Research Report

ANTHROPOMETRIC MEASUREMENTS OF PUBLIC ELEMENTARY SCHOOL STUDENTS IN DISTRICT IV OF MANILA

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ABSTRACT

***Background and Purpose**:* Musculoskeletal discomfort and low back pain could arise from the mismatch between the school furniture and the body dimensions of the children. Lack of normative anthropometric measurements of Filipino children serving as basis for chair construction could be the reason for this problem. This study aims to obtain sample anthropometric measurements in sitting of Filipino school-aged children from District IV, Manila. ***Methodology**:* 578 children (M: 278 F: 300) aged 6-12 years old enrolled in schools of District IV, Manila were selected using purposive sampling. Pertinent anthropometric measurements in sitting were taken. Children were instructed to sit up straight with shoulders relaxed and head in midline. Each participant was seated on a monoblock chair without backrest while maintaining a 90°-90° hip-knee angle measurement. ***Results**:* The results showed a statistically significant difference between age groups in the measurements for most of the body dimensions of children from age 6 to 11 years old showing an increasing trend. Measurements between 11 and 12 year old age groups were not statistically significant. There was a statistically significant difference between male and female measurements particularly in the 8, 11 and 12 age groups. ***Discussion and Conclusion**:* School-aged children will not all fit in one standard chair because of the significant differences in measurements across age group and gender. The group recommends a careful examination of school furniture construction, taking into consideration the changing anthropometric data of the children as they grow older and the gender differences between school-aged children.

***Key words**: Anthropometry, Ergonomics, Children, Chair Design (non-MeSH)*

INTRODUCTION

School furniture is used extensively by elementary students during a vital period of their human physical development.[1] Improper fit of furniture to their body dimensions results in poor sitting postures. This could lead to faulty biomechanics in both sitting and standing which would later become a problem for the child. Further, improper posture can cause stress to joints which, combined with weak muscles, can cause their wear and permanent damage.[2]

Mismatch between school furniture and anthropometric measurements of children is a causative factor for low back pain and musculoskeletal discomfort in school students.[1,3,4] Further, musculoskeletal stress resulting from efforts to maintain stability and comfort in sitting is not conducive for learning.[5] In a study by Hanninen and Koskelo in 2002[6], adjustable chairs appropriate for the children's size were given to the experimental group while traditional chairs were given to the control. Not only did the experimental group showed a decrease in muscle pain and headaches but they also obtained significantly higher grades than those of the control.[6]

Preventing these ill-effects of improper school furniture should be a health concern of everyone. Applying the principles of ergonomics in the chair design for these children may help solve the probable long-term health problems associated with incorrect sitting posture.

Ergonomics is defined as the study of the individual within the work environment.[7] Its main concern is to match the product to the user to be able to optimize efficiency, safety, comfort and ease of use of the product.[8] Anthropometric data are useful building blocks towards good ergonomic designs[9] to minimize the improper posture and the deleterious effects in the child's health and development. However, there is currently limited information on the anthropometric measurements of Filipino children in terms of their sitting postures. Therefore this study was conducted, primarily to obtain data on anthropometric measurements in sitting of Filipino children, age 6-12 years old. This study would also like to determine if there are statistically significant differences in measurements of these children based on age and gender.

METHODOLOGY

This observational study was conducted in Manila, District IV public elementary schools upon approval of the Asst. School Division Superintendent of the Department of Education. This district was selected through random sampling. There are 25,344 enrolled students in this district as of the school year 2004-2005. Pupils aged 6-12 years old, who were enrolled in any of the classes from grades 1-6 in schools who agreed to participate in the study, were included. Participants were obtained through purposive sampling. Excluded were those with severe behavioral problems, obvious postural deformity as determined by researchers, body asymmetry or amputation, and those enrolled in Special Education (SPED) Program.

Procedure

Each participant's sitting anthropometric measurements were obtained in a standard way based on previous studies done by Parcells in 1999[10] and Pheasant 1996[11]. Body dimensions important in sitting posture like sitting height, sitting shoulder height, sitting elbow height, thigh thickness, buttock-knee length, buttock-popliteal length, knee height, popliteal height and hip breadth were measured. Each participant was seated on a monoblock chair without backrest, feet planted on the ground, slightly apart, with shoes taken off (Figure 1). To maintain a 90°-90° hip-knee angle in all measurements, phonebooks were placed under the feet of the student for adjustment. While the examiners were measuring, participants were instructed to sit up straight with shoulders relaxed and head in midline. For consistency, all measurements were taken on lateral view (right side) of the subject except for hip breadth which was taken posteriorly. Landmarks of these measurements were adapted from a study by Prado-Leon, et al.[12] Measurements were taken using a steel tape measure (Stanley Manufacturing, Philippines) (Figure 2). Illustration boards were used as level landmarks at each end of the part to be measured. (e.g. board placed over the participant's head in measuring for the sitting height).

Figure 1. Position of participant during measurement

Figure 2 Actual measurement on a subject

Prior to actual measurements, the researchers practiced obtaining anthropometric measurements and performed reliability testing. Results of this preliminary testing were analyzed using Pearson's *r* coefficient. Pearson's *r* score over 0.7 is considered to be of high reliability.[13] High intratester reliability and intertester reliability were found among the assessors. Intratester reliability of assessor 1 was 0.727127, assessor 2 was 0.727111 and assessor 3 was 0.727231. The intertester reliability between assessors 1 and 2 was 0.719744, between assessors 1 and 3 was 0.724981, and between assessor 2 and 3 was 0.724425.

Data analysis

Measures of central tendency were used to describe the data. The mean and standard deviation of each anthropometric measure were computed and were classified by age and by gender. The 5th and 95th percentile of the said measures were also calculated to accommodate children with higher or lower measures than the average group. Microsoft Excel 2002 was used to acquire the above computations. The paired t-test was used to compare if there was a significant difference on each anthropometric measures between age groups and gender groups. A *p* value of ≤ 0.01 was considered significant.

RESULTS

Ten out of the 14 elementary schools in Manila District IV agreed to participate in this study. All data obtained in the study were measured from the 578 participants. Figure 3 shows the distribution of participants from the participating schools. The distribution of students per year and per gender is presented in Table 1.

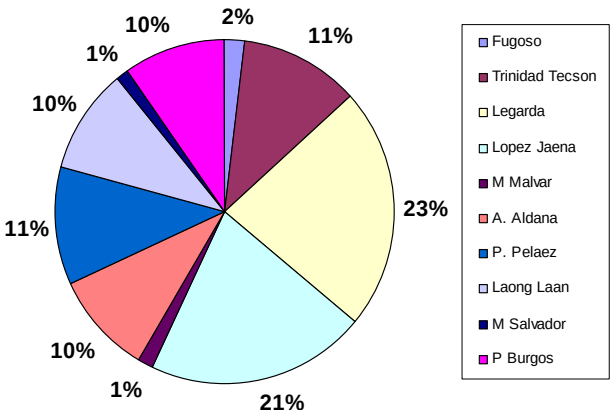

Figure 3. Sample size distribution among schools

Table 1. Summary of Population Distribution by Age and by Gender

Age in years	Total Population	Sample Population		
		n	boys	girls
6	2698	76	36	40
7	3986	80	39	41
8	3960	82	41	41
9	4334	87	43	44
10	3787	97	49	48
11	4071	78	33	45
12	2508	78	37	41
Total	**25,344**	**578**	**278**	**300**

Based on power calculation, the researchers should be able to obtain at least 95 subjects per age group. Only the 10-year old subjects met the expected sample size, while the other age levels were under the expected sample size value due to limited samples obtained in these age levels.

The obtained anthropometric measures were sorted by age then by gender. The mean, standard deviation as well as the 5th and 95th percentile were presented in Tables 2-8.

The mean of each anthropometric measure was compared between age groups (Table 9). The mean of each anthropometric measure as sorted by gender was also compared per age group (Table 10).

From the gathered data, it can be seen that most body dimensions measured from ages 6 to 11-significantly increased, specifically in measurements of Sitting Height, Buttock to Knee Length, Knee Height and Popliteal Height. There was no statistical significance in the difference between the following body dimensions: Shoulder Height of 10 and 11 years old, Elbow Height of 7 to 8 and 9 to 11 age group, Thigh Thickness of 9 to 11 years old, Buttock to Popliteal Length of 9 to 10 years old and Hip Breadth of 6 to 8 and 10 to 11 years old. The difference between ages 11 and 12 years old was statistically significant only for Popliteal height.

DISCUSSION

Growth or the increase in physical measurements, is most rapid during infancy and from pre-pubescence through adolescence.[14] Body dimensions of children ages 6 to 12 years old tends to remain relatively stable throughout childhood with minimal increase in size as the child grows older.[15] This coincides with the data obtained from this study. Body dimensions found to have statistically significant differences between age groups were sitting height, knee height, buttock to knee length and popliteal height, confirming that in all children, there is greater limb growth compared to trunk growth.[16]

In terms of gender, the measurements of the male and female mean values for the 8, 11 and 12 years age groups showed significant differences. It can be noted in the aforementioned age groups that the majority of the differences are located primarily in the extremities, rather than the trunk. Females showed greater anthropometric values compared

Table 2. Summary of Anthropometric Dimensions of Children aged 6 yo (all measurements in cm)

		Sit Height	Shoulder Height	Elbow Height	Thigh Thickness	Butt-Knee	Butt-Popliteal	Knee Height	Popliteal Height	Hip Breadth
Male (n=36)	Mean	60.4	38.0	15.8	7.9	37.0	31.5	34.6	28.7	22.3
	SD	2.9	2.8	1.7	1.0	2.3	2.2	2.1	1.7	1.6
	5th %-ile	55.5	34.5	13.5	6.7	34.4	28.8	32.0	25.9	19.5
	95th %-ile	64.6	42.6	18.1	10.0	40.9	35.4	38.0	31.4	24.5
Female (n=40)	Mean	61.0	37.8	15.5	7.9	37.0	32.0	34.6	28.9	22.3
	SD	3.0	2.1	1.7	1.1	2.9	4.2	2.2	2.0	2.2
	5th %-ile	56.0	34.5	13.0	6.0	33.3	27.0	31.0	26.4	19.5
	95th %-ile	65.0	40.7	17.5	9.4	41.6	39.6	38.0	33.0	26.1
Total (n=76)	Mean	60.7	37.9	15.6	7.9	37.0	31.8	34.6	28.8	22.3
	SD	3.0	2.4	1.7	1.0	2.6	3.4	2.1	1.9	1.9
	5th %-ile	55.8	34.5	13.2	6.5	33.5	27.4	31.5	25.9	19.5
	95th %-ile	65	42.0	18.1	9.6	41.6	37.0	38.0	32.6	25.5

Table 3. Summary of Anthropometric Dimensions of Children aged 7 yo (All Measurements in cm)

		Sit Height	Shoulder Height	Elbow Height	Thigh Thickness	Butt-Knee	Butt-Popliteal	Knee Height	Popliteal Height	Hip Breadth
Male (n=39)	MEAN	63.5	39.8	16.2	8.7	39.1	33.2	36.6	30.7	23.0
	SD	3.4	3.1	1.7	1.6	3.1	3.0	2.4	1.8	2.7
	5th %-ile	58.0	36.0	13.8	6.3	35.0	29.5	34.0	28.0	19.9
	95th %-ile	69.5	44.3	19.0	11.6	44.0	38.2	40.6	33.6	26.0
Female (n=41)	MEAN	63.2	39.2	16.2	8.8	39.1	32.5	36.5	30.2	23.0
	SD	3.5	2.6	2.2	1.9	3.4	3.5	2.5	1.9	3.5
	5th %-ile	59.0	34.0	13.0	6.0	34.0	27.2	32.5	27.5	19.5
	95th %-ile	67.5	43.0	19.0	11.5	44.0	37.0	40.5	33.0	28.0
Total (n=80)	MEAN	63.4	39.5	16.2	8.8	39.1	32.8	36.5	30.5	23.0
	SD	3.4	2.9	2.0	1.7	3.2	3.3	2.5	1.9	3.1
	5th %-ile	58.0	35.4	13.2	6.2	34.6	27.7	32.5	27.5	19.5
	95th %-ile	69.5	44.0	19.0	11.6	44.0	38.0	40.5	33.4	27.05

Table 4. Summary of Anthropometric Dimensions of Children aged 8 yo (All Measurements in cm)

		Sit Height	Shoulder Height	Elbow Height	Thigh Thickness	Butt-Knee	Butt-Popliteal	Knee Height	Popliteal Height	Hip Breadth
Male (n=41)	MEAN	65.1	40.6	16.4	9.0	40.3	33.9	37.8	31.5	23.3
	SD	3.2	2.9	2.2	1.6	3.2	2.6	2.2	1.6	2.8
	5th %-ile	60.5	36.1	13.5	7.0	36.0	30.4	34.0	29.0	20.0
	95th %-ile	69.5	45.0	20.0	12.0	46.0	38.0	41.0	34.0	28.0
Female (n=41)	MEAN	66.5	41.2	16.6	9.4	42.0	34.9	39.0	32.3	23.8
	SD	3.5	3.0	2.3	1.9	3.7	4.0	2.3	1.7	3.1
	5th %-ile	62.0	37.0	14.0	7.0	37.0	29.0	36.0	30.0	20.0
	95th %-ile	71.5	46.0	21.0	12.5	49.5	43.0	43.0	35.0	29.6
Total (n=82)	MEAN	65.8	40.9	16.5	9.2	41.2	34.4	38.4	31.9	23.6
	SD	3.4	3.0	2.2	1.7	3.5	3.4	2.3	1.7	2.9
	5th %-ile	61.0	36.4	13.5	7.0	36.5	30.0	34.6	29.4	20.0
	95th %-ile	71.0	46.0	20.5	12.5	47.9	40.0	42.0	35.0	29.3

Table 5. Summary of Anthropometric Dimensions of Children aged 9 yo (All Measurements in cm)

		Sit Height	Shoulder Height	Elbow Height	Thigh Thickness	Butt-Knee	Butt-Popliteal	Knee Height	Popliteal Height	Hip Breadth
Male (n=43)	MEAN	68.6	42.9	16.9	9.7	44.2	37.2	41.2	34.4	25.8
	SD	3.2	3.4	1.9	1.7	3.8	3.7	2.5	2.9	3.7
	5th %-ile	63.6	39.1	14.1	7.5	38.8	32.2	37.1	31.4	21.1
	95th %-ile	74.5	48.8	19.5	12.0	51.3	44.7	45.8	37.3	32.0
Female (n=44)	MEAN	69.0	43.4	17.2	10.2	44.9	38.1	41.1	33.9	25.1
	SD	3.6	2.5	1.8	1.7	3.8	3.5	2.6	1.9	3.1
	5th %-ile	64.2	40.1	13.7	8.0	40.1	33.0	38.0	31.0	21.5
	95th %-ile	75.2	47.3	20.0	13.0	50.7	43.0	45.4	36.9	30.3
Total (n=87)	MEAN	68.8	43.2	17.0	10.0	44.6	37.6	41.1	34.1	25.4
	SD	3.4	3.0	1.9	1.7	3.8	3.6	2.5	2.4	3.4
	5th %-ile	63.7	40.0	14.0	7.5	38.9	32.5	37.5	31.1	21.2
	95th %-ile	74.9	47.8	20.0	12.9	51.3	44.4	45.9	37.2	31.5

Table 6. Summary of Anthropometric Dimensions of Children aged 10 yo (All Measurements in cm)

		Sit Height	Shoulder Height	Elbow Height	Thigh Thickness	Butt-Knee	Butt-Popliteal	Knee Height	Popliteal Height	Hip Breadth
Male (n=49)	MEAN	69.7	44.0	17.1	9.7	45.2	39.2	42.2	35.0	27.2
	SD	3.5	2.8	1.9	2.1	4.2	9.3	2.7	2.3	3.1
	5th %-ile	64.2	39.4	14.5	7.0	39.2	32.9	37.5	31.0	23.0
	95th %-ile	75.4	48.0	20.5	13.6	51.6	45.8	46.0	38.9	32.5
Female (n=48)	MEAN	70.5	44.9	17.7	9.8	46.5	38.7	42.4	34.9	27.6
	SD	4.4	3.7	2.9	1.6	4.1	3.5	3.0	2.3	3.8
	5th %-ile	64.0	39.7	13.4	7.2	40.4	33.9	38.0	32.0	21.5
	95th %-ile	78.3	50.7	23.0	11.9	52.8	44.3	47.0	39.0	33.2
Total (n=97)	MEAN	70.1	44.5	17.4	9.7	45.8	39.0	42.3	35.0	27.4
	SD	4.0	3.3	2.4	1.9	4.2	7.0	2.8	2.3	3.4
	5th %-ile	64.0	39.5	14.0	7.0	39.5	33.0	37.5	31.3	22.4
	95th %-ile	76.6	49.5	21.5	13.0	52.6	44.6	46.2	39.0	33.0

Table 7. Summary of Anthropometric Dimensions of Children aged 11 yo (All Measurements in cm)

		Sit Height	Shoulder Height	Elbow Height	Thigh Thickness	Butt-Knee	Butt-Popliteal	Knee Height	Popliteal Height	Hip Breadth
Male (n=33)	MEAN	71.3	48.0	20.7	9.8	45.7	38.8	43.7	36.3	27.6
	SD	3.6	10.6	10.9	1.9	6.8	3.2	2.8	2.1	3.2
	5th %-ile	66.1	42.0	15.8	8.0	41.3	34.8	39.4	32.8	23.5
	95th %-ile	77.1	66.8	37.4	13.8	52.6	45.0	47.8	40.0	32.4
Female (n=45)	MEAN	73.7	46.9	18.8	9.9	48.7	40.9	45.0	36.8	28.7
	SD	3.9	3.9	2.7	2.0	4.6	4.1	2.8	2.2	3.8
	5th %-ile	79.1	53.9	23.5	13.5	55.9	47.0	49.1	40.2	35.9
	95th %-ile	66.1	42.0	15.8	8.0	41.3	34.8	39.4	32.8	23.5
Total (n=78)	MEAN	72.7	47.4	19.6	9.9	47.4	40.0	44.5	36.5	28.2
	SD	3.9	7.5	7.4	2.0	5.8	3.9	2.9	2.2	3.6
	5th %-ile	66.9	42.0	15.4	7.5	41.0	34.1	40.0	32.8	23.4
	95th %-ile	78.5	54.6	23.7	13.5	54.2	46.5	49.0	40.0	34.3

Table 8. Summary of Anthropometric Dimensions of Children aged 12 yo (All Measurements in cm)

		Sit Height	Shoulder Height	Elbow Height	Thigh Thickness	Butt-Knee	Butt-Popliteal	Knee Height	Popliteal Height	Hip Breadth
Male (n=37)	Mean	72.7	45.6	18.1	9.7	47.1	39.0	44.7	37.1	27.2
	SD	4.3	3.0	2.2	1.5	3.5	3.6	2.9	2.1	3.4
	5th %-ile	67.9	42.5	15.4	8.0	42.0	33.8	40.8	34.0	22.0
	95th %-ile	79.9	50.3	22.1	12.5	53.1	45.2	48.8	40.2	32.6
Female (n=41)	Mean	74.5	48.7	21.4	10.3	48.4	41.4	45.1	37.2	29.1
	SD	3.9	6.9	10.0	2.1	3.4	9.7	2.7	2.1	3.1
	5th %-ile	68.0	43.5	16.5	8.2	42.7	34.6	41.2	34.0	25.0
	95th %-ile	80.8	53.5	22.5	15.4	54.5	46.3	48.5	41.2	33.8
Total (n=78)	Mean	73.7	47.2	19.8	10.0	47.8	40.3	45.0	37.2	28.2
	SD	4.2	5.6	7.5	1.8	3.5	7.5	2.8	2.1	3.4
	5th %-ile	68.0	42.9	15.5	8.0	42.2	34.1	40.9	33.9	22.7
	95th %-ile	80.3	53.1	22.5	13.5	53.7	46.3	48.8	40.6	33.8

Table 9. Comparison of Mean Measures between age groups using T-test

	Sit Height	Shoulder Height	Elbow Height	Thigh Thickness	Butt-Knee	Butt-Popliteal	Knee Height	Popliteal Height	Hip Breadth
6 & 7 y/o	7.03*	4.97*	2.49*	4.55*	5.73*	2.84*	7.01*	8.08*	1.93
7 & 8 y/o	6.58*	4.26*	1.14	2.51*	5.32*	4.20*	7.42*	7.54*	1.82
8 & 9 y/o	8.16*	7.12*	2.86*	4.11*	8.38*	8.27*	9.96*	8.61*	5.12*
9 & 10 y/o	3.21*	3.86*	1.40	1.43	2.97*	1.85	4.08*	3.64*	5.68*
10 & 11 y/o	5.81*	2.19	1.22	0.62	2.97*	2.43*	6.57*	6.34*	1.93
11 & 12 y/o	2.06	1.38	1.66	0.76	-0.02	0.28	1.57	2.60*	-0.09

*statistically significant

Table 10. Comparison of Mean Measures between genders per age group using T-test

	Sit Height	Shoulder Height	Elbow Height	Thigh Thickness	Buttock-Knee	Buttock-Popliteal	Knee Height	Popliteal Height	Hip Breadth
6 y/o	1.29	-0.49	-1.00	0.03	-0.12	0.79	-0.21	0.93	0.29
7 y/o	-0.55	-1.46	-0.17	0.39	-0.09	-1.17	-0.29	-1.69	-0.08
8 y/o	2.57*	1.29	0.49	1.30	2.83*	1.53	3.31*	3.04*	1.03
9 y/o	0.65	1.27	1.37	1.88	1.24	1.81	-0.30	-1.84	-1.37
10 y/o	1.21	1.66	1.48	0.51	2.21	-1.06	0.58	-0.27	0.68
11 y/o	4.03*	2.39*	2.29	0.50	3.16*	3.30*	3.25*	1.51	1.96
12 y/o	2.90*	2.86*	2.15	1.77	2.55*	1.63	0.98	0.45	3.89*

*statistically significant

Table 11. Comparison of sample measurements of Filipino, American, and Mexican children ages 6-11 years old (All measurements in cm)

	Filipino	American[19]	Mexican[12]
Sitting Height	60.7-72.7	64.8-74.5	63.0-74.1
Hip Breadth	22.3-28.2	21.5-27.6	23.7-29.6

Sources:
[19] http://www.itl.nist.gov/iaui/ovrt/projects/anthrokids/datatoc77.html
[12] Prado-Leon et al (2001)

Table 12. Comparison of sample measurements of Filipino and Vietnamese children ages 6-10 years old (All measurements in cm)

	Filipino	Vietnamese[1]
Shoulder Height	37.9-44.5	37.7-45.7
Elbow Height	15.6-17.4	16.4-18.0
Knee Height	34.6-42.3	34.1-41.2
Popliteal Height	28.8-35.0	27.4-33.8
Buttock-Popliteal Length	31.8-39.0	29.8-35.7

Source:
[1] Diep NB (2003)

Table 13. Seat height, depth, and minimum desk/table clearance, & desk height to accommodate 5-95% of the sample.

Age	Seat Height (cm) (= 88 – 95% of the 5th %-ile popliteal height)	Seat Depth (cm) (= 80 – 95% of the 5th %-ile butt-popliteal length)	Minimum Desk/Table Clearance (cm) (= 95th %-ile knee height + 2)	Minimum Desk Height (cm) (= 95th %-ile elbow height)
6	23.5 – 25.3	21.6 – 25.7	39.9	18.4
7	24.2 – 26.1	22.2 – 26.3	42.5	19.0
8	25.9 – 27.9	24.0 – 28.5	44.0	20.5
9	27.4 – 29.5	26.0 – 30.9	47.9	20.0
10	27.5 – 29.7	26.4 – 31.4	48.2	21.5
11	28.9 – 31.2	27.3 – 32.4	51.0	23.7
12	30.2 – 32.6	27.6 – 32.8	49.9	22.0

with males (Table 10). There were more 11 and 12-year old females measured compared to males. This could have affected the results. However, there was an equal number of 8-year old children for both genders, indicating that there really is a difference between the body dimensions of male and female children starting at an early age.

Girls enter puberty about 2 years earlier than boys.[17] Girls tend to be slightly shorter from birth to the end of preschool years. However, upon reaching the age of 6 to 12 years, girls who are shorter at the age of six catch up with the height of boys by age 11 and surpass the height of the boys by age of 12.[18] Boys have longer extremities, while girls have greater hip widths and thigh sizes at this age group.

When matching up the data obtained from this study and from those done previously, the comparison on Table 11showed that American children[19] have smaller hips but are taller in height.

On the other hand, Mexican children[12] have wider hips and are also taller (Table 11). In another observation, Vietnamese children from urban schools[1] are generally smaller in most measurements (Table 12).

Differences in measurement between children from different countries can be attributed to a number of factors. The physical characteristic of the children, shaped by nutrition, culture, race and genes contribute greatly to the variability in measurements. Diverse measuring techniques and equipment may have also contribute to this disparity. Therefore, anthropometric measurements from other countries could not be used as a basis for Filipino school furniture design and one cannot import prefabricated school chairs from other countries to be used in the Philippine classroom setting.

Using the 5th and 95th percentile from the gathered data, one can compute for the seat height, depth, desk clearance, and desk height which will accommodate a representative 90% (5-95%) of the population of school children. The seat height reference should be of the shortest popliteal height so that all may sit with their feet flat on the ground. Seat depth reference should be of the shortest butt-popliteal length so that the popliteal area will not touch the edge of the seat. Desk clearance reference should be of the highest knee height so that the knee will not touch the bottom of the desk. Minimum desk height reference should be of the highest elbow height so that elbows may rest on the desk without bending the trunk towards the side of the desk. With this information, this study suggests chair dimensions that would accommodate the middle 90% of the sample population. (Table 13)

In addition, the group recommends using the 95th percentile of the Hip Breadth when measuring for the seat width. For the clearance of objects in front of the chair, the group recommends the use of the 95th percentile of buttock to knee length. This is to ensure that the chair will accommodate children with different sizes.

Good fit is crucial to comfortable and supportive sitting. Ergonomic features and adjustments are of little or no value if the chair does not properly fit the individual using them. Ergonomic designs distribute the weight of the occupant to various parts of the body. Persons with smaller body frame may feel pressure on the thighs and on the backs of the knees because of chairs that are too high or too deep and this also forces them to dangle their feet. They often have to move forward on the chair to relieve excessive pressure on their thighs and to let their feet reach the floor comfortably. Moving forward causes them to move away from the backrest and causing them to have a slumped posture with a flattened lumbar spine. An excessively high seat will lead to compressive forces on the lumbar spine with an increased potential for muscular, ligament or disc injury. Tall people may use chairs that are too low, leaving a disproportionate amount of weight to be supported by the ischial tuberosities. A low seat for them also may lead to increased elbow flexion and wrist extension as the student reaches for the workspace.[20]

Ultimately, the purpose of creating school furniture is for the child to be able to sit comfortably for prolonged periods of time while performing school work. In addition to finding the right size of the chair, school furniture designs should include adjustments to ensure proper fit. Providing the proper fit of the chair will minimize the incidences of musculoskeletal pain and promote proper posture especially at an early age.

This study can be used as reference for measurements to be used for future studies on school furniture design for Filipino primary school children. However, this study was limited by some factors as follows: The researchers were not able to meet the target sample size of 95 students per age group except among 10 year old students due to students' and researchers' conflicting schedule. Secondly, not all of the District IV schools have been included in the study due to a number of schools' request to have a scheduled time for the measurement. The researchers were also unable to measure sitting scapular height which is an important measure in determining backrest height. Lastly, only purposive sampling was done rather than randomized sampling.

CONCLUSION

This study presented sample anthropometric measurements in sitting of Filipino elementary school children of District IV, Manila. The research showed that body dimensions of children increase as the child grows older. Results also proved that there was a significant difference between male and female measurements particularly in the 8, 11, and 12 age groups.

Since the data are only limited to elementary schools in one district in Manila, it will be necessary to measure students from other districts, and if possible, from other cities and provinces in the Philippines using randomized sampling in order to obtain baseline normative measurements in sitting with a greater sample size. These will be significant in establishing more generalized data that would

help in designing an ergonomic chair for the students. Further, it would be helpful to take the scapular height of the students and find a more standardized way in taking the measures.

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