ORIGINAL ARTICLE

SITTING ANTHROPOMETRICS GROUPINGS OF SCHOOL CHILDREN FROM GRADES 1 TO 5

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ABSTRACT

This study on anthropometrics of Primary School children from grade 1 to 5 in Peninsular Malaysia involves 2310 students aged seven to eleven years old. The objectives were to analyze the differentiation of anthropometrics between children of grades 1 to 5 and grouping them to suitable levels in which they are appropriate to propose chair dimensions. A multi-stage sampling method was used, and rural and urban areas were also included in providing anthropometric database that represents the whole Peninsular Malaysia population. There were six dimensions measured in this study, which are sitting shoulder, sitting subscapular height, sitting elbow height, hip width, buttock-popliteal length and popliteal height. All the measurements were chosen to represent dimensions needed to construct ergonomic school chair. From the results, ANOVA showed p-values of <0.01 for all body dimensions when compared to grades 1 to 5. Column charts were also illustrated, where grade 1 and 2 had similar anthropometrics. Therefore, it can be concluded that Level 1 chairs should made to accommodate grades 1 and 2, and Level 2 chairs should cater children of grades 3, 4 and 5.

***Keywords**: Ergonomics, anthropometrics, children, chair*

INTRODUCTION

Studies on children anthropometrics have been made in several countries[1, 2, 3]. In Malaysia, researchers commonly group students to two groups when determining furniture sizes for school children since Malaysia's National Primary school are differentiate by level 1 (grades 1-3) and level 2 (grades 4-6). Research on school children anthropometrics for children aged 8, representing level 1 and age 11 for level 2[4] has been made. Other than that, other study that distinguished children based on level 1 and 2 was also applied[5]. However, proof on the validity of those grades to be grouped into certain levels has not been proven. Dismissing this issue will cause mismatches, hence leading to musculoskeletal disorders when children whom are not as the same size as other grades are grouped. Musculoskeletal disorders in primary school children has been reported where 33% endured neck pain in their lifetime, followed by upper back pain of 20.2% and low back pain of 13.1% all of which were associated to school furniture alongside with schoolbag load[6]. Furthermore, mismatches of school furniture were also reported to have 100% high mismatches of the seat height for 8 year old children and 79% for 11 year olds[7]. Other than that, mismatch studies on provinces of rural and urban areas needs to be apprehended, as studies on children's nutritional status showed there are differences on these two areas where a study stated that rural areas have more underweight of 2.2% children, and as for urban areas, 17.6% children were reported to be overweight[8] Due to this, anthropometrics of school children from both provinces are vital to be included in order to represent all Primary school children across Peninsular Malaysia.

For this study, the objectives were to differentiate body measurements of school children between grades 1 to 5 in order to allocate children to their proper levels and obtain proper measurements of children for school chairs. The dimensions used in this study consist of six anthropometrics dimensions which are used to determine chair sizes for backrest, seat and legs.

METHODS

A quantitative approach study comprising of National Primary school children were involved in the anthropometric data collection. The sampling method used was multi-stage sampling where a combination of sampling methods applied. The first step was to cluster the states in Malaysia to four regions as in Figure 1.

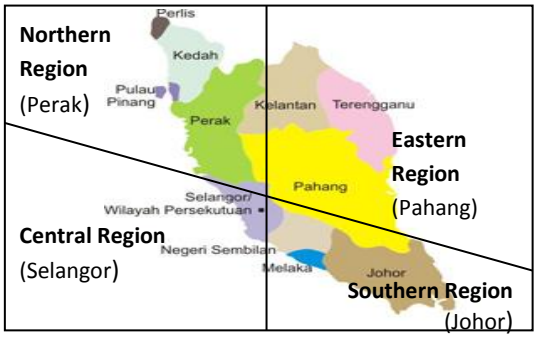


Figure 1: Peninsular Malaysia Map divided into Regions

States that were chosen representing each region has the highest number of schools as in the

Ministry of Education list; these were Perak, Selangor, Pahang and Johor. Secondly, schools were than chosen by the largest number of students among all the districts. In Pahang, Perak and Selangor, each had 600 samples representing, however, Johor had 510 samples. This comes up with a total of 2310 children measured, where 1161 were female and 1149 were male.

In order to produce chairs that can accommodate the overall population, children from schools of different provinces of rural and urban areas were also included to be the samples. By doing so, school furniture with the new dimensions can be supplied to both rural and urban areas. Anthropometrics data of grade 1 to grade 5 were collected which include students of both gender. The students were randomly selected and without disabilities.

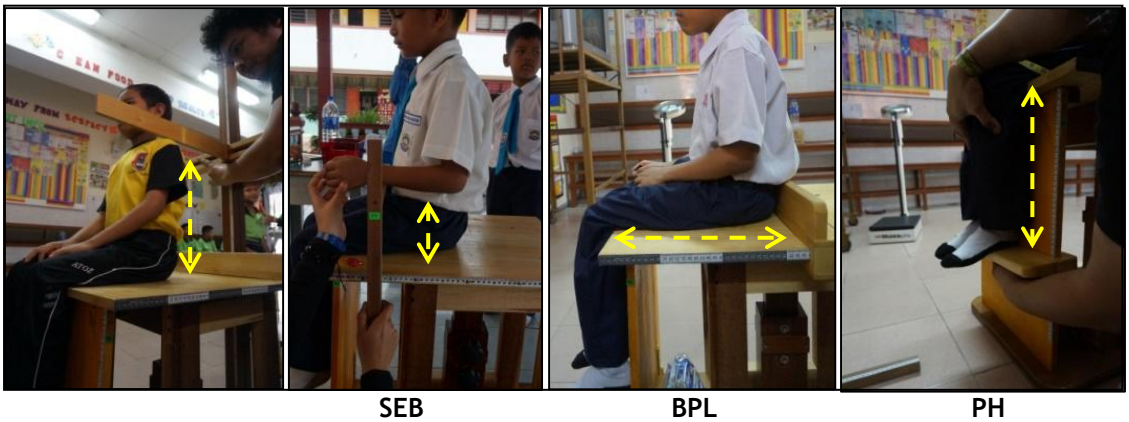
In collecting the anthropometrics data, a custom made measurer which could measure children in a sitting position was made. In designing a custom made measurer for sitting position, it is important to make sure the size of the measurer could measure all types of body sizes, especially the seat[9]. The custom made measurer as shown in figure 2, allows efficiency in collecting anthropometric data as less time was used due to the simultaneous measurements that can be taken with the measurer. Six dimensions which are hip width, sitting shoulder sitting subscapular height, buttock-popliteal length, sitting elbow height and popliteal height were collected and analyzed. Figure3 simulates some of the dimensions measured in the study.

In analyzing the data, Statistical Package for the Social Science (SPSS) was used to analyze the significant differences among grades of 1 to 5 by performing ANOVA. Furthermore, correlation coefficient was also made, followed by column charts to allocate appropriate levels for each grade.

Figure 2- Custom made measurer

RESULTS

As one of the objectives of the study was to group the children into suitable groups in order to propose dimensions for ergonomic chair construction, column charts were made since graphics are very helpful in eliciting the changes in body dimension[10]. To determine the appropriate levels in which the grades should be grouped, the most distinct mean values were observed. According to figure 4, where charts of the upper body is shown, an inclination of anthropometrics as the age inclines can be seen. All of the upper body dimensions for grade 3 were seen to be bigger than the total average value. Furthermore, the mean for grade 3 was closer to grade 4 than to grade 2. From this, it can be concur that for the upper body parts, grades 1 and 2 should be in a group, and grades 3, 4 and 5 in another group.



SS **SEB** **BPL** **PH**

Figure3 -Anthropometric Data Collection of Sitting Shoulder (SS), Sitting Elbow Height (SEB), Buttock-popliteal Length (BPL) and Popliteal Height (PH)

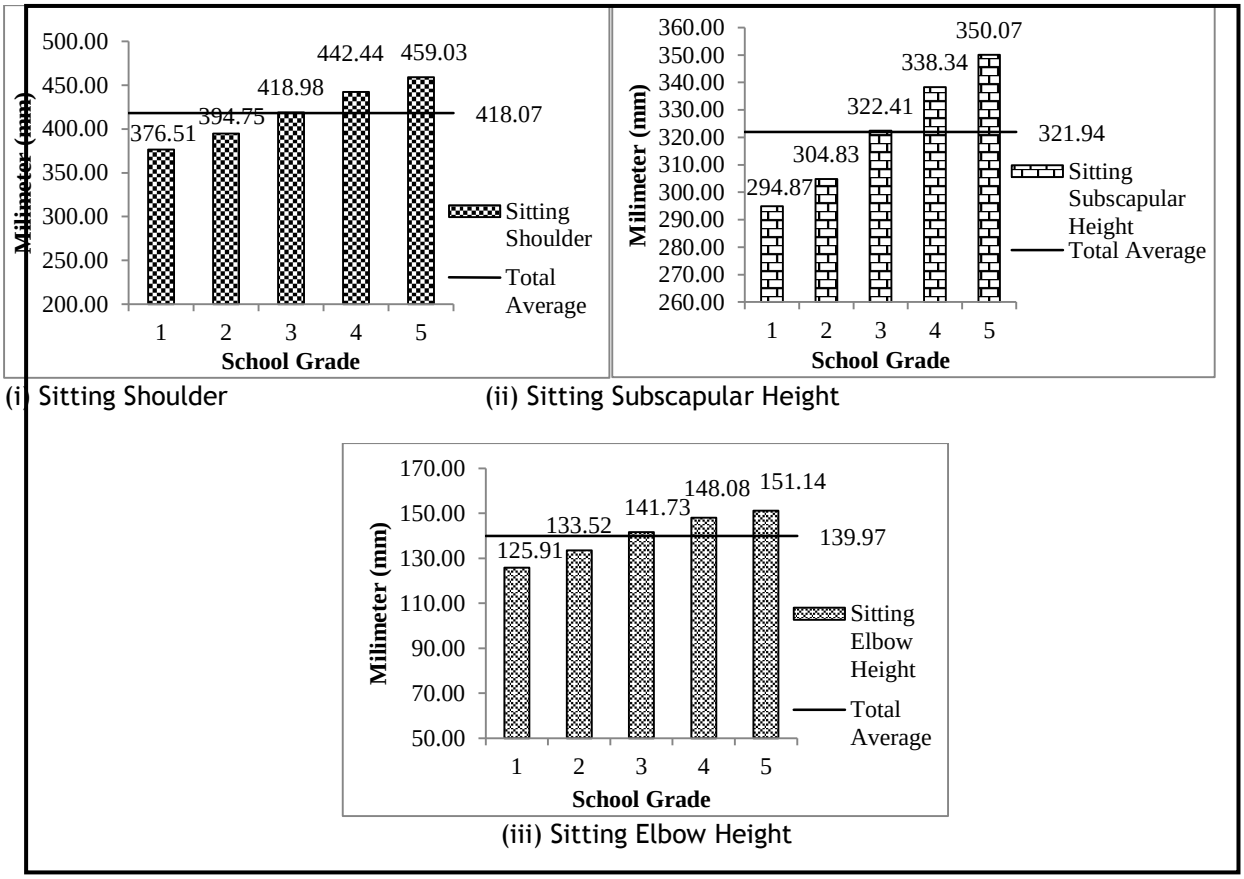


Figure 4 -Anthropometric Data of Upper Body Parts; (i) Sitting Shoulder, (ii) Sitting Subscapular Height and (iii) Sitting Elbow Height

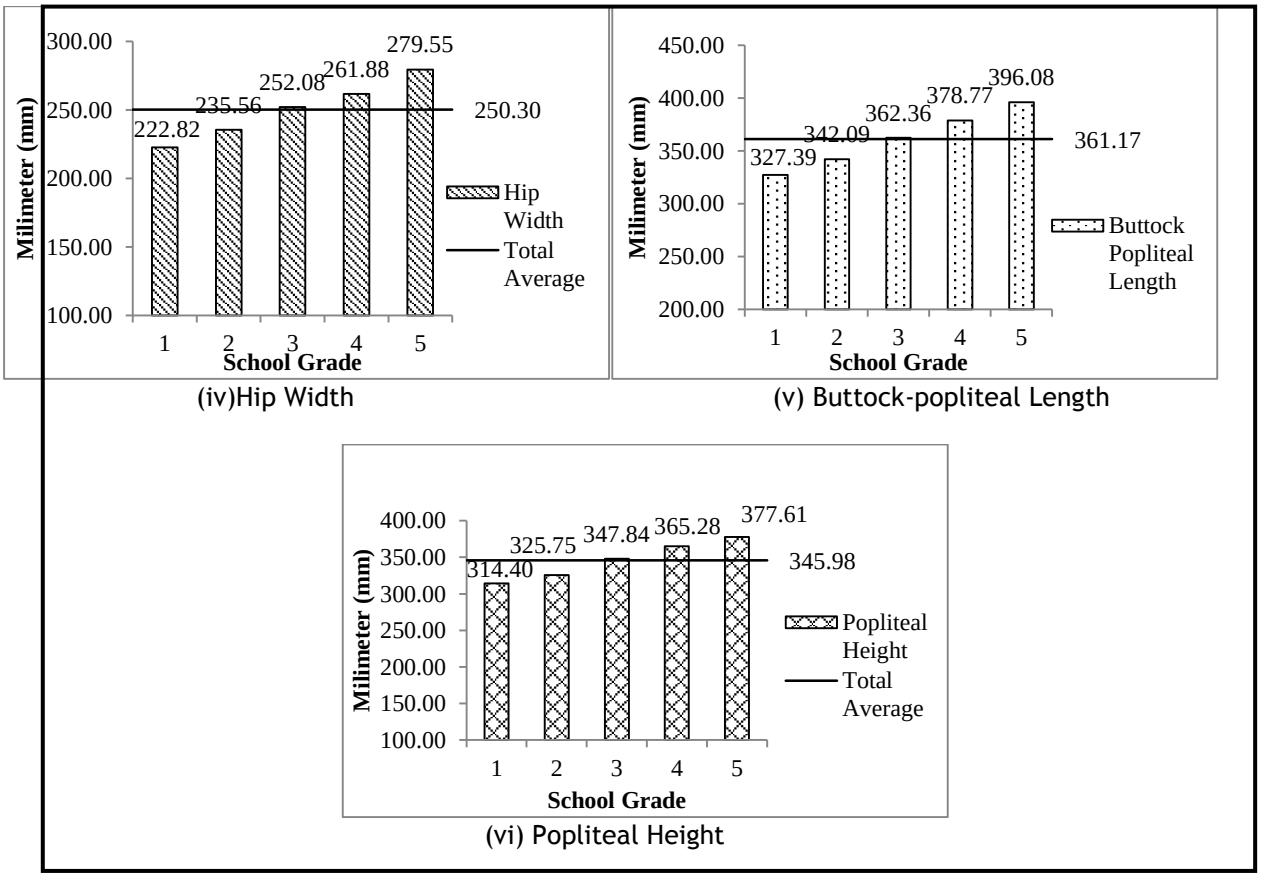


Figure 5 -Anthropometric Data of Lower Body Parts; (iv) Hip Width, (v) Buttock-popliteal Length and (iv) Popliteal Height

Figure 5 shows mean values of lower body parts of grade 1 to 5. Body parts included in the figure are hip width, buttock-popliteal length and popliteal height. According to the figure, all of the lower body parts of school children showed an increment of grade 1 to grade 5. Results showed all of lower body parts for Grade 3 surpass the total average line. Based on the figures, mean of grade 1 and 2 are below the total average line and as for grade 3, 4 and 5, showed mean of above the average line. The results also conform to other study, where grade 1 and 2 of the popliteal length had similar dimension[11].

From the results of anthropometric data analysis, it can be seen grade 1 and 2 consistently had mean values below total average, and as for grade 3, 4 and 5 had consistently shown mean results above total average. As an overall for the anthropometric data analysis, the findings conform the grouping between grades where it is appropriate to group grades 1, 2 as one level, whereas grades 3, 4 and 5 as second level. Therefore, to develop a sitting anthropometric database, levels of 1 and 2 was proceeded with the stipulated grades.

In determiningthe differentiations of anthropometrics of grade 1 to 5, analysis of variance (ANOVA) was made. According to table 1, ANOVA results showed all of the body dimensions had highly significant differences between grades with p-value of <0.01 for all the body dimensions measured. This shows that children of grades 1 to 5 had different anthropometrics among each other.

Correlation coefficient was also analyzed to determine whether there is a relationship between grades and body dimensions. In order to determine whether there is a correlation, the results should show values between -1 to 1, and p-value of <0.05 to determine the significances. Based on table 2, results showed a significantly positive relationship between grades and body dimensions. The result was undeniably true considering as grade increases, so as the growth of their body. This was also proven by other study[12]. This shows that children's anthropometrics are growing every year, hence proving the needs of proposing furniture that has increasing dimensions as grades increase.

Table 1- Summary of ANOVA for Anthropometrics of Grades 1 to 5

Dimension	Mean (mm)	Standard Deviation	F	p-value
Hip Width	250.30	47.03	128.07	p<0.01*
Sitting Shoulder	418.07	46.66	423.29	p<0.01*
Sitting Subscapular Height	321.94	33.95	333.71	p<0.01*
Buttock-popliteal Length	361.17	38.48	412.94	p<0.01*
Sitting Elbow Height	139.97	23.74	106.33	p<0.01*
Popliteal Height	345.98	35.48	466.86	p<0.01*

** The mean difference is significant at p<0.05*
N=2310

Table 2- Pearson Correlation Coefficient of Grades 1 to 5 with Body Dimension

Dimension	Hip Width	Sitting Shoulder	Sitting Subscapular Height	Buttock Popliteal Length	Sitting Elbow Height	Popliteal Height	Thigh Thickness
Pearsons Correlation	0.425	0.650	0.604	0.646	0.390	0.666	0.415
Sig (2-tailed)	.000	.000	.000	.000	.000	.000	.000

N=2310

Following the results obtained, two different measurements were proposed for the two levels; table 3 and 4 shows data on sitting anthropometrics of primary school children of Level 1 (Grade 1 and 2) and Level 2 (Grade 3, 4 and 5) students. The dimensions stated in the table are used to propose dimensions to construct ergonomic chair for schools. However, when designing a chair, it is important to consider other measurements such as shoe thickness, where 2cm shoe thickness should be considered[13] and added in the measurements.

Table 3 - Anthropometrics Dimensions for Level 1 (Grade 1 and 2) children

Chair Parts	Body Dimensions	Mean (mm)	SD	Percentiles (mm)	
				5th	95th
Backrest	Sitting Shoulder	385.32	35.78	334.00	442.00
	Sitting Subscapular Height	299.68	24.32	264.00	340.00
Arm Rest	Sitting Elbow Height	129.59	21.18	98.00	164.00
Seat	Hip Width	228.97	35.28	181.00	297.55
	Buttock Popliteal Length	334.49	29.28	291.00	383.00
Legs	Popliteal Height	319.88	26.07	280.00	363.55

Table 4 - Anthropometrics Dimensions for Level 2 (Grade 3, 4 and 5) children

Chair Parts	Body Dimensions	Mean (mm)	SD	Percentiles (mm)	
				5th	95th
Backrest	Sitting Shoulder	440.06	39.70	376.00	510.00
	Sitting Subscapular Height	336.88	31.21	288.00	392.85
Arm Rest	Sitting Elbow Height	146.94	22.80	113.00	188.00
Seat	Hip Width	264.62	48.50	202.00	354.85
	Buttock Popliteal Length	379.08	33.18	328.00	435.00
Legs	Popliteal Height	363.50	29.73	312.00	411.85

CONCLUSION

In developing ergonomic school furniture, it is important to account anthropometrics of the intended user. Other information such as differences among gender and provinces were also had to be looked at in order to have accurate measurements for chair construction that can accommodate the overall population of the designated users.As from the result, an adjustable chair seems the only way to be helpful in catering the variety sizes of children; however, cognitively where students tend to play with adjustable chairs also had to be considered, plus, the considerations of producing economically friendly furniture is also important. Due to this, fixed dimension chairs that are made for different levels of children as in this study is appropriate to apply when constructing ergonomic chair.

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COMPETING INTERESTS

There is no conflict of interest.

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