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Anthropometric Dimensions and Classroom Furniture Measurements Among Pre-school Students in Kerman, South East of Iran

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ABSTRACT

Introduction: With the alternation of the educational system from a three-stage into a two-stage system in Iranian schools since several years ago, five-year-old children entered from kindergartens to primary schools. This study was conducted to investigate the harmonization of classroom furniture with anthropometric dimensions in preschool students.

Methods: In this cross-sectional study, 366 male and female preschool students were selected by cluster sampling method in Kerman, Iran. Some of the anthropometric dimensions such as shoulder, elbow, and popliteal height, popliteal buttock length, and buttock breadth were measured. mean, maximum, minimum, standard division, and 5th, 50^{th,} and 95th percentiles were calculated for both the sexes and were compared with five dimensions of the existing seats. Next, the dimensions of the standard seats were determined according to the anthropometric dimension's students. Data were analyzed using SPSS 21 .

Results: Results of this research indicated that there is no consistency between the seats and pre-school student's anthropometric dimensions in Kerman city. Seat height was matched with popliteal height in 28.7% and less than 1% of boy and girl student's anthropometric dimensions respectively. Backrest height and seat depth matched with shoulder height and popliteal- buttock length separately in fewer than 10% and armrest height was too smaller than elbow height and seat width was too larger than buttock breadth in both sexes.

Conclusions: Due to adding a new grade to primary school, it seems that no work has been done for improving the furniture. Therefore, in this article, we presented the dimensions of an appropriate seat. This may help not only save production costs in the industry but also increase the matching between students' anthropometric and seat dimensions.

Keywords: Anthropometry, Primary school, Classroom furniture, Pre-school student

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Introduction

Schools are the second home for students and they spend between five to seven hours of their useful time in schools 1. Students spend about 80% of their time in a sitting position in the classroom performing activities related to reading and writing 2. In school, students usually gain permanent habits of sitting on the chair 3. One of the effective factors in improving education is the quality of educational environments and their equipment 4. Musculoskeletal disorders in pupils are usually caused by unfit school furniture, heavy school bags, lack of exercise, and inappropriate position. These disorders have a negative effect on their emotional and physical activities 5. The unfit sitting position in childhood can lead to injury in adulthood 6. The good sitting position in childhood causes good sitting habits in adulthood while bad sitting habits acquired in childhood are very difficult to change in adolescence or adulthood 3. Tichauer stated that school furniture can affect the individual and social behaviors of students and cause students to dislike education and escape from schools 7. Kane explained that unfit chairs caused fidget, restlessness, and constant movement in traditional chairs 8. In the same line, Diep reported that one of the reasons for the mismatches between seats and students is the scarcity of data on anthropometric measurements in a community 9. In a British context, Murphy, through a cross-sectional study on 11-14-year-old English schoolchildren, stated that neck pain and lower back pain significantly relate to school furniture design 10.

For the above reasons related to bad posture, the presence of mismatches in classroom furniture in childhood can cause problems in adulthood. Anthropometric measures are very different between age groups, the same age between both genders and different cultures.

Pre-school students have been added to primary school in Iran in recent years. Thus, there is not sufficient information in this respect. Two studies have been conducted on high and primary school students in Kerman respectively for the determination of students' physical dimensions and their proportion to the dimensions of the furniture 11, 12. The purpose of this study is to complete the anthropometric data in the students in Kerman, evaluate existing seat fitness for preschool students, and present standard seat dimensions according to the anthropometric data.

Methods

This cross-sectional study was performed on 366 people 183 females and 183 males pre-school students in the areas of 1 and 2 of Kerman city by cluster sampling method with a design effect of 1.02.

At first, the target population was taken from the Statistics Unit of the Kerman Department of Education. The sample size formula in the two groups of girls and boys was as follows:

$$n_A = \frac{(\varphi+1)\left(Z_{1-\beta}+Z_{1-\alpha/2}\right)^2\sigma^2}{\varphi d^2} + \frac{Z^2_{1-\alpha/2}}{2(1+\varphi)},\ n_B = \varphi n_A;$$

where φ is the sample size allocation ratio in the two groups of girls and boys, α is the probability of making a type I error, β is the probability of making a type II error, σ is the common variance of scores in the two groups of girls and boys, and d is the acceptable margin of error. According to the results of the pilot study conducted by the researchers on 30 participants 15 participants from each group the sample size was calculated. By considering the $\varphi=1, \alpha=0.05,\ \beta=0.1,\ \sigma=9.28,\ d=3.5$, the sample size in each group was equal to 183 people.

The students were selected from 8 schools that were located in eight different areas in the city four schools in each area and two schools for every sex. Later, anthropometric dimensions and classroom furniture measurements of two classes were measured in each school.

The stature, weight, and 18 anthropometric diminutions of the preschool students were measured. Five anthropometric diminutions of them were used for chair design and assessment of mismatches between classroom chairs and

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students' body dimensions Table 1. Anthropometric measurements were performed in the spring according to the standard physical setting of Pheasant Stephen while the students wore a normal uniform and no shoes. These measurements consisted of height and weight, shoulder height, elbow height, popliteal height, buttock-popliteal length, and buttock width Table 1. Besides, five classroom chair dimensions related to the chair design were measured that included seat height, seat depth, seat width, backrest height, and armrest height. The measuring instruments included a meter, a goniometer Moltgen, and a digital scale Zyklusmed Zyklusmed, Hamburg, Germany with accuracy gram. Measurements' length was set to the nearest millimeter; however, they were reported in centimeters. The criteria used to determine the acceptable range in the chair design were 5th, 50th, and 95th percentiles 13.

This comparative cross-sectional study was evaluared by independent-Samples T-test for comparision of anthropometric measurements between the two groups. For assessment of match of anthropometric dimentions with classroom chairs measurements, statistical indicators such as mean, maximum, minimum, standard division, and 5^{th}, $50^{th,}$ and 95^{th} percentiles were calculated for both the sexes.

A difference of $p < .05$ was considered statistically significant. The collected data were analysed with SPSS version 21. Other appropriate statistical software such as Microsoft Office Excel 2010 was employed as well.

Table 1. *Dimensions and Percentile Required for the Chair Design*

Anthropometric dimensions	Application	Percentile used
Buttock width	Determination of seat width	95^{th}
Buttock- popliteal length	Determination of Seat depth	5^{th}
Popliteal height	Seat height Determination of	5^{th}
Elbow height	Determination of armrest height	50^{th}
- Shoulder height	Determination of backrest height	5^{th}

Table 2. *The Anthropometric Dimensions of the Students in 5, 50, and 95 percentiles and comparison of means them between girls and boys,*p≤0.05*

Anthropometric dimensions	Sex	95 percentile cm	50 percentile cm	5 percentile cm	Mean ± SD cm
Buttock width	girl	25	22	20	22.24 ±1.96
	boy	27	22	20	22.77 ±1.9
Buttock- popliteal length	girl	36	32	28	32.15 ± 2.33
	boy	35	31	28	31.21 ± 2.25
Popliteal height	girl	33	27	23	25.87± 4.53
	boy	32	29	27	29.55 ± 1.74*
Shoulder height	girl	42	37	33	36.71 ± 2.67
	boy	41	37	32	36.53 ± 2.51
Elbow height					

Results

The anthropometric dimensions of the students were measured and presented in Table 2.

Except for popliteal height, other measured dimensions indicated slight differences between girls and boys. Therefore, a suggested chair was designed for both sexes.

These results showed that most of the chair dimensions were larger than the anthropometric dimensions among the students.

According to the mean of elbow height in pre-school students, armrest height in the 50^{th} percentile obtained was 16 cm. while the mean of armrest height for the pre-students was 13 cm for the boys and 12 cm for the girls. These data matched with 0.7 % of the boys and didn't match

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with girls in elbow height Fig 1. But with the rise of armrest height until 16 cm, the match percent increased about 45%.

The seat height mean obtained was 30 cm for the boys and 35 cm for the girls that matched with 28.7% and under 1% of students, respectively. As regarded, a short chair is more comfortable for tall people than a high chair for short people, 5th percentile of popliteal height was used for seat height of the suggested chair. It was achieved 27 cm Fig 2. By adding 2 cm to the shoe heel, this number was changed to 29 cm.

Back seat height was 32 cm and 35 cm for the boys and the girls accordingly that matched with 6% and 10% of students, respectively. According to the 5th percentile of shoulder height, the back seat height of the suggested chair was selected to be 36.5 cm Fig 3. By designing this chair the match percent increased up to 10 % in the boys.

According to Fig 4, the depth of the seat was 28 cm for the boys and 27 cm for the girls and matched with 6.7% and 2.5% of students, respectively. The seat depth of the suggested chair was achieved as 31 cm according to buttock-popliteal length in 5Th percentile.

The width of the existing chairs was 34 and 33 cm in the girls and boys, respectively. There was no proportion between seat width and buttock width. According to buttock width in the 95th percentile, the seat width of the suggested chair obtained was 23 cm Fig 5. By reducing 10 cm from the seat width, the match percent increased to 22%.

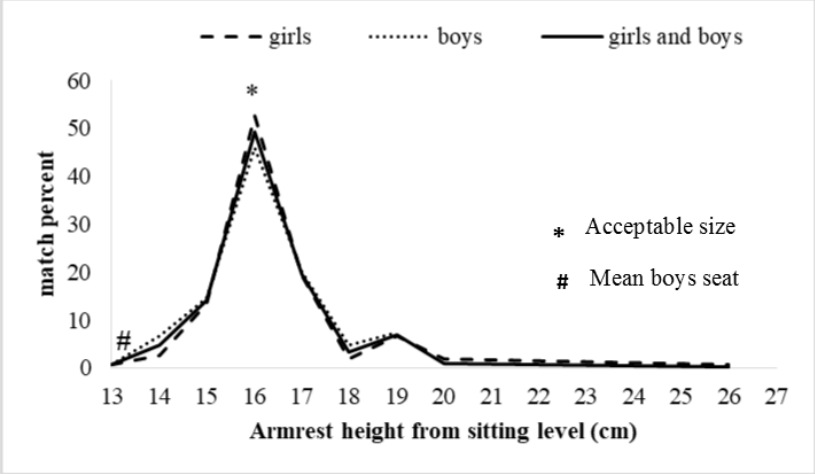

Figure 1. Percentage of Anthropometric Dimensions of Students with Armrest Height

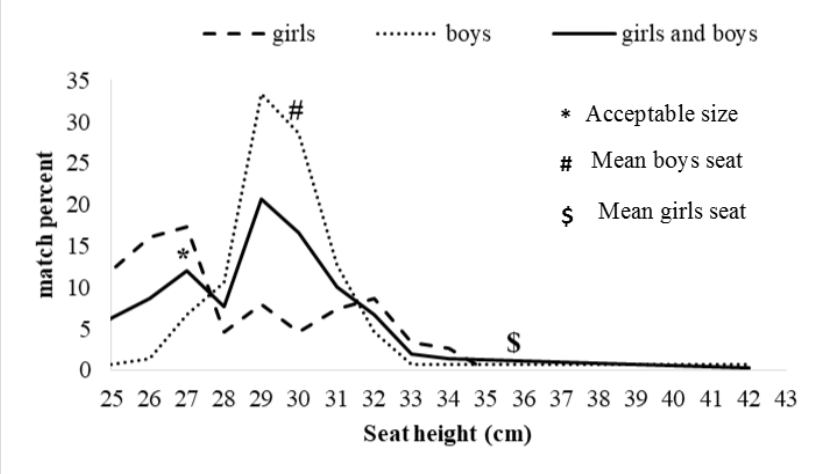

Figure 2. Percentage of Anthropometric Dimensions of Students with Seat Height

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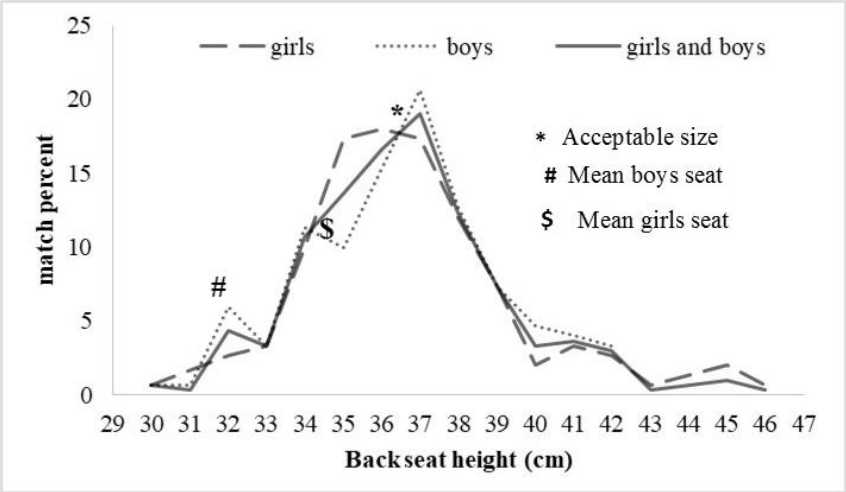

Figure 3. Percentage of Anthropometric Dimensions of Students with Back Seat Height

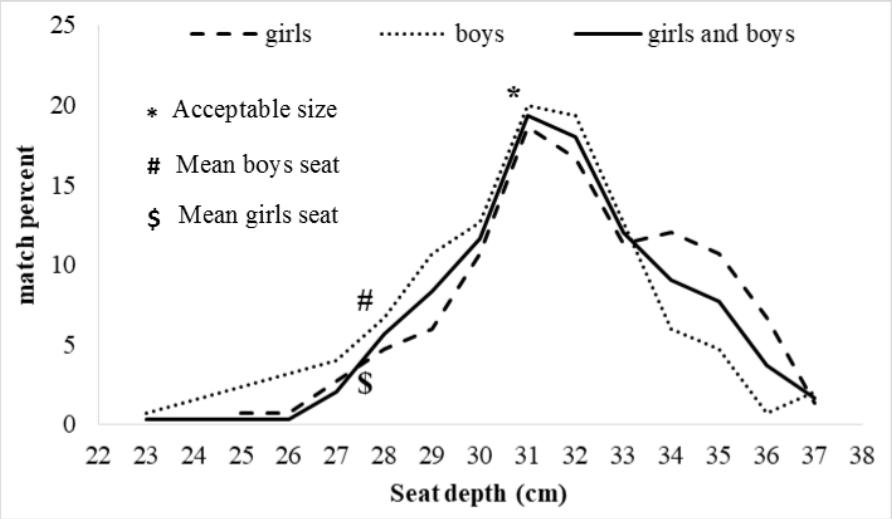

Figure 4. Percentage of Anthropometric Dimensions of Students with Seat Depth

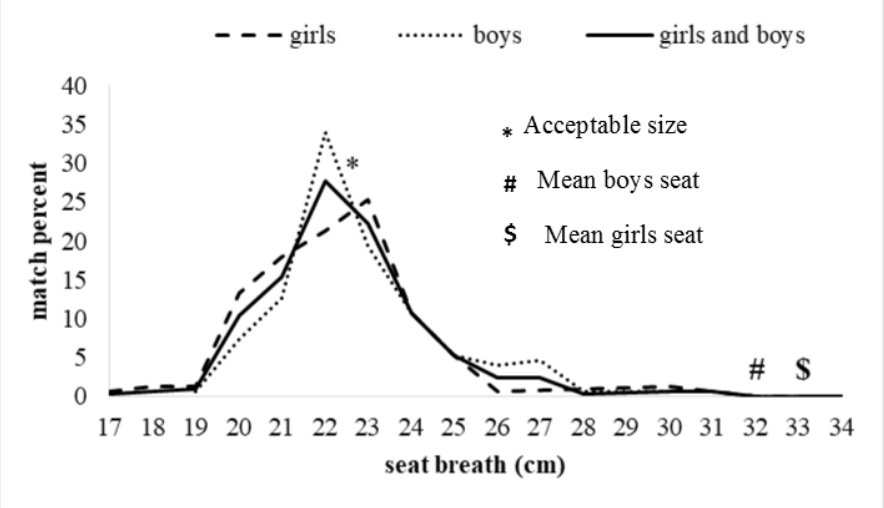

Figure 5. Percentage of Anthropometric Dimensions of Students with Seat Width

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Discussion

The anthropometric dimensions of pre-school students were measured and given to the faculty of medicine in order to store in the anthropometric dimensions database in Kermanian students.

There were a few differences between anthropometric dimensions in the pre-school girls and boys students, therefore a suggested chair was designed with measurements of 16, 29, 36.5, 31, and 23 for armrest height, seat height, back seat height, seat depth, and seat width respectively. Chair design based on anthropometric diminutions correct sitting posture and reduce musculoskeletal problems among preschool students 14.

Additionally, these results displayed that there is a considerable mismatch between student's seats and their anthropometric dimensions, especially armrest and seat height in the female students, back seat height in male students, and depth and width seat in the male and female students.

In this study, armrest height was too short for students' body dimensions. It just matched 0.7% of boys' anthropometric parameters and did not show any correspondence with girls' anthropometric dimensions. A suitable armrest by reducing neck, shoulder, and back stresses and minimizing the pressure between arm and armrest provides a good surface area for the arm 15. An appropriate armrest with reducing the weight on the seat pan decreases the stress on the vertebral column 13. An armrest height mismatch increases body flexion on one side and the arm has to endure the body's whole weight. This position, in addition to fatigue, causes stress in the vertebral column 16.

Seat height was another seat diminution obtained in this study. It was equivalent to 28.7% of popliteal height in male pre-school students and didn't match with the popliteal height of females. In this study, seat height in 71% boys and 100% girls was higher than the acceptance range. Therefore, students have to sit on seats with too much height, and consequently, their feet soles are not in contact with the ground. This position increased tension in the popliteal fossa and popliteal vessels 16. Since these vessels supply blood in the legs and feet, the reduced blood flow in the extremities causes numbness, tingling, and feet swelling 18. In other cases, this mismatch pushes the students forward, and being in this position for a long time causes musculoskeletal and back pain disorder 19. In the same line, Castellucci et al. performed a study on 3078 students in Chile and reported popliteal height is the most important anthropometric measurement for classroom furniture design 20. Moreover, our results agree with Shahabi et al.'s report that stated the mismatch percentage for popliteal height in boys and girls of third-grade elementary school to be 95% and 90% respectively 12. In another study on 10-13 years students in Hong Kong, Chung Wong reported 93-100% of high mismatches 21. Similarly, Panagiotopoulou, in a study conducted on primary school students in Greece, stated that 95-100% mismatches were observed between popliteal height and seat height in 2nd, 4th, and 6th grades among students 3. Additionally, Fidelis et al. in a study on primary school students in Nigeria claimed that 43% of the males and 42% of the females had seat height mismatches 22. Dianat, in a training program on high school students in Iran, reported that the highest mismatch was observed in 9th grade which reduced in accordance with the increasing grade level 11. Finally, Habibi in a study on elementary school pupils in Isfahan, Iran stated that seat height in available school furniture is much higher than the acceptable height 23.

In the present study, seat depth was too shallow for students. 93% and 97.5% of girls and boys use shallow seats respectively. Parcells in a study reported that a narrow seat causes the lack of support in the lower thigh of its user and may cause the person to feel going forward 24. Fidelis et al. reported that seat depth matched 47% and 44% of boys and girls primary students in Nigeria 22.

A good back seat that maintains the natural spinal curve reduces lordosis and kyphosis posture 25. According to this result, back seat height was matched with 6% and 10% of the anthropometric dimensions in girls and boys. In other words, the shoulder height of more than 90% of students was

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below the acceptance range. As previous studies reveal, sitting on chairs with insufficient back seat support increases flexion of the lumbar spine and increases the force on the lower back 26.

The present study was carried on pre-school students' furniture for the first time and proposed a standard chair for these students. Due to Iran being a vast country with varieties in sizes and races of people, it would have been better if clusters were selected from all over the country or similar studies were accomplished on other pre-school students with one or two chair suggestions for these students.

Thus, one of the limitations of this study was selecting one city for research.

Conclusion

These findings display that the majority of the students use unsuitable furniture and they have to sit in an inappropriate position. An unfit sitting position in childhood not only causes fatigue and lower back pain but also leads to musculoskeletal disorder in adulthood. Due to the large size of most of the chair dimensions, we can improve sitting position by reducing the size of them and additionlly decrease the production fee in the industry. On the other hand, by adding a new grade to primary schools, it is recommended to design new school furniture for preschool students according to anthropometric body diminutions.

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Ethical Considerations

Compliance with ethical guidelines

All ethical principles were considered in this article.

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Authors' Contribution

Study concept and design: Fatemeh Seyedi. Collection, analysis, and interpretation of data: Mohammad Ali Shahabi-Rabori, Fatemeh Seyedi, Seyed Hassan Eftekhar-Vaghefi. Drafting of the manuscript: Fatemeh Seyedi, Mohammad Ali Shahabi-Rabori. Study supervision: Seyed Hassan Eftekhar-Vaghefi.

Conflict of interest

Authors have declared that no competing interests exist.

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