ORIGINAL ARTICLE

MISMATCH BETWEEN FURNITURE DIMENSION AND ANTHROPOMETRIC MEASURES AMONG PRIMARY SCHOOL CHILDREN IN PUTRAJAYA

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ABSTRACT

Ergonomic is important in classroom. Sitting for protracted period in class may lead students to develop musculoskeletal disorders. Their physical health and performance in the class may increase by designing school furniture that match with human body. In Malaysia, there is a lack of ergonomic assessment for school environment especially in urban areas. The aim of this study is to determine the mismatch between the furniture dimension and anthropometric parameters among primary school children in Putrajaya. This is a cross-sectional study which involved 100, Year 1 and Year 6 primary school students randomly selected in Putrajaya. Five anthropometric measurements (popliteal height, buttock popliteal length, elbow height, shoulder height (sitting), hip breadth) as well as five furniture dimensions (seat height, seat depth, seat width, backrest height and seat to desk height) were measured. Instrument used is Martin type anthropometer set, SECA body meter, and SECA weighing scale. Calculation for determining mismatch between the furniture and anthropometric measures were calculated using a standard mismatch formula. There was 100% mismatch for seat height, seat depth, and seat to seat to desk height for Year 1. As for Year 6, mismatch was reported 100% for backrest height and seat to desk height. There were significance difference for parameters of popliteal height between Year 1 and Year 6 and between male and female of Year 1. There was a presence of mismatch between furniture dimension and children anthropometric measurement. Proposed dimension of furniture shows decrease in percentage of mismatch for the most parameter of anthropometric measurement.

Keywords: *Mismatch, anthropometric measures, furniture dimension, primary school children*

INTRODUCTION

The comfort, physical health, and well-being of students during learning lessons in classroom depend partially on the work spaces, furniture and equipment that they use in school which should conform to the anthropometric and biomechanical characteristics of the students[1]. Classroom features including workspace and personal space play an important role in children's growth and performance as their age marks the period of anatomical, physiological and psychological developments[1]. Also, their attention and motivation are all related to classroom ergonomic which is critical to healthy child development.

Children spend their time for about 6 hours daily at school. These children sit and do their school work for about 60% to 80% of the school hours. However, individual adjustments for the seat arm and back are normally not being provided[2]. Inappropriate design of school furniture will likely cause some anatomical-functional changes and problems in the learning process[3]. Without any ergonomic criteria, there is high possible of mismatch between furniture and students' anthropometry[3]. Such mismatches were reported in previous studies of several countries[4,5,6].

As a result, the children may suffer from back pain and other musculoskeletal disorders[7,8]. For example, findings of a previous study showed that low back pain was found to be prominent among taller students which was hypothesised to be attributed by the mismatch between children's anthropometry and the furniture's dimensions[9]. Thus, it is fundamental that school furniture should meet the children requirements, and allow for the changing of postures[10].

Studies on ergonomic assessments are therefore needed to assess the risk of mismatch of school furniture to students. However, unlike in the South American and European countries studies that provide empirical evidence on the extent and the nature of a possible mismatch between school furniture and school children's bodily dimensions are rarely available in Malaysia. Moreover, during the past decade, ergonomic research mainly focused on the design of work furniture, and little interest has been shown in the design of school furniture which is used by children for prolonged periods of time at school[11].

The main objectives of this study are: to determine the differences in anthropometric data between Year 1 and Year 6 school children; to determine the differences in anthropometric data between male and female school children in Year 1 and Year 6 school children; to measure the selected parameter of school furniture used in Putrajaya school; to determine a suitable furniture dimension with anthropometric data according to 5th and 95th percentile of Year 1 and Year 6 school children; and finally to propose a new chair dimension based on children anthropometric data.

METHODS

This is a cross-sectional study that aims to determine the mismatch between school furniture and anthropometric measures among primary school children in Putrajaya. Participants chosen for this study were randomly selected from schools in Putrajaya. Study samples were selected from Year 1 and Year 6 school children in the selected school, Sekolah Kebangsaan Presint 14. The inclusive criteria was Malaysian citizen, Year 1 and Year 6 students with no physical disabilities.

Anthropometric data and furniture dimension were measured to determine the matching of school furniture. The selected anthropometric measures were popliteal height, buttock popliteal length, hip breadth, shoulder height and elbow height. For furniture parameter/dimension, it included seat height, seat depth, seat width, backrest height and seat to desk height. Individual factors such as height, weight, gender and age which can contribute to the matching of school furniture were obtained.

A self-administered questionnaire was distributed to the respondents during school hours. The respondents answered all questions under the supervision and guidance of researcher. The questionnaires consist of three parts: Socio-demographic and background information, selected parameter of chair and desk, and anthropometric data of students. For anthropometric measurements, the respondents' body weight was measured using weighing scale and for height, height scale was used. Body Mass Index (BMI) was then calculated. For each respondent, measurement was taken thrice in order to determine the average measurement. Anthropometric measurements were collected by using Martin type anthropometer and each of the respondents sit on a flat chair surface with an angle of 90°. The anthropometric measurements were based on methods in MS ISO 7250-1:200817[12].

All measurement were made by the same measurer and recorded by an assistant for four different sessions. During the measurement, student was wearing clothing as minimal as possible and without shoes. The type of clothing was coded on the anthropometric data sheet. For support surfaces, sitting surfaces were flat, horizontal and not compressible. Accuracy and repeatability of the measurements were achieved by intra-tester reliability test.

For furniture measurement, the dimensions of the classroom furniture that were measured based on Panagiotopoulou et al.[5] were as follows: seat height (A), seat depth (C), seat width (D), backrest height (B), seat to desk height (E). Match measurements were taken by comparing the anthropometric measures of school children (stature, elbow height, shoulder height, upper arm length, knee height, popliteal height and buttock popliteal length) with furniture dimensions. The findings of the measurement were calculated to determine the match or mismatch of the furniture. The used equations were based on previous published literature[3,4,13]. All data collection was analysed by using statistical packages for social sciences version 17.0 (SPSS version 17.0).

Ethics

The participation to this research is voluntarily based. Those volunteers were given briefings on conduct of the experiment including the research background and the purpose of this research. All volunteers were asked to complete their written permission using agreement form and upon approval of their parents. This study was approved by the UPM's Ethics Committee for Research.

RESULTS

There were 100 students involved in this study. All of them were Malay (50% male and 50% female) 50 % of them were 7 years old and 50 % were 12 years old. Majority of the school children (38%) were above 140cm height and underweight (72%).

Anthropometry Measurements Differences among Age and Gender Groups

Findings indicated that the different of popliteal height (PH) between school children in Year 1 and Year 6 was statistically significant (t-value = -3.09). See Table 1. Table 2 shows that there was a significant difference in anthropometric data between male and female of Year 1 for parameter of PH. The difference in mean value for popliteal height (t-value=10.55) of female was higher than male. For Year 6, there was no significant difference for all of the anthropometry parameters. However, Table 3 shows that the difference in mean value for popliteal height (t-value=1.206) of female was higher than male.

Dimensions of school furniture

From the observation, there were two type of school furniture (chair and desk) used by children. Both furniture (ten units each) including desk were randomly chosen. Five furniture dimensions were selected in this study; seat height, seat depth, seat width, backrest height and seat to desk height. All five parameters were matched with five children anthropometric measurement in order to determine the mismatch. For Year 1, the highest mean value was seat width and the lowest was backrest height and seat to desk height. For Year 6, the highest mean value was backrest height while seat to desk height scores was the lowest. Standard deviation for all

furniture dimensions were in the range of 0.03 to 0.10cm.

Percentile of Anthropometric measurement and Determination of School Furniture Dimension according to Age and Gender

The value that has been chosen was the lowest value for 5th percentile, and the highest for 95th percentile. For the proposed dimensions of the furniture for Year 1 students, 5th percentile has been used on popliteal height and buttock popliteal length. While for hip breadth, 95th percentile on shoulder height and elbow height was used. Referring to Table 4, popliteal height and hip breadth of male was obtained. Meanwhile for the buttock popliteal length, shoulder height and elbow height, mean value for female was taken. For the proposed dimensions of furniture for Year 6 students, all parameter mean values of popliteal height and buttock popliteal length, hip breadth, shoulder height, and elbow height were taken from the male. All of these values were chosen as they satisfies all criteria of the 5th and the 95th percentile.

Proposed Furniture Dimension of 5th and 95th percentile

Table 5 shows the proposed dimension for Year 1, while Table 6 shows the proposed dimension for Year 6. Based on proposed furniture dimension for Year 1, the highest increase percentage of matching for children anthropometric data is seat depth (84%) followed by seat to desk height (80%) as compared to the current. Meanwhile, seat height scored the lowest (10%) but still show increased in matching. For Year 6, backrest height showed the highest percentage (100%) of matching followed by seat to desk height (94%).

Table 1 - Differences in Anthropometric Data between Years 1 and Years 6 (n=100)

Variables	Year 1(n=50)		Year 6(n=50)		t-value	p-value
	Range (cm)	Mean± SD(cm)	Range (cm)	Mean± SD(cm)		
PH	26.5-36.5	30.8±2.5	32.2-42.0	37.7±2.0	-3.093	0.003*
BPL	27.0-36.3	30.0±2.0	35.2-49.2	39.3±2.8	0.344	0.731
HB	18.0-28.0	21.5±2.1	21.3-35.0	27.2±2.6	0.511	0.590
SH	34.0-47.4	37.9±2.6	42.0-54.5	47.3±2.74	0.112	0.911
EH	12.5-19.3	15.2±1.5	14.3-21.0	18.1±1.6	1.088	0.279

*N=100, *significant at p<0.05.*
PH: Popliteal height, BPL: Buttock Popliteal Length, HB: Hip Breadth, SH: Shoulder Height, EH: Elbow Height.

Table 2 - Differences in anthropometric data between genders in Year 1

Variables	Male(n=25)		Female(n=25)		t-value	p-value
	Range (cm)	Mean± SD(cm)	Range (cm)	Mean± SD(cm)		
PH	26.5-33.0	28.7±1.3	29.0-36.5	32.9±1.5	-10.55	<0.001*
BPL	28.0-35.5	30.4±2.1	27.0-36.3	29.6±1.8	1.509	0.138
HB	19.0-28.0	21.8±2.2	18.0-28.0	21.1±2.0	1.136	0.262
SH	34.5-42.0	37.6±2.3	34.0-47.4	38.1±3.0	-0.709	0.482
EH	12.8-18.4	15.6±1.3	12.5-19.3	14.8±1.7	1.891	0.065

*N=50, *significant at p<0.05*

Table 3 - Differences in anthropometric data between genders in Year 6

Variables	Male(n=25)		Female(n=25)		t-value	p-value
	Range (cm)	Mean± SD(cm)	Range (cm)	Mean± SD(cm)		
PH	32.2-42.0	37.3±2.4	34.5-40.0	38.0±1.5	-1.206	0.234
BPL	35.2-44.0	39.1±2.6	35.3-49.2	39.3±3.1	-0.139	0.890
HB	21.3-35.0	27.3±3.4	21.5-29.5	27.1±1.6	0.177	0.861
SH	42.0-54.5	47.6±3.3	42.7-50.0	46.9±2.1	0.994	0.325
EH	15.0-21.0	18.2±1.8	14.3-21.0	18.0±1.3	0.301	0.764

*N=50, *significant at p<0.05*

Table 4 - Percentile of Anthropometric Data According to Age and Gender

Variable (cm)	Year 1(n=50)						Year 6(n=50)					
	Male(n=25)			Female(n=25)			Male(n=25)			Female(n=25)		
	5th	50th	95th	5th	50th	95th	5th	50th	95th	5th	50th	95th
PH	26.51	29.0	32.1	29.6	33.0	36.1	32.52	37.5	41.7	34.7	38.2	40.0
BPL	28.0	30.0	35.0	27.21	29.0	35.0	35.22	40.5	43.4	36.0	38.6	47.6
HB	19.3	21.5	27.71	18.2	21.2	27.0	21.8	26.7	34.22	22.6	27.2	29.3
SH	34.7	37.0	41.6	34.3	38.0	45.91	42.1	48.0	54.52	42.8	47.0	49.9
EH	13.0	15.5	18.3	12.5	14.5	19.01	15.1	18.0	21.02	14.9	18.0	20.6

N=100

1= value used for school dimension in Year 1
2= value used for school dimension in Year 6

Table 5 - Proposed dimension according to percentile for Year 1

Furniture Dimension	Percentile		Furniture Dimension		Matching (%)	
	Current	Proposed	Current	Proposed	Current	Proposed
Seat height	100	5	39.8	26.5	0	10
Seat depth	100	5	40.0	27.2	0	84
Seat width	100	95	40.1	27.7	100	96
Backrest height	100	95	26.0	45.9	100	100
Seat to desk height	100	95	26.0	19.0	0	80

Table 6 - Proposed dimension according to percentile for Year 6

Furniture Dimension	Percentile		Furniture Dimension		Matching (%)	
	Current	Proposed	Current	Proposed	Current	Proposed
Seat height	100	5	39.0	32.5	84	96
Seat depth	100	5	37.0	35.2	54	74
Seat width	100	95	35.0	34.2	98	98
Backrest height	100	95	41.0	54.5	0	100
Seat to desk height	100	95	29.0	21.0	0	94

DISCUSSION

Differences of anthropometric parameters among age and gender group

The present study found significant difference in anthropometric measurements between Year 1 and Year 6 for the parameter of popliteal height. This finding was supported by previous research which was conducted in Johor[2]. Most of the standard deviation for the anthropometric parameter increased with age. This study also demonstrated that there was a significant difference in anthropometric data between male and female for a parameter of popliteal height of Year 1 where female have higher shoulder height than male.

Mismatch of school furniture dimension

In summary, results showed that the current school furniture dimension and anthropometric data of the school children was not matched. For Year 1, 100% of mismatch reported for seat height, seat depth, and seat to desk height. While for Year 6, mismatches were reported for backrest height and seat to desk height. It shows that the design of the furniture specifications does not follow most of the children anthropometry. A study which was performed at Gaza strip found that mismatches in seat height, seat depth and desk height occurred for 99% of the students, while the mismatch for the back rest height was only 35%[14].

Match of proposed furniture

From this study, two proposed dimension of furniture were suggested for both Year 1 and Year 6 according to 5th and 95th percentile. For Year 1, both seat depth and seat to desk height increase 84% and 80% match with the student's anthropometry. As for Year 6, the 100% matching for student's anthropometry with the backrest height dimension with the newly proposed dimension. In addition, other parameters also showed an increase in percentage of matching

with the newly proposed dimension. These findings indicated that the proposed dimension is better than the current dimension. These results were supported by previous findings which indicates that the newly proposed dimension furniture for both ages result in the increase of percentage of matching for all parameters in which seat depth shows the highest increase of 88.9% of matching for Year 2 and 95.6% for backrest height of Year 5[2].

CONCLUSION

The findings of the present study indicated that differences between the age groups are statistically significant in selected anthropometric data between Year 1 and Year 6 for parameter of popliteal height. Since the proposed dimensions shows the highest increase in the percentage of match, it is necessary for the school furniture to be redesigned according to age groups by which different dimension for different age groups. Consideration given to these baseline anthropometric data for redesigning school furniture will enhance not only students' health but also strengthen and develop learning process and activities.

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COMPETING INTERESTS

There is no conflict of interest.

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