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Investigating the match between anthropometric measures and the classroom furniture dimensions in Iranian students with health approach: A systematic review

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Abstract:

Ergonomics of schools and school furniture is one of the main issues in students' education. The proportion of school furniture to the anthropometric dimensions of students is one of the main ergonomic challenges in schools that affect students' health. This systematic review study aimed to examine the match between anthropometric measures and school furniture dimensions among Iranian students. A systematic review was carried out using databases to Google Scholar, SID, IRANDOC, PubMed, MEDLINE, and ScienceDirect and specific keywords to find papers published before March 2020. The references of seminal studies were also used to extend the search scope. Totally, 11 studies entered the review. The results showed that there was no proportion between classroom furniture and students in schools under study. This lack of proportion was evident at different grades in both boys' and girls' schools. The results showed a lack of proportion between classroom furniture and Iranian students. There is a need to design and procure furniture based on the anthropometric dimensions of the society that will help to health promotion of students. An updated national anthropometric databank of Iranian students can be a step to solve the problem.

Keywords:

Anthropometry, ergonomics, Student, Iran

Introduction

Anthropometry is the science of measuring dimensions, sizes, and body properties of individuals to design suitable equipment and work environment.[1] Students normally spend half of the day at school and a large portion of this time on the benches in classrooms. Leaning forward and a static posture are some of the factors that can damage the vertebral column and the intervertebral disks in particular.[2] Studies have shown that school furniture in general is about the same size and rarely fit the body dimensions of the users.[3] A study in the USA on 74 students in the age range of 11–13 years showed that only 18.9 of the students fitted the furniture at school, and for the rest, the depth and height of chairs were unsuitable.[4]

Studies have shown that the lack of proportion can lead to pain in the lower leg, foot sole, knee, neck, shoulders, and waist. In addition, this causes disruption in blood circulation and varicose veins.[5] Because of lifestyle changes following the expansion of digital life and cyberworld, back pain has become a health problem in children.[6] According to annual statistics in the USA, about US$25 million is spent on

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general back pain with students and part of the problem is because of lack of proportion of school furniture to students' body.[7] Students have shown that the lack of proportion of the height of sitting surface of the chair to the leg length has a significant relationship with wrong sitting posture. In addition, lack of proportion of the elbow height in sitting position to table height has a significant relationship with pain in shoulders and neck.[8] Lack of proportion of the dimensions of chair and table makes the user to sit in a wrong way on the chair. This increases the risk of musculoskeletal disorders and learning and concentration problems in students and reduces educational efficiency.[9]

On the other hand, furniture designed based on ergonomic principles can prevent neck ache and back pain in students and decrease fatigue in students.[10] There have been studies in different Iranian cities on the proportionate of school furniture to the anthropometric dimensions of students.[10-21] Some studies have emphasized on negligence in observing internal standards of designing school furniture and the necessity of developing indigenous standards based on anthropometric dimensions.[22] The point is that students' anthropometric dimensions dictate the proper dimensions of the chair and tables in classrooms.[8] There are a few databanks of anthropometric data of students in Iran.[15] But many anthropometric studies have been done on adults and some occupations such as nurses, and that information has been used for design.[23] A review study tried to analyze Iranian students' anthropometric data in 2016, while the study population was limited to elementary students.[24] However, so far, no review study has been conducted that examines all levels of education. Taking into account the large student population, 20 million Iranian population [15], and that they are the future of any society, their health is of the highest importance. In light of this, the present study is a review of studies on the proportion of school equipment to the anthropometric dimensions of students in Iranian schools with health approach and tries to propose recommendations.

Methodology

Paper search strategy

A systematic search in databases Google Scholar, SID, MEDLINE, IRANDOC, PubMed, and ScienceDirect was performed using keywords, namely "Ergonomics," "chair and table," "proportion," "school," "Iran," and "Anthropometric" to find papers published before March 2020. The reference list of the found papers was used to extend the scope of the study. The outcomes of measuring body dimensions and chair and table dimensions were found in the papers.

The findings, along with the reported indices in studies including anthropometric dimensions, chair dimensions, table dimension, height, backrest, and the likes, were evaluated. Studies were either in English or Persian, and the geographical sites were schools in different cities of Iran. Studies on irrelevant outcomes with information gaps were excluded. After omitting the repetitious papers, the papers were examined based on inclusion/exclusion criteria by two independent authors. The information about studies that entered the final phase of the analysis was extracted and analyzed.

Selection of studies

The studies that met the following criteria entered the study:

1. Published in Persian or English
2. Conducted in schools.

Studies on other topics pertinent to schools such as ergonomics, safety, lighting, environmental hygiene, and the like or studies with information gap were excluded.

In addition, the studies only on anthropometric to design and evaluate chairs and tables were excluded.

Extraction and synthesis of evidences

Two independent authors extracted data from each study using a form. The extracted information is:

1. Study information (author, year, and design)
2. Study place (schools in Iran at all grades and cities)
3. Data gathering methods (library review, questionnaire, and observation)
4. Outcomes of study (anthropometric indices and dimensions of chair and table).

Results

The flowchart of finding and assessing studies is pictured in Figure 1. Totally, out of 13 studies found (18 studies were removed), 12 were relevant and the full text of 11 studies was available. It is notable that one of the 12 studies had not been published, and the results had been published as news, which was excluded. Given the small number of papers, the whole information about the studies was used here. Table 1 lists the specifications of the studies.

The number of measured anthropometric dimensions was different in different studies so that some had measured 18 dimensions,[11,12] some 22,[15] some 17,[11] and some only nine dimensions.[12]

The height of the table and chair sit in some studies was higher than the standard, and the distance between the two legs of the table and bench has been usually higher than the standard level.[3] Some of the anthropometric dimensions were found suitable so that Bidgoli *et al*.

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Figure 1: The flowchart of finding and assessing studies

reported that about 91% of tables and benches had a suitable length and good depth.[16] Dianat reported that 85.5% of the chairs had a good backrest height and 74.4% have a good depth.[12] Habibi conducted a study in Isfahan, Iran, and showed that chair and table designs in girls' and boys' schools should be completely different and based on body dimensions of the users.[3]

Some studies compared the old and new design benches and concluded that a few changes have been made in the new design so that the depth of sitting section and a decrease in its height were a few improvements.[10] Still, the height of the new design was too high.[10,14]

Discussion

Studies of anthropometry dimensions have been conducted in different cities of Iran and at different school levels. The results showed that there was a poor proportion between students' anthropometric dimensions and the aspects of chairs and benches. Among the reasons for this, lack of proportion is using European standards in the design of tables and benches, while the anthropometric dimensions of Iranian and European races are different. Therefore, there is a need to make designs based on Iranian anthropometric data.[15] Some of the studies showed that there was a difference between the anthropometric dimensions of Iranian students and the CDC(Centers for Disease Control and Prevention) standards databank.[25] A study on measuring the anthropometric aspects of elementary students in Iran showed that the available anthropometric data of Iranian students were much less than that of American and Greek students and more than that of Vietnamese students. Iranian students' anthropometric dimensions are mostly similar to those of Mexican students.[11] In addition, there are differences between different Iranian races (e.g., Fars, Lor, and Arab) in terms of anthropometric dimensions, and the studies emphasized the necessity of developing a comprehensive databank for any nation and race.[15] One of the reasons for the lack of proportion reported by the studies was a change of usage so that in some cases, elementary schools have been used as a high school or junior high school without changing the school furniture.[26] In some cases, the same benches and tables have been used for all levels so that the sitting and table heights were too low for students of higher grades or too high for students of lower grades.[18] It is recommended to pay more attention to the proportion of school furniture in two anthropometric dimensions of students.

Habibi in Isfahan showed that bench and table design for girls and boys schools should be completely different and based on their body dimensions. They reported that boys and girls grow differently so that between the ages of 7 and 11 years, boys are bigger than girls in all aspects, while between 10 and 11 years, girls are taller than boys on average.[3] Hafezi showed that between the ages of 8 and11 years, some aspects such as sitting height, sitting eye height, sitting elbow height, knee height, and hip-knee length were higher in girls than boys. In addition, height, the distance between two elbows, the distance between two forearms, and diameter of one and two thighs were higher in boys than girls.[3,11,12] These findings are consistent with studies in other countries, including Mexico and Greece.[27,28] Therefore, gender differences need to be taken into account in the design of school furniture.

The majority of studies reported that the height of chairs and benches was not suitable. The height of chair is the most important variable and the starting point of the design process.[29] Dianat *et al*. studied students in the age range of 15–18 years and showed that 60.9% of chairs and 51.7% of tables were not standards in terms of dimensions.[12] Studies have shown that with a too high table, the students have to remain standing up for a long period of time, and this causes varicose veins of the legs. In addition, with a too high sitting height, students' legs cannot touch the ground, and this negatively affects the knees, legs, and foot sole.[3] Moreover, with a too high table, the student has to keep the shoulders higher than the normal position, which causes neck and shoulder problems.[30]

The sitting height is based on a percentile value of 5% of popliteal height. The studies showed that siting height was too high, so that the feet soles do not touch the ground, and this badly affects the knees, legs, and feet soles[3] along with excessive pressure below the thighs.[1] The distance between the two legs of table and bench should be based on a percentile value of 95% of the buttock width plus 12 cm. The studies showed, however, that this distance was higher than the standard, and the

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Table 1: Lists the specifications of the studies

Row	Study	Study section	Year	Region	Design	Study method	Outcomes examined	Key findings
1	Dianat *et al.*[12]	Male and female high school	2013	Kerman	Cross-sectional	Measurement	Measurement of anthropometry dimensions for comparison and presentation of proposed size	There is a mismatch between the body dimensions of the students and the dimensions of the benches
2	Varmazyar *et al.*[13]	Female high school	2007–2008	Qazvin	Cross-sectional	Interviews and measurements with anthropometric devices (caliper, wager, and anthropometers)	Measurement of anthropometry dimensions for comparison and presentation of proposed size	All dimensions of the table and chair, except for their height, are far from the standard dimensions
3	Habibi *et al.*[14]	Male and female primary	2009–2010	Esfahan	Cross-sectional	Measurement	Measurement of anthropometry dimensions for design	There is a mismatch between the body dimensions of the students and the dimensions of the benches
4	Habibi and Hajsalehi[3]	Male and female primary	2011	Esfahan	Cross-sectional	Observation Interview Measure of anthropometric checklist	Measurement of anthropometry dimensions for comparison and presentation of proposed size	There is a mismatch between the body dimensions of the students and the dimensions of the bench
5	Rashidi *et al.*[15]	All, of course	2007–2008	Lorestan	Cross-sectional	Questionnaire and measurement	Measurement of anthropometry dimensions for design	There is a mismatch between the body dimensions of the students and the dimensions of the benches
6	Bidgoli *et al.*[16]	Female primary	2011	Aran and Bidgol	Cross-sectional	Questionnaire and measurement	Measurement of anthropometry dimensions for design	There is a mismatch between the body dimensions of the students and the dimensions of the benches
7	Sari Sarraf *et al.*[17]	Male and female primary	2011	Maryland	Cross-sectional	Measurement	Measurement of anthropometry dimensions for comparison and presentation of proposed size	There is a mismatch between some of the body dimensions of the students and the dimensions of the benches
8	Heidarimoghadam *et al.*[10]	Male primary	2013	Hamadan	Cross-sectional	Measurement	Measurement of anthropometry dimensions for comparison and presentation of proposed size	Both desks and benches were not suitable for students
9	Heidarimoghadam *et al.*[18]	Female primary	2013	Hamadan	Cross-sectional	Measurement	Measurement of anthropometry dimensions for comparison and presentation of proposed size	There is a mismatch between the body dimensions of the students and the dimensions of the benches
10	Ghofrani and Noori[19]	Female primary	2011	Yazd	Cross-sectional	Measurement	Measurement of anthropometry dimensions for comparison and presentation of proposed size	There is a mismatch between the body dimensions of the students and the dimensions of the benches
11	Yadollahi and Tabarsa[20]	Male primary	2011	Azadshahr and Gonbad		Measurement	Measurement of anthropometry dimensions for comparison and presentation of proposed size	There is a mismatch between the body dimensions of the students and the dimensions of the benches

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student has to bend the body and the head and arms have to be stretched forward.[3]

The studies showed that anthropometric dimensions, including backrest height and depth, was suitable.[12] Bidgoli *et al*. reported that 91% of the tables and benches had a suitable length and depth.[16] They also reported that open space under the table was suitable in more than 60% of the cases. Habibi showed that the open space under the table was suitable in both detached and attached table and bench of old designs.[14]

A comparison of the old and new designs of tables and benches showed a few improvements in some aspects such as the increase in the depth of sitting section, and the results were better table and benches with shared sitting section. In addition, there was a decrease in the height of sitting sections, and the benches had a better design.[10] Habibi showed that the new design of tables and benches was improved in all aspects except for the height.[14] The new design was featured with detached table and chairs with separate backrests, which was an improvement compared to the old design. Still, since the backrest height was increased, it was not proportionate to the anthropometric dimensions of students.[10]

Taking into account the anthropometric dimensional differences in different generations, the standards should be revised periodically.[11] Since procuring new furniture every few years is not economic, chairs with ergonomic design and adjustable height are better choices. In addition, ergonomic chairs prevent musculoskeletal disorders that are mostly because of the hard surface of benches and nonadjustable backrests. Lack of dimension proportionate of furniture to users creates musculoskeletal and posture disorders in students.

Studies showed that there was no specific process of measuring anthropometric dimensions. The studies had focused on different variables, and the height was the most important factor in this regard and the other aspects received less attention. The reason for this is that other aspects such as hand height and leg height are proportionate to one's height unless there are physical and bodily disorders.[1] Among the limitations of these studies, lack of a specific study on special children's schools is notable (although it was beyond the scope of the present study). Given the special physical condition of some children, there is a need to pay more attention to them and introduce furniture design suitable for them.

It is suggested that future studies be conducted to prepare a comprehensive database of anthropometric data for different ethnicities and cities in Iran. Furthermore, Studies are suggested to design of furniture proportion with the dimension of Iranian students.

Conclusion

The results showed that school furniture was not proportionate to the users, and there was a need to design and procure furniture proportionate to the anthropometric dimensions in the society that is helpful to the health promotion of students. Given that these dimensions are functions of gender, age, and gender, there is a need to develop a comprehensive anthropometric databank for every society, and these databanks should be revised periodically. Adjustable and ergonomic furniture also prevents future musculoskeletal disorders in students.

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Conflicts of interest

There are no conflicts of interest.

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