Applied Mechanics and Materials Vols. 465-466 (2014) pp 1191-1195

doi:10.4028/www.scientific.net/AMM.465-466.1191

Development of Malaysian Primary School Children Anthropometrics Data for Designing School Furniture Parameters

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Keywords: Anthropometric Dimensions, Classroom Furniture Design, Primary School Children, Rapid Upper Limb Assessment (RULA) and Musculoskeletal Disorder (MSD).

Abstract. This paper explains the measurement of anthropometricdimensions ofprimary school children and investigation ofrisk factors associated with musculoskeletal disorders (MSDs) among primary school children. A total of 266 students within three different schools were participated in anthropometric data measurements and questionnaire survey of the MSDs prevelance complain among them. Ten anthropometric measurements (Stature, Sitting height, Sitting shoulder height, Popliteal height, Hip breadth, Elbow seat height, Buttock-popliteal length, Buttock-knee length, Thigh clearance and Weight) were used. Martin type anthropometer set, height scale and weighing scale were used as a direct measurement method for the data collection on this study. Musculoskeletal symptoms were recorded using Modified Nordic Body Map Questionnaires. In addition Rapid Upper Limb Assessment (RULA) was used to assess the awkward posture of the school children for both designs. The results of the proposed furniture shows a better RULA final score for each group of muscles which give a score ranging from only 1 to 2 (Acceptable Posture) compared to the existing furniture that need further investigation. This anthropometrics data is very useful to the furniture manufacturer in designing school furniture in order to reduce the mismatch between furniture designed and Malaysian primary school children.

Introduction

Anthropometric dimensions are an important factor that should be taken into account in school furniture design. School furniture design is among several factors that may contribute to musculoskeletal pain (MP) among school children [1]. There are many factors that can influence student's posture, which includes the anthropometric dimensions of school children, and design features of school furniture. Some of these dimensions are not easy to measure and they need a large sample size and a lot of dimensions. A previous study showed that the postural behavior of school children may affect MSDs prevalence [2]. The researcher also found that the majority of school children had poor sitting posture while writing and reading. Besides, unsuitable school furniture influenced the occurrence of MSDs [1,3]. Therefore, developing the anthropometrics data for Malaysian primary school children is very crucial to reduce the mismatch between furniture design and human body dimension that will contribute to the MSDs prevalence.

Literature Review

Anthropometric data are used to ensure that products are produced to fit and suit as many people as possible. Children's anthropometric measures vary widely across different age groups, within the same age groups, between genders and between different cultures [4].

A number of studies have demonstrated that there was a mismatch between the design of school furniture and the anthropometric dimensions of school children [5]. Many factors can influence student's sitting posture, these include the anthropometric dimensions of schoolchildren, the measurement and design features of the school furniture [6]. Major mismatches in "fit" are common

among school children and their classroom furniture dimensions [7]. Such mismatches result in poor seated work postures and an increase in musculoskeletal discomfort among children. Musculoskeletal disorder has been cited to be associated with school furniture (chair/desk) [8]. Studies in Malaysia [9] show that, there are significant differences ($p<0.001$) for percentage of mismatch between the child's anthropometric measurements and their school furniture. Hundred percent high mismatch was reported for seat height, seat depth and desk height.

Methodology

A total of 266 students consist of male (167) and female (99) primary school students were involved in the survey and measurement. Their ages range from 7-12 years old. The students were randomly selected covering each level of primary school education and mix races Malay (184, 69%), Chinese (65, 25%) and Indian (17, 6%).Two sets of questionnaires were used in this study. The first set was used to determine the children's background such as school name, gender, ethnic, and standard. The second set was used to obtain information on the Musculoskeletal Disorder (MSD). The Standard Nordic Musculoskeletal Questionnaire (SNMQ) was taken from the study of Kuorinka, I. et al. [10] and this self-administered questionnaire set was translated into Malay language for better understanding. Ten anthropometric dimensions (Fig. 1) ware measured in this study such as stature, sitting height, sitting shoulder height, popliteal height, hip breadth, elbow seat height, buttock-popliteal length, buttock-knee length, thigh clearance and weight using a "TTM" Martin's Body Measuring Kit.

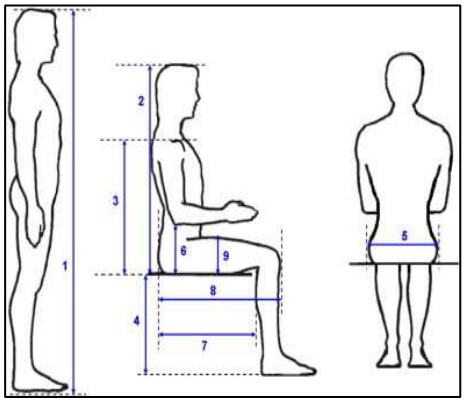


Fig. 1: Representations of Anthropometric Measurements for Primary School Furniture Design [11].

The dimensions were measured manually using a portable anthropometry. For a precise measurement to be obtained, a customized anthropometric chair was used. This would ensure that the student's posture can be adjusted based on their individual popliteal height.

Results and Discussion

The results from the lifetime prevalence of MSDs survey (Fig. 2) shows that the highest complaint was foot pain (114 students, 48%) followed by wrist pain (97 students, 41%) and upper arm pain (94 students, 39%). Higher prevalence of MSD reported pain occurs more frequent among male than the female students. This could be due to gender differences as the physical and physiological characteristics of males and females are different. Therefore factors such as gender, age and awkward posture have been associated with higher MSD prevalence rates.

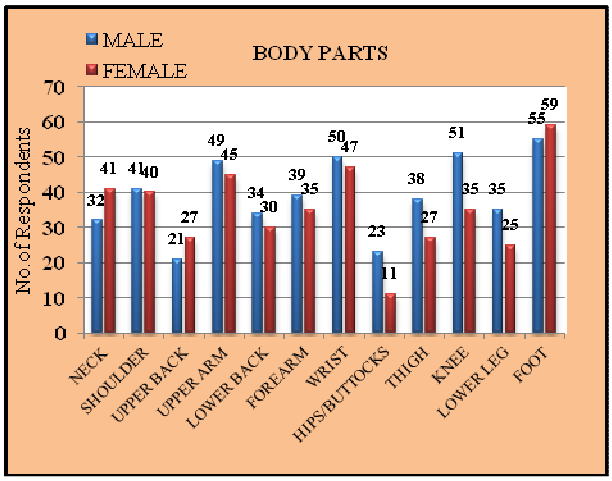


Fig. 2: MSD prevalence among school children.

Antropometrics Data Measurement

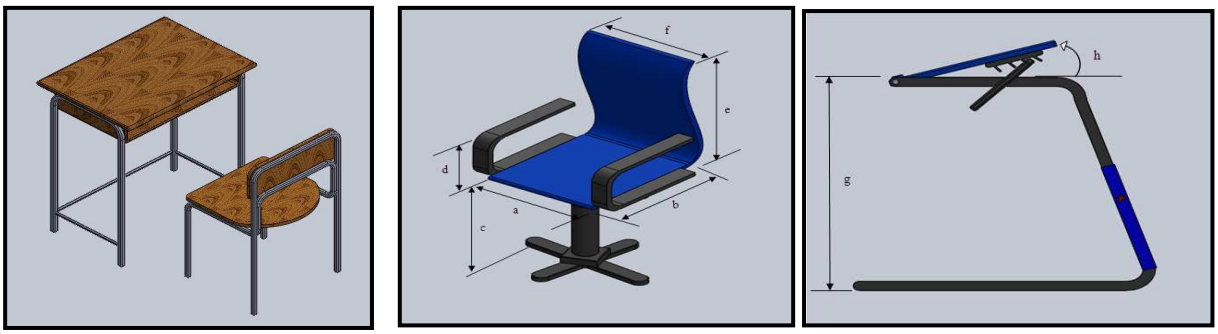
The results from the measurements of anthropometry are listed in Table 1. These data were measured and analyzed by using Statistical Package of Social Science (SPSS Version 16) for data analysis of the reliability studies. The result shows, anthropometric dimensions of this study have very good reliability since the alpha obtained was 0.913. In general, most of the female's anthropometrics data shows the higher value compared to the male's anthropometrics data except for hip breadth and weight.

Table 1: The anthropometrics data for Malaysian Primary School Children

Classifications	SAMPLE (n=167)				SAMPLE (n=99)			
	Male				Female			
	5th percentile	50th percentile	95th percentile	Standard Deviation	5th percentile	50th percentile	95th percen-tile	Standard Deviation
1. Stature (cm)	112.44	126.2	145.52	11.29	110.2	129.1	151.3	13.63
2. Sitting Height (cm)	57.94	65.2	73.9	4.94	57.3	66.3	79.4	6.84
3. Sitting - Shoulder Height (cm)	34.5	40.6	49.2	4.13	35.2	42.1	50.5	5.04
4. Popliteal Height (cm)	30.2	31.3	40.56	3.15	30.3	31.9	40.8	3.62
5. Hip Breadth (cm)	20.34	24.3	34.6	4.49	19.6	23.5	32.5	4.1
6. Elbow-Seat Height (cm)	10.18	14.4	18.46	2.55	12.6	17.5	22.4	2.56
7. Buttock-Popliteal Length (cm)	26.68	32.5	39.26	3.71	26.3	33.4	42.5	4.85
8. Buttock-Knee Length (cm)	34.24	39.5	49	4.36	34.1	42.3	52.4	5.69
9. Thigh Clearance (cm)	7.74	9.7	13.6	1.73	6.8	9.6	14.3	2.23
Weight (kg)	18.84	25.5	51.36	10.17	17.9	25.9	50.7	10.87

Desk and Chair Dimension for Current and Proposed Design

From observation, it was found that there are mismatch between current chair and desk dimension with student body dimensions. Fig. 3(a) shows the current design for chair and desk. There are no arm rest, headrest, proper backrest and adjustability features provided. These features very important and should be considered to reducefatigue among school children. The chair and desk design which consider the important features based on the school children anthropometrics data was proposed as shown in Fig. 3(b) and Fig. 3(c) respectively. The comparison of furniture dimension had been made for the current and proposed design to determine the correct dimension ranges to match with Malaysian primary school children body dimensions (Table 2).



(a) Current design (b) Proposed chair design (c) Proposed desk design

Fig. 3: The chair and desk for current design and proposed design

Table 2: The comparison of furniture measurement for primary school children

Item	Chair and Desk features	Current Measurement (cm)	Proposed Measurement (cm)	Guidance
a	Seat width	38.0	34.6	95th tile of hip breadth
b	Seat depth	37.0	26.3	5thtile of buttock-popliteal length
c	Seat height	41.0	30.2 – 40.8	5th tile of popliteal height
d	Armrest height	Not provided	10.2 – 12.6	5th tile of elbow – seat height
e	Backrest height	36.0	50.5	95th tile of sitting - shoulder height
f	Lumbar support angle	Not provided	10˚ (Pheasant, 2006)	Range of 5th - 95th percentile lumbar support angle
g	Desk clearance from floor	55.0	37.5 – 54.4	Range of 5th –95th percentile popliteal height + thigh clearance
h	Desk height from floor	68.0	40.4 – 63.2	5th tile of elbow seat height + popliteal height

The collected anthropometric data was used to the proposed design. With some improvement of the chair and desk height adjustable range, backrest height with lumbar support and armrest all could be able to increase school children's comfort and reduce the musculoskeletal pain. From the simulation, the chair and desk should be adjusted height to accommodate the 95th percentile school children's popliteal height. To satisfy an ergonomic principle such as adjust the chair height, lumbar support and the armrest as in the comfort area, the proposed chair and desk design based on anthropometric dimensions showed a better fit for 5th percentile and 95th percentile school children.

RULA was used to evaluate the awkward posture of children in sitting position. Using both existing furniture and the proposed furniture which was integrated with both manikins developed. The results of the proposed furniture shows a better RULA score for each group of muscle which

give a score ranging from only 1 to 2 (Acceptable Posture) compared to the existing furniture. A final score that ranges from 1 and 2 indicates that the posture is acceptable if it is not maintained or repeated for long periods of time. Both writing and reading concluded that there was reduction of risk from unacceptable category to an acceptable limit [12]. On the other hand, the existing furniture has a poor RULA score for each group which give a score is 4 compared to the proposed furniture. The score indicates that further investigation is needed and changes may be required.

Conclusion

In conclusion, the anthropometrics data of the primary school children has been developed. The proposed chair and desk design parameters have been determined to provide greater comfort for the school children and reduce the potential prevalence of musculoskeletal disorders. The results showed by RULA, that the features of classroom furniture may contribute to the onset of pain in schoolchildren. The RULA analysis on the proposed design also showed a lower rating, indicating an improvement needed in the design. This anthropometrics data is very useful to the furniture manufacturers in designing school furniture in order to reduce the mismatch between furniture designed and Malaysian primary school children. Perhaps it will also help to increase the satisfaction among Malaysian school children.

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