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A mismatch between existing and ergonomicaly formulated dimensions for Indian classroom furniture

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ABSTRACT

The present study aimed to know the extent of mismatch between existing classroom furniture and the formulated dimensions based on anthropometric measurements of female students. A total sample of 20 classrooms was selected and an anthropometric data of 320 subjects were recorded, based on which the dimensions were formulated for ergonomically suitable classroom furniture. It was observed that depth of the table was inadequate and the slope of table top was below 15 degrees which can lead to poor posture and fatigue. But in 55 per cent of the classrooms, total chair height and seat height was close to the formulated one. On the other hand, seat depth was less and seat width was more in comparison to the formulated counterparts whereas seat slope was within the recommended average. The distance of seat to the top of desk was exceeding the formulated dimension, but height of the backrest was less.

Key Words : Anthropometric measurements, Classroom furniture and mismatch

INTRODUCTION

During the past decade, research in ergonomics has led to an improvement in the technology of work and furniture design based on the bio-mechanics of human body. However, the largest workplace of all, *i.e.*, the classroom is still being ignored. At present, there are 1800 girls' colleges in India (Chronicle Year Book, 2009). Designing for girls is significant because they have special requirements. Besides, the stature and anthropometric measurements of female students are entirely different from those of the male students. Thus, there is a need to focus attention on classroom furniture designing for girls. Comfortable work design would enable them to maintain good body posture and cause lesser physical fatigue. Study table and chair that gets into the psycho-physiological requirements of the users contribute towards synchronizing comfort and efficiency. Young female students are at a special risk of suffering from negative effects of badly designed and ill-fitted classroom furniture and working environment owing to the prolonged periods spent seated in the class-

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room. According to Chakrabarti (2004), one should consider appropriate anthropometrical requirements for sitting, for seat, for work surface dimensions, legroom and clearances while designing furniture. Present study was planned with the following objectives:

– Formulate the dimensions based on anthropometric measurements of female students.

– To compare the existing classroom furniture dimensions with the formulated dimensions in order to know the gap between the two.

METHODOLOGY

The study was conducted in Ludhiana city. The local selection of the sample was purposive because of the workability and kind of measurements required. A total sample of 10 colleges was randomly selected for this study. Two classrooms from each college, making a total of 20 classrooms were selected for taking the measurements of existing furniture. A record sheet was constructed to note the dimensions of existing classroom furniture. Anthropometric data of 320 subjects (16 subjects from each of the 20 classrooms) were also recorded, based on which the dimensions were formulated for ergonomically suitable classroom furniture. These dimensions were then compared with the existing furniture dimensions in order to know the gap between the two. The data were analyzed using various statistical tools like averages, frequencies, percentages and standard deviation.

RESULTS AND DISCUSSION

Comparison of existing furniture dimensions with the formulated dimensions:

The existing furniture dimensions were compared with the formulated ones (Table 1) in order to know the mismatch between two.

Study table/desk:

Table 2 shows a slight mismatch in the height of desk and the anthropometric measurements with the difference of 1.45±0.05 cm which was found to be statistically significant. Excess table height could lead to forward stretching of the body which will create neck and back problems. The width of the desk on the other hand, is 43.80±8.62 cm as compared to the formulated dimension of 62.27 cm. The difference was 18.78±0.55 cm and the t value was found to be statistically significant. This reveals that the space available for writing and drawing work for the students in the existing furniture was very less. A greater space should be provided for this purpose by designing the classroom furniture according to the anthropometric measurements. In case of depth, the difference between the two was 23.30±1.50 cm, thus providing inadequate space which can lead to compressing of arms and puts pressure on the shoulder joints. The gap for the slope of table top was 4.25±0.08 degrees which can force the users to acquire forward bending and stooping posture for longer period of time which can cause back problems.

Study chair:

The gap for total seat height between the two was calculated as 17.42±0.75 cm. The seat height was almost appropriate according to the anthropometric measurements of female

Table 1: Formulated guidelines based on anthropometric measurements (n=320)

Furniture	Dimension	Anthropometric measurement used		Formula used	Formulated dimension	Source
		Anthropometric measurement	Value (cm)			
Study table/ desk (without foot rest)	Height	Maximum knee height, Maximum thigh height	51, 19	Maximum knee height+ Maximum thigh height	70 cm	Roberts (1960)
Study table/ desk (with foot rest)	Height	Maximum knee height, Maximum thigh height	51, 19	Maximum knee height+ Maximum thigh height+6cm	76 cm	Roberts (1960)
Study table/ desk	Width	Stature height (H)	155.67	0.40H	62.27 cm	Central Building Research Institute (1999)
Study table/ desk	Depth	Stature height (H)	155.67	0.39H	60.71 cm	Central Building Research Institute (1999)
Study chair	Seat height	Minimum sitting popliteal height	44	Minimum sitting popliteal height	44 cm	Roberts (1960)
Study chair	Seat width	Maximum sitting hip breadth	37.59	Maximum sitting hip breadth+7.5 cm	45.09 cm	Roberts (1960)
Study chair	Seat depth	Minimum sitting buttock-popliteal length	32.50	Minimum sitting buttock-popliteal length+7.5cm	40 cm	Roberts (1960)
Study chair	Backrest height	Average sitting shoulder height	54.80	Average sitting shoulder height±3cm	51.80-57.80cm	Roberts (1960)
Study chair	Backrest width	Average hip breadth	36.00	Average hip breadth +7.5cm	43.50 cm	Roberts (1960)
Study chair	Lumbar support height	Average navel height	22.88	Average navel height±5 cm	17.88-27.88cm	Roberts (1960)
Study chair	Lumbar support width	Average hip breadth	36.00	Average hip breadth±3cm	33-39 cm	Grandjean (1988)

Table 2 : Comparison of existing classroom furniture dimensions with formulated dimensions

Furniture	Existing dimensions	Formulated dimensions	Gap	t-value
Study table/desk				
Height	77.30±4.76 cm	76.00 cm	1.45±0.05	7.51*
Width	43.80±8.62 cm	62.27 cm	18.78±0.55	5.90*
Depth	37.50±13.08 cm	60.71cm	23.30±1.50	17.38*
Slope	8.50±2.62 degrees	12.50 degrees	4.25±0.08	13.90*
Study chair				
Total height	83.50±6.71cm	101.19 cm	17.42±0.75	61.3*
Seat height	43.25±1.65cm	44.00 cm	0.80±0.01	5.20*
Seat depth	43.80±1.66 cm	40.00 cm	3.75±0.04	8.23*
Seat width	42.40±2.19 cm	45.09 cm	2.65±0.03	11.60*
Seat slope	4.35±1.81degrees	4.00 degrees	0.40±0.01	1.73*
Height of backrest	41.20±5.75cm	54.80±3cm	13.70±0.20	6.08*
Slope of backrest	104.30±1.34degrees	103.00degrees	1.35±0.02	7.51*
Thigh clearance height	31.50±2.62 cm	26.50 cm	5.25±0.06	17.30*

*Significant at 5 per cent level of significance.

users. In case of seat depth, the gap between existing and formulated was 3.75±0.04 cm which can result to forward bending away from the backrest so the user cannot rest her body against it and if she tries that, it would make the legs remain in the air. Both these situations would cause stress on the backbone and discomfort or swelling in the legs. The gap in seat width between the two was 2.65±0.03 cm. The smaller seat width would give inadequate space for the hips to rest, thereby causing discomfort in the lower back and thighs. The difference in seat slope was 0.40±0.01 degrees which was almost appropriate according to the dimension. The gap was 13.7±0.20 cm for backrest height. The smaller height of the backrest would not provide enough support to the back, thereby causing stiffness and discomfort in the upper back, spine and even neck. Further, the gap in case of seat slope was 1.35±0.02 degrees and for the height of seat in relation to work surface was 5.25±0.06 cm both of which were statistically significant.

A mismatch that is statistically significant was observed in all the dimensions. This mismatched or ill fitted furniture can lead to problems like, fatigue, muscular stress and pain/ discomfort in different body parts and the free movement of students in the classroom can be obstructed. This in turn results in greater fatigue and discomfort and is likely to lead to poor postural habits as well as neck or back complaints. Most importantly, musculoskeletal stress resulting from efforts to maintain stability and comfort of seating may make for a fidgety individual, a condition not conducive to focused learning.

Conclusion :

The results of present study revealed a considerable mismatch between existing furniture dimensions and those based on anthropometric measurements of female students. A mismatch that is statistically significant was observed in all the dimensions. Thus, there is a need for development of ergonomically designed classroom furniture according to the anthropometric

measurements of end users which would be suitable in terms comfort level and physical appearance in order to have better acceptability, especially in case of female students, where not enough research has been made to meet the ergonomic requirements in design even though girls' colleges are increasing in India now.

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