

# **A Practical Method for School Furniture Design to Prevent Musculoskeletal Disorders among Pupils**

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## **Abstract**

**Background:** Design of school furniture is one of the contributing factors to back pain among pupils. Research has implicated that mismatch between school furniture and body size may be regarded as a causative factor for musculoskeletal disorders amongst pupils. To investigate the fitness between school furniture and pupils this study was designed and implemented in Hamadan City, west of Iran.

**Methods:** This descriptive study was done on 1580 pupils from 11 to 18 years old including both genders, using cluster sampling. Anthropometrical dimensions including height and weight were measured and demographic data collected.

**Results:** According to ISO 5970 procedure, all studied pupils, divided into four groups. In the first group, including both genders in first grade of secondary school, size 3 was purposed for redesign of school furniture. In the second group, including boys in second and third grade of secondary school, size 4 was purposed for redesign of school furniture. Accordingly, in the third group including girls from second grade of secondary school to end of high school, size 4 was purposed for redesign of school furniture. In forth group including high school boys, size 5 was purposed for redesign of school furniture.

**Conclusions:** Current design of school furniture is not compatible with the purposed dimensions. In most cases, the same size furniture was in use from secondary schools to high schools.

**Keywords:** *Anthropometrics, School Furniture, Ergonomic Design, Iran*

## **Introduction**

The education is an inevitable part of a civilized nation. Education of future generations requires a remarkable investment, representing a very high load to developing countries. Amongst critical elements to the good development of school children are the tools needed. In that sense, school furniture is an extremely important tool. School furniture must respond to the characteristics of the population that uses it. The dimensions of school furniture must conform to the anthropometrical dimensions of the boys and girls and designers must have information available so meet those requirements.

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Children spend a large part of their times in the classroom. School age is a vital period for child development. Regarding low back pain, sitting posture is the most troublesome situation. Some studies showed that design of school furniture is one of the contributing factors to back pain among pupils (1). Research has implicated that mismatch between school furniture and body size may be regarded as a causative factor for musculoskeletal disorders amongst pupils (2).

For this reason, conducting a study to help develop appropriate design strategies for school furniture design is necessary. In order to reach an optimal fitness between school furniture and the pupils, the furniture should be designed according to psychophysical charac-

teristics of the users as well as educational environment specifications. There are very few developing countries, which have anthropometrical data of school children for the purpose of furniture design (3).

To investigate the fitness between school furniture and pupils, this study was designed and implemented in Hamadan City, west of Iran.

**Materials and Methods**

This descriptive study was done on 1580 pupils from 11 to 18 yr including both genders, using cluster sampling. After the selection of the schools and, before proceeding with the measurements, permissions from the regional offices of the Ministry of Education and the school Principals were necessary. Data was collected in the selected schools. In order to collect the data it was necessary to prepare special forms for the identification of the school, the grade level and the measurements for each child. After obtaining the consent of the student, weight (kg) and standing height (to the nearest centimetre) was measured using a body weight scale (up to 120 kg) and a tape measure respectively. After completion of data collection, ISO 5970 procedure was applied for redesign of school furniture- see ISO 5970 -1979 (4).

**Results**

Table 1 shows mean of age in school children. Descriptive statistics of height in schoolboys is reported in Table 2 and descriptive statistics of height in schoolgirls is reported in Table 3.

Our finding showed that in schoolboys:

1-Maximum height was observed during 13-15 yr old.

2-Maximum weight was observed during 14-15 yr old.

3-Increase of height is small after 17.

Our finding showed that in schoolgirls:

1-Maximum height was observed during 12-13 yr old.

2-Maximum weight was observed during 16-17 yr old.

3-Increase of height is small after 17.

**Table 1:** Mean of age in school children (year)

Grade	Girls	Boys
1 <sup>st</sup> grade- secondary school	12.2	11.6
2 <sup>nd</sup> grade- secondary school	13.3	12.8
3 <sup>rd</sup> grade- secondary school	14.3	14
1 <sup>st</sup> grade- high school	15	15.2
2 <sup>nd</sup> grade-high school	16.2	15.5
3 <sup>rd</sup> grade-high school	17.1	16.7
End of high school	17.6	18.2

**Table 2:** Descriptive statistics of height in schoolboys

Grade	Mean	STD Deviation	Maximum	Minimum	Percentiles			
					5	50	90	95
1 <sup>st</sup> grade- secondary school (n=130)	143	7.6	161	123	132	142	151	154
2 <sup>nd</sup> grade- secondary school (n=125)	148	8.1	173	129	135	148	158	161
3 <sup>rd</sup> grade- secondary school (127)	157	9.3	186	133	142	157	169	172
1 <sup>st</sup> grade- high school (n=109)	165	9	184	146	150	166	176	180
2 <sup>nd</sup> grade- high school (n=111)	169	8.9	186	147	154	170	179	182
3 <sup>rd</sup> grade-high school (n=105")	171	6.6	190	153	160	172	180	182
End of high school (n=122)	172	6.1	190	155	162	173	180	183

**Table 3:** Descriptive statistics of height in schoolgirls

Grade	Mean	STD Deviation	Maximum	Minimum	Percentiles			
					5	50	90	95
1 <sup>st</sup> grade- secondary school (n=118)	143	8.4	165	115	129	144	153	156
2 <sup>nd</sup> grade- secondary school (n=98)	150	6.9	175	130	138	150	159	161
3 <sup>rd</sup> grade- secondary school (n=100)	154	7.1	171	132	143	156	162	162
1 <sup>st</sup> grade-high school (n=115)	155	7	167	144	148	156	161	166
2 <sup>nd</sup> grade-high school (n=106)	157	4.8	168	141	149	158	163	165
3 <sup>rd</sup> grade-high school (n=120)	157	6.6	171	144	148	157	163	156
End of high school (n=100)	159	6.5	177	145	150	158	166	168

**Table 4:** Grouping of pupils according to ISO 5970

Groups	Mean of Height (cm)	ISO Size
Group1: Boys and Girls 1 <sup>st</sup> grade of secondary school	143	ISO SIZE3 Height: 130-148 cm
Group 2: Boys 2 <sup>nd</sup> and 3 <sup>rd</sup> grade of secondary school	148-157	ISO SIZE4 Height: 148-162 cm
Group 3: Girls 2 <sup>nd</sup> grade of secondary school to end of high school	150-159	ISO SIZE4 Height: 148-162
Group 4: Boys 1 <sup>st</sup> grade to end of high school	165-172	ISO SIZE 5 Height: 162-184

## Discussion

Our findings showed that current design of school furniture in educational facilities under study in majority was not compatible with the purposed dimensions. In some cases, it was found that the furniture was made of non-wooden materials e.g. metal furniture! Moreover, the same size furniture was in use from secondary schools to high schools.

After data collection, according to ISO 5970 procedure, all studied pupils, divided into four groups. In the first group, including both genders in first grade of secondary school, size 3 of ISO 5970 was purposed for redesign of school furniture. In the second group, including boys in second and third

grade of secondary school, size 4 of ISO 5970 was purposed for redesign of school furniture. Accordingly, in the third group including girls from second grade of secondary school to end of high school, size 4 of ISO 5970 was purposed for redesign of school furniture. In forth group including high school boys, size 5 of ISO 5970 was purposed for redesign of school furniture (Table 4).

Redesign of school furniture according to grouping proposed in table 4 is regarded as an easy ergonomics solution to incompatibility of current design of school furniture.

Our findings showed that current design of school furniture is not compatible with the purposed dimensions. In most cases, the same size

furniture was in use from secondary schools to high schools.

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