chair

Table 6: Size of different parts of the chair

Different parts of the chair	Size mean (Cm)
seat area height from the ground	45.5
Length of seat area	39.5
Width of seat area	40
Width of backing	45
Height of chair elbow from the seat area	25
Length of chair elbow	60
Height of backing	44.5

Table 7: Comparison of the size of different parts of the chair with the corresponding dimensions

Dimensions	Proper percentile	The value associated with percentile	Associated part	Size mean (Cm)
Popliteal height	5	46	seat area height from the ground	45.5
Length of hip – popliteal	50	49	Length of seat area	39.5
Width of hip	95	50.05	Width of seat area	40
Width of shoulder	95	54	Width of backing	45
Height of elbow support	50	30	Height of chair elbow from the seat area	25
Length of the elbow to fist	95	39	Length of chair elbow	60
Height of shoulder	95	72	Height of backing from the seat area	44.5

According to the analysis, the height of seat area from the ground is almost appropriate, the length of the seat area, the width of the seat area and backing of the chair are smaller than the optimal size. Besides, the height of the chair`s elbow from the ground is shorter than the optimal value, and the length of the chair`s elbow is appropriate. Last but not least, the height of the backing from the seat area is shorter than the shoulder height, so it is not an acceptable measure. Therefore, from the different parts examined, only the height of the seat area and the length of the chair`s elbow are plausible. The rest of the parts are not commensurate with the student's physical sizes.

In light of what was said and given the students' feelings of the cause of the discomfort they are facing, it can be said that the chairs used in most universities are not in accordance with the students' physical dimensions and hence, they are problematic.

DISCUSSION

Data eighteen body dimensions of 60 male students (undergraduate and graduate) from Qom University of Technology, Iran) were collected and analyzed. The

data presented in this article comes from a small sample of university students in Qom province of Iran and does not represent the country's entire population. An important issue that affects the stature and weight of every population is the age [16]; however, this variable was not considered in the comparisons

As shown in Table 9, there is no meaningful value for the Kolmogorov-Smirnov test (sig Larger than 0.05). Therefore, the independent t-test can be used to compare the undergraduate and master's groups. Because the sig (2-tailed) value is less than 0.05, there is a significant difference between the two groups of undergraduate and master's students.

The results of this study indicated that the dimension of the university`s chair was inappropriate for the students, confirming the findings of previous studies [17 and 18].

Anthropometric data gathered in this study is useful in the design of products for Industrial Design students. Using the mean and standard deviation, calculation of percentiles only needs an easy step. Although the participants' sample was limited, anthropometric data could be useful to design processes, products, furniture, tools, among others for the working population. Additionally, data could be useful for research purposes. When using anthropometric information to design a particular device, it is not always possible to use a predetermined process due to the variety of situations in which the device is made.

CONCLUSION

Therefore, it is recommended to design seats produced for universities, which are based on the appropriate physical dimensions of the student. Besides, if possible, universities can provide students with chairs that have adjustable, adjustable and changeable parts, as well as chairs that have a suitable back for the head and neck. The seats should be adjustable and the seat should be soft enough to reduce pressure on the thighs. This allows students to feel comfortable and maximize their efficiency.

ETHICAL ISSUES

Ethical issues such as plagiarism have been observed by the authors.

CONFLICT OF INTEREST

The corresponding author states that there is no conflict of interest.

ACKNOWLEDGEMENT

The authors are grateful to unanimous referees and appreciate their precious and constructive comments.

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