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EVALUATION OF CHILDREN'S ANTHROPOMETRIC MEASURES IN RURAL AND URBAN AREAS FOR ERGONOMIC APPLICATION

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ABSTRACT

The prominent issue of the mismatches of children's body dimensions with school furniture has made people realize the essential factors of providing ergonomic furniture. By evaluating rural and urban areas, school furniture can be designed for both areas based on their anthropometrics, thereby combating mismatches. This quantitative study focused on four regions in Malaysia. A total sample of 2,400 primary school children from seven to eleven years old from both rural and urban schools was evaluated. Six anthropometric aspects were measured: stature, subscapular height, shoulder breadth, hip width, buttock popliteal length, and popliteal height. The measurements were evaluated using SPSS, with which T-tests were performed, to evaluate the anthropometric differences between each province. Each region showed different results when its rural and urban areas were compared. This reveals that anthropometrics are different in certain areas, even when they are in the same country. The importance of knowing such matters will help to ease the sizing of products (such as furniture) based on location, hence, making ergonomic products possible.

Keywords: Anthropometrics; Children; Ergonomic; Urban; Rural

1. INTRODUCTION

Anthropometrics is an essential factor that needs to be fulfilled in order to claim that a product is ergonomic. It is important to collect anthropometric data, which differ among ethnicity (Lin et al., 2004), age groups, and cultures (Panagiotopoulou et al., 2004), as well as gender and population (Chandel & Malik, 2011). Ergonomics, which is a discipline of the understanding of interactions between humans and other elements to optimize performance (Dul & Weerdmeester, 2008), must be applied to all ages. Even though ergonomics concentrated on adults first, where it was applied to war equipment and industrial manufacturing (Helander, 1997), numerous studies concerning children have been done more recently. Furthermore, the increase of musculoskeletal disorders in children has made people realize the importance of providing ergonomic features in children's environments, especially in schools, where they spend most of their time (Ismail et al., 2009). In Malaysia, studies have unraveled mismatches between children and school furniture, where a majority of the research showed a high volume of mismatch (Isa et al, 2013). However, very few studies on the comparison of school children in rural and urban areas have been done**.** The term "rural" varies from place to place. It often refers to areas in a country that are less densely populated. There are different types of rural areas,

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defined by how accessible they are from urban areas, which can range from the rural urban fringe to extreme rural or remote areas. “Rural” also means many things to many people, such as agricultural landscapes, isolation, small towns, and low population density (Hart et al., 2005). Meanwhile, urban areas can be defined differently in different countries. In Malaysia, urban areas are adjoining built-up areas that have a combined population of 10,000 people or more at the time of a census (Urbanization and Urban Growth Issues for the Next Malaysia Census 2010, 2009). In some countries, an urban area is characterized as a much denser population than that of a rural area and is more developed and technological. The nutritional status of the children in rural and urban areas in Malaysia has changed throughout the years. This makes anthropometric information for both rural and urban areas an important aspect to consider when applying ergonomics to furniture design. Differences in the anthropometrics between the two types of provinces can be seen in numerous studies, one of which was done by Bong and Jaafar (1996), where 1,275 primary one and primary six children in urban schools in Selangor were assessed, and 9.8% were found to be overweight. Meanwhile, lower height was found in 29.2% of the children studied in a rural district in Perak and 0.87% were overweight (Marjan et al., 1998). From this, it can be seen that there are differences in body composition between the two areas, hence a possibility of different anthropometrics. Studies have uncovered mismatches in school furniture with students’ anthropometric measurements. In Malaysia, most of the studies have revealed a high mismatch between anthropometrics and the school furniture. Studies, such as those by Afzan et al. (2012) and Yusoff et al. (2016), have reported a 100% mismatch of seat height and seat depth.

Before the current study, direct observation was done in schools to see the mismatches between the children and the furniture. As shown in Figure 1, children were seen to be sitting on the edge of the seat during a writing activity. This was due to the mismatch of the chair with the children’s size, which was also reported by Isa et al. (2013), where 80% of the children were found to be mismatched in the distance between the seat to the buttocks-popliteal length. Another study also reported a high mismatch (100%) of 8-year-old children with the seat height (Afzan et al., 2012). Figures 2 and 3 show that mismatches also occur to larger children, where thighs could not fit underneath the table, and slouching occurs if the height of the furniture is not suitable.

Figure 1 Children sitting on the edge of the chair

Figure 2 Thigh does not fit underneath desk

Figure 3 Slouching occurs when the body and furniture are mismatched

2. METHODOLOGY

2.1. Sampling

Multistage sampling was used as the sampling method in this study. The first stage was to divide Peninsular Malaysia into four different regions. Afterwards, only one state represented each region, as can be seen in Figure 4. The states that were chosen for this study were Perak, Pahang, Selangor, and Johor. Then, two schools were chosen in each state to represent the rural and urban areas. This study used Roscoe's rule of thumb to obtain its sampling amount where a minimum number of 30 for each subsample is sufficient (Sekaran, 1992). Therefore, for each gender, 30 samples were analyzed. A sampling chart is shown in Figure 5 for further understanding. In total, 2,400 school children were included in this study.

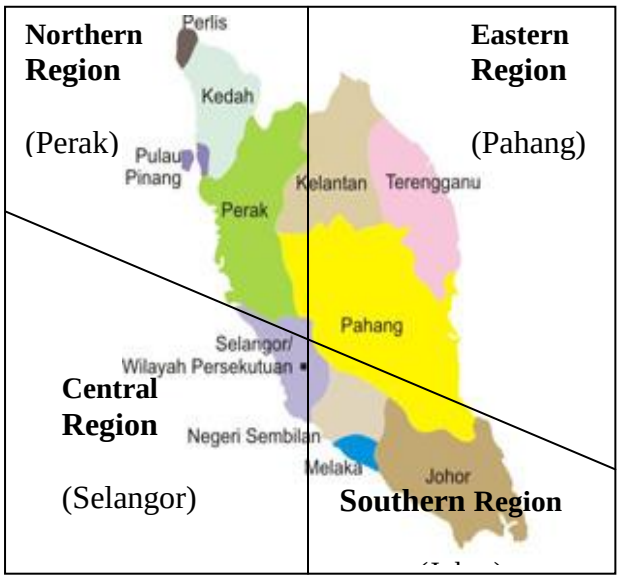


Figure 4 Peninsular Malaysia map divided into regions

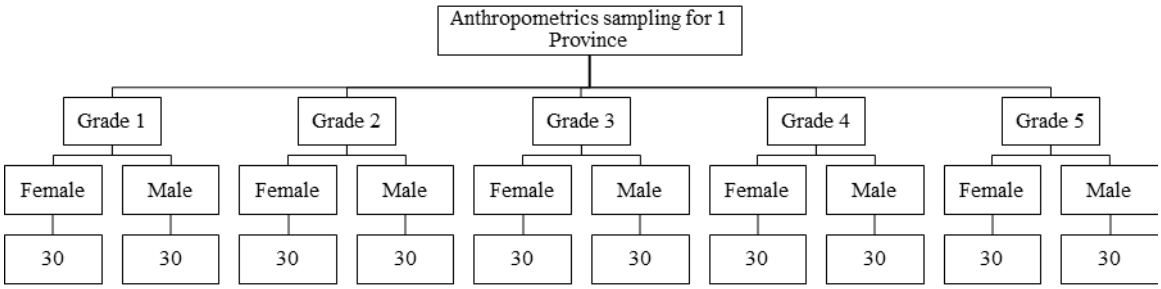


Figure 5 Sampling in each province

2.2. Rural and Urban Classification

Identifying rural and urban areas is quite difficult. However, rural and urban areas can be differentiated in many ways. Some countries base their area identification on the country's department of statistics. In some countries, rural and urban areas are categorized according to the size of the land and the population; for example, in Japan, the number of 500 residents per square kilometer was set to identify rural areas. However, in Belgium, two different optimal population density limits were identified (Pizzoli & Gong, 2007). In this study, rural and urban areas were declared according to the Ministry of Education's school listings, where they had already categorized all the schools by their designated provinces of rural and urban.

2.3. Equipment Preparation

A custom-made measuring chair was built to measure the children in a sitting posture, as shown in Figure 6. This enabled the children to be measured while they were sitting in a more efficient way. Simultaneous measurements were able to be collected, hence lowering the time taken to measure the children. The measuring chair was checked to make sure that the seat angle was at 90 degrees by using a level. Three replicates of each body dimension were taken to ensure that no human errors occurred. An anthropometer was also used to measure hip width (see Figure 7).

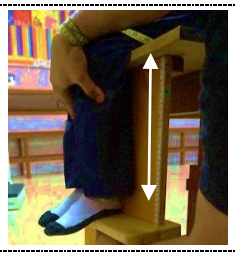
Figure 6 A custom-made measuring chair for the sitting position

Figure 7 Anthropometer

2.4. Data Gathering and Assessment

The anthropometrics used in this study only included the parts of the body that are used in designing a basic chair. Furthermore, the body parts were grouped into two sections, which were the upper and lower parts of the body. The process of collecting the anthropometry data were based on the procedures of Malaysian Standard MS ISO 15535:2008, standard used for establishing an anthropometric database. Table 1 illustrates the data gathering process in detail**.**

Table 1 Categorization of body parts

Body Section	Dimension	Figure
UPPER BODY	Stature - Stature, which is the vertical distance from the floor to the highest point of the head. The samples were measured with hands straight on the sides, shoes off, and head at a Frankfort plane where the ear canal is horizontal to the lower border of the eye orbit.	
	Sitting Subscapular Height - Vertical distance between the subscapular to the seat.	
	Shoulder Breadth - The lateral distance of the widest part of the shoulder, measured with an anthropometer.	
LOWER BODY	Buttock-Popliteal Length - The length of the buttocks to the popliteal horizontally.	
	Popliteal Height - The distance between the popliteal to the floor or the edge of the foot.	
	Hip Width - The widest horizontal length of the hips while sitting.	

3. RESULTS AND DISCUSSION

3.1. Rural and Urban

Descriptive statistics of the differences between the rural and urban areas overall are shown in Figure 8 for the upper body. The upper body, which includes stature, shoulder breadth, and sitting subscapular height, showed that urban children had higher measurements. This is similar to the study by Shariff et al. (2000), where they found urban areas such as Kuala Lumpur, 5.8% children were overweight and had increased to 10.1% in 2004 (Moy et al., 2004). Nevertheless, in the current study, both rural and urban areas had slightly different measurement values. Furniture designers should consider these measurements in making adjustments to chair backrests for ergonomic considerations.

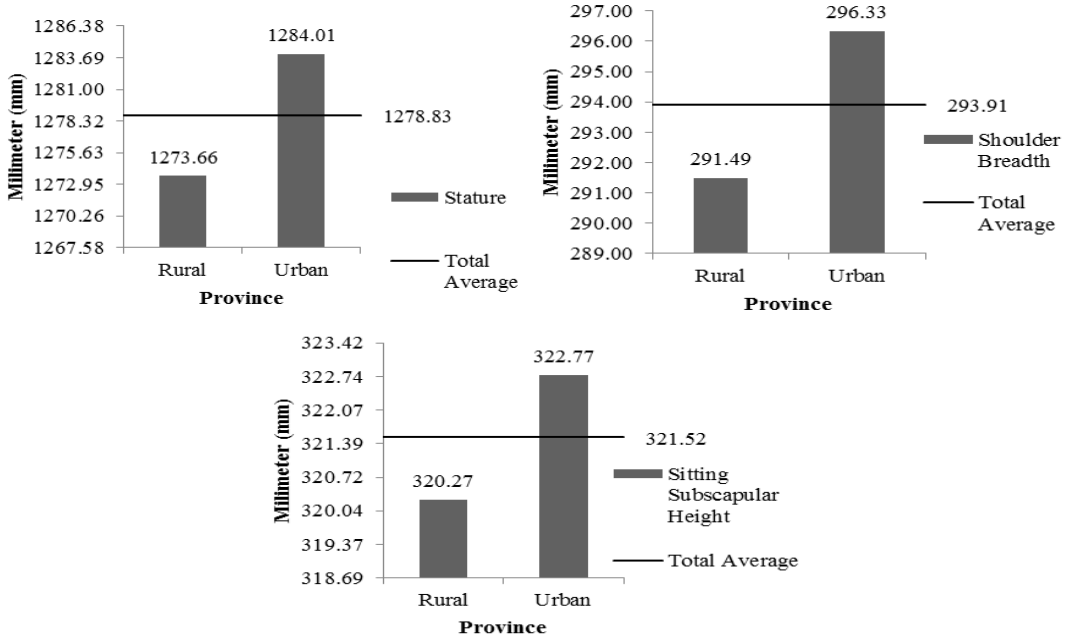


Figure 8 Upper body

The lower body, which consists of hip width, popliteal height, and buttock-popliteal length (see Figure 9), revealed even smaller differences between the rural and urban areas, most of which were less than one millimeter apart. Overall, there were no significant differences between the rural and urban areas in Peninsular Malaysia. However, a deeper evaluation was conducted, where T-tests on each region (differentiating rural and urban) were done, and the results can be seen in Table 2.

Table 2 Summary of T-tests for the rural and urban areas in each region

Body Section	Body Dimension	Region			
		Central	Northern	Southern	Eastern
UPPER BODY	Stature	0.027*	0.233	0.303	0.002
	Sitting Subscapular Height	0.412	0.206	0.032*	0.000*
	Shoulder Breadth	0.000*	0.377	0.928	0.004*
LOWER BODY	Buttock-Popliteal Length	0.073	0.298	0.555	0.003*
	Popliteal Height	0.000*	0.128	0.027*	0.008*
	Hip Width	0.544	0.036*	0.740	0.657

** The mean difference is significant at $p < 0.05$*

Table 2, exhibits significant differences in certain areas only. In the Eastern region, four out of six body dimensions showed significant differences between the rural and urban children, however, in other regions, such as Northern and Southern, most of the body dimensions had similar dimensions, therefore no significant differences can be concluded for these regions.

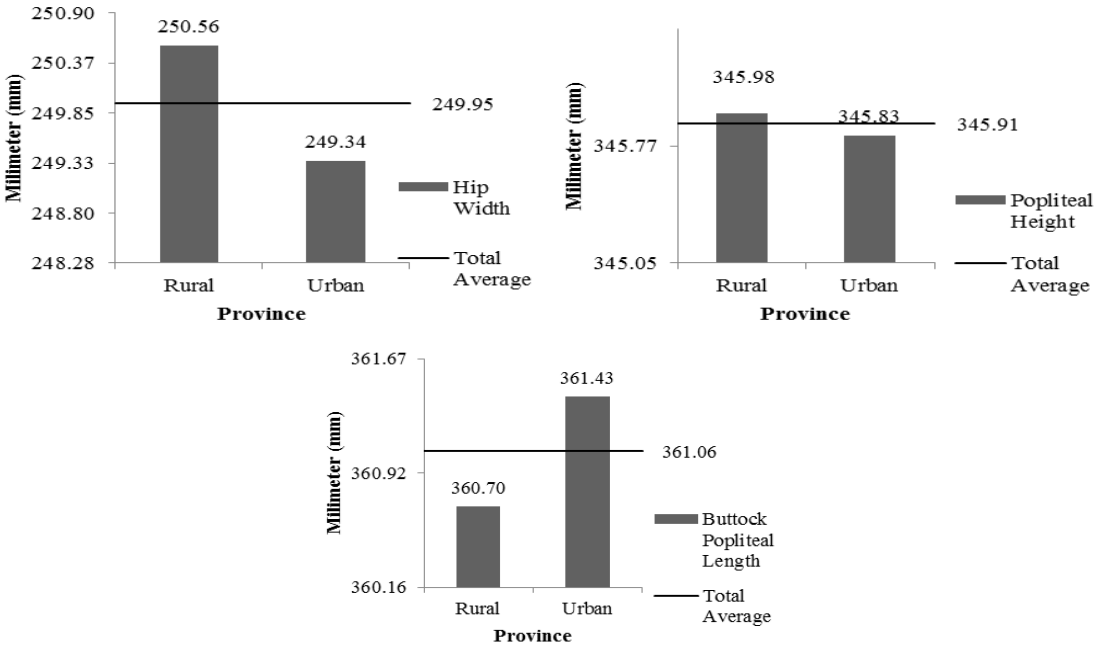


Figure 9 Lower body

4. CONCLUSION

The evaluation done in this study showed that different regions had different results for rural and urban areas. While some regions showed similar anthropometrics, others had significant differences between rural and urban children. The reason behind this may be due to the different development of each region. Therefore, there is a need to include regional differences when conducting rural and urban anthropometric studies. The importance of investigating this will ease ergonomic product design and the ability to create products that cater to the intended user population. Furthermore, the differences in these two areas may be different in other countries. The need to compare rural and urban areas in future studies is very compelling, as this will help each country in applying ergonomics to all its furniture, and especially for children.

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