

## **An Analysis of Anthropometric Data and design of a Writing Desk for rural Bengalee Primary School Children**

Subrata Dutta<sup>1</sup>, Soudeep K Sau<sup>2</sup>, Prakash C Dhara<sup>3</sup>

<sup>1</sup>Research Fellow, Ergonomics and Sports Physiology Division, Dept. Of Physiology, Vidyasagar university, Midnapore (W) – 721 102, W.B. <sup>2</sup>Reader, Dept. Of Physiology, Rungta College of Dental Sciences and Research, Kohka Kurud Road, Bhilai – 490 024, C.G. <sup>3</sup>Professor, Ergonomics and Sports Physiology Division, Dept. Of Physiology, Vidyasagar university, Midnapore (W) – 721 102, W.B.

### Abstract

This study represents the results of an anthropometric survey conducted on Bengalee primary school boys with age range 6-9 years in the remote area of the city of Midnapore in Paschim Medinipur District, West Bengal. Anthropometric body dimensions were taken based on international standards. The sample consisted of 410 primary school boys. Means, standard deviations (SD), 5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup> percentiles were computed by using statistical package. It was observed from the results that all anthropometric dimensions of the primary school children were increased with their age. Moreover, there were little deviations between mean values of different anthropometric dimensions between the boys of 6 and 7 years ranges from 3.3-6.9 and only 3.3% to 7.6%. So, in the present study, the required anthropometric dimensions were collected from primary school boys having age range 6-9 years, and the suitable percentile values (5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup>) of anthropometric measures were computed and taken on account for designing a writing desk during sitting on the floor. The anthropometric databases of the present study may be helpful for designing school furniture and layout design of the classroom for the primary school children

**Key Words:** Anthropometric dimensions, primary school boys, percentile values, writing desk

Author for correspondence: Subrata Dutta, subrata.mid10@gmail.com

Introduction: A school is a second home for the children. Children spend a considerable part of their daily life in school. Children have to spend about 80% of their school time in the classroom performing various activities like reading, writing, drawing and other related activities, which requires them to sit continuously for long hours.<sup>[1]</sup> In Western cultures students have traditionally been seated in a chair. When assumed for long periods of time, however, the standard chair-seated posture puts considerable stress on the lumbar

spine.<sup>[2]</sup> The sitting position has been found to be the most troublesome situation in connection with low back pain.<sup>[3, 4, 5]</sup> Postural complaints at primary school age are increasing significantly.<sup>[3]</sup> Therefore, a human compatible working environment should be given because it enhances the attentiveness and satisfaction. Back pain is a significant burden of primary school children and if causes of back pain could be identified at an early stage the opportunity for remedial action would be improved. “Poor sitting habits” were statistically associated with low back pain.<sup>[6]</sup> In a large number of rural primary schools in West Bengal state, students are not provided with bench and desk. They sit on the floor for attending the class. They sit on a typical Indian traditional sitting posture, i.e., sitting on the floor with folded legs. Sometimes the children stretch their legs while sitting on the floor. However, in other schools students use a unit of bench and desk for reading purpose. Sitting in the same posture for a long time causes an extremely undesirable physiological strain and the muscles, the ligaments, and the disc and that the situation is related to pain. However, when the children sat on the floor there was no question of fitting the furniture with body dimension of the user. They can sit freely on the floor. It gives the body a stable posture. Slightly forward or reclined sitting posture relieves the strain on the back muscles and

makes sitting more comfortable. Slightly forward bent trunk holds body weight in balance. But, during performing their activities, they have to adopt sharp forward bent posture. The backward rotation of the pelvis puts the spine into a state of more kyphotic and increases the pressure within the discs. Sitting in the same posture in a forward bending position for a long time puts an extremely undesirable physiological strain on the muscles, ligaments and in particular on the discs.<sup>[7, 8]</sup> The children may feel discomfort/pain in different parts of the body especially at neck, thigh and lumber region and muscle fatigue also occurs. Hence, it is necessary that the school furniture should suit the requirements of school children.<sup>[1]</sup> Keeping these facts in mind, only a desk may be placed in front of the student for writing and reading. Keeping above all facts in mind, if a suitable desk is placed in front of the student for writing and reading, they may overcome muscular as well as spinal stresses. As the elbows get support on the writing desk, the work surface come closer to the children, the lumbar and backbone move less forward in order to balance the force. As a result, backbone is about to drawn straight and the body will naturally sit up correctly. So, every effort should be made to ensure that young children do not experience back pain and other musculoskeletal disorders due to prolonged sitting on improperly designed classroom

furniture. This study proposes probable guidelines for the design of ergonomic-oriented classroom furniture for primary school children. Hence there may be the chances of improving posture and reducing the stresses during doing class work. A writing desk was designed on the basis of body dimension of the children as well as applying other ergonomic principles. The present investigation was aimed to design the proper writing desk for class room activities according to ergonomics point of view for the rural primary school children in the class room. The objectives of the present study were:

- 1) To assess of body dimensions of the school children and setting up an anthropometric database of the Bengalee school children (6-9 years of age) for the purpose of designing of school furniture.
- 2) To design a writing desk for comfortable and healthful seating of the school boys during attending classes and promotion of classroom activities by reducing body discomfort and awkward postures should be the ultimate goal of the present study.

Material and Methods:

***Selections of site and subjects:*** The study was carried out in the 10 rural primary schools located at remote areas under Midnapore Sadar in West Midnapore District, West Bengal

during the period of 2009-2011 calendar years. For this study 410 primary school boys were selected at random. For the collection of required data, the approval was obtained from the school authorities before commencement of the study. The study was cross-sectional in nature and all subjects belonged to the Bengalee ethnic group. The age of the students were authenticated from the school records provided by the school authorities.

### **Measurement of Body Dimensions:**

Different anthropometric measures of the school children were taken by adopting proper landmark definitions and standard measuring techniques.<sup>[9, 10]</sup> The required equipments were

- 1) An anthropometer (Holtain),
- 2) A sliding caliper,
- 3) A steel tape.

The data recorded for a subject was the mean of three trials. All the measures were taken while subjects adopted traditional sitting posture. The following anthropometric dimensions were taken for this study:

**Height (under traditional sitting):** The vertical distance from the floor to top of the head was measured by an anthropometer.

**Buttock - Knee length (under traditional sitting):** Horizontal distance from the most posterior portion of buttock to anterior surface

of knee under traditional sitting was measured by shortened anthropometer.

**Knee- to- knee distance under traditional sitting:** The horizontal distance between two lateral most points of two knees under traditional sitting condition was measured by shortened anthropometer.

**Elbow height from floor under traditional sitting:** Vertical distance from floor to elbow was measured by anthropometer when fore arm is placed horizontally with floor and forms angle with the upper arm.

**Elbow to elbow length in writing position (under traditional sitting):** Horizontal distance across the lateral surfaces of the elbows (when children used to write on the floor/desk), was measured by shortened anthropometer.

**Knee height under traditional sitting:** The vertical distance from the floor to top surface of the bent knee under the traditional sitting was measured by shortened anthropometer.

**Arm reach under traditional sitting:** The horizontal distance between the maximum bulges of the body posteriorly and dactylion III was measured by an anthropometer.

**Span of arms flexed at the elbows (*Spine Akimbo*) under traditional sitting:** The horizontal distance between the olecranon on either side. The elbows were placed at the level of the shoulders and touch the center of the wall of the stand.

### **Percentile values of anthropometric dimensions of the user**

For selecting design dimension of the school furniture and classroom layout, different percentile values of the measured body dimensions of the students were calculated. Three percentile values, 5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup>, for each body dimension were computed with the help of standard statistical packages.

**Anthropometric survey:** Optimal furniture design recommendations are often based on the relationship of the furniture dimensions with the anthropometrics of the seated person. The most of the primary schools are situated in rural and semi-urban areas where the school authority is unable to provide such furniture because of financial paucity. If prolonged sitting at school furniture is a risk factor for the development of musculoskeletal symptoms, and there exists an optimal relationship between the anthropometric dimensions of the student population and the dimensions of the fixed. Therefore, a human compatible working environment should be given because it enhances the attentiveness and satisfaction. Anthropometry is a research area in ergonomics dealing with the measurement of human body dimensions and certain physical characteristics [11, 12]. Therefore, the effect should be done to design low cost writing desk according to the anthropometric considerations.

**Result and Discussion:** The mean values are represented in Table-1 under traditional sitting posture, i.e., sitting on the floor with folded legs. Table-1 reflects that all anthropometric dimensions of the school children increased with increment their age. With the increase of age, development of skeletal system, muscular system, and other systems of the body occurs, and therefore the resultant effect anthropometric measures increase.

Table-1: Mean±SD of different anthropometric body dimensions under traditional sitting posture.

Dimensions (under traditional sitting) (cm)	Age groups			
	6 years (n=101)	7 years (n=102)	8 years (n=103)	9 years (n=104)
Sitting height	54.98±3.92	56.07±3.95	63.12±5.60	66.40±5.63
Buttock - Knee length	27.28±3.24	31.06±3.25	35.36±5.39	38.22±5.93
Knee- to- knee distance	37.21±3.26	41.30±4.18	45.63±5.43	49.49±5.60
Elbow height from floor	17.53±2.50	17.58±2.88	21.28±2.03	24.14±3.17
Elbow to elbow length in writing position	30.03±3.27	35.44±3.32	35.12±5.14	36.55±5.18
Knee height	10.35±1.70	11.11±2.07	13.33±2.17	14.82±2.86
Arm reach	49.48±1.98	50.75±3.84	52.45±3.07	53.93±3.53
Span of arms flexed at the elbows (SpineAkimbo)	54.65±3.23	56.73±5.21	62.34±3.89	64.80±4.83

During designing any furniture for any individual, the individual body dimensions are used. But for mass production, the percentile values of body dimensions of mass population have been used. The reliable anthropometric data for a target population were necessary when designing for that population otherwise the product may not be suitable for the user.<sup>[13]</sup> Here 5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup> percentile values of different body dimensions are computed for

designing of writing desk. A 95<sup>th</sup> percentile value of a body dimension would indicate that 95 % of the study population have the same or less body dimension, and only the remaining 5 percent of the population have greater values and for the 5<sup>th</sup> percentile value indicate the opposite. The 50th percentile value represents closely the average, which divides the whole study population into two equal halves.

The percentile values of different physical dimensions of primary school children are presented in Table-2 and Table-3. The computed values of 5<sup>th</sup> and 95<sup>th</sup> percentiles were used for designing of writing desk.

From the Table 2, it is observed that mean differences (%) of anthropometric dimensions between the primary schoolboys of 6 and 7 years ranges from 3.3-6.9%. It was also noted that mean differences (%) of studied anthropometric dimensions of primary schoolboys of 8 and 9 years (Table-3) are low (only 3.3% to 7.6%). From the above observation, it may be stated that both age groups of Bengalee primary school population had no such notable changes in their body dimensions. Therefore, the boys of four age groups are merged together and may be considered as a single group while selecting design dimensions for the school furniture.

Table 2: Mean  $\pm$  S.D., and percentile values of different anthropometric dimensions of schoolboys of different age groups

Dimensions (under traditional sitting) (cm)	6 years	7 years	Mean diff. (%)	Grand Mean and SD	Percentiles		
					5th	50th	95th
Sitting height	54.98 $\pm$ 3.92	56.07 $\pm$ 3.95	5.4	55.6 $\pm$ 4.1	53.0	55.6	57.2
Buttock - Knee length	27.28 $\pm$ 3.24	31.06 $\pm$ 3.25	4.6	30.7 $\pm$ 3.7	29.0	30.7	32.3
Knee- to- knee distance	37.21 $\pm$ 3.26	41.30 $\pm$ 4.18	5.8	39.4 $\pm$ 2.9	37.8	39.4	41.0
Elbow height from floor	17.53 $\pm$ 2.50	17.58 $\pm$ 2.88	3.8	17.3 $\pm$ 4.5	15.6	17.3	18.9
Elbow to elbow length in writing position	30.03 $\pm$ 3.27	35.44 $\pm$ 3.32	7.6	32.9 $\pm$ 4.2	31.3	32.9	34.5
Knee height	10.35 $\pm$ 1.70	11.11 $\pm$ 2.07	5.3	11.0 $\pm$ 2.7	9.3	11.0	12.6
Arm reach	49.48 $\pm$ 1.98	50.75 $\pm$ 3.84	3.3	49.9 $\pm$ 1.7	48.3	49.9	51.5
Span of arms flexed at the elbows (Spine Akimbo)	54.65 $\pm$ 3.23	56.73 $\pm$ 5.21	6.9	55.6 $\pm$ 3.7	53.9	55.6	57.2

During design of a writing desk for the primary school boys, the anthropometric design principle should be applied. Anthropometry is a research area in ergonomics dealing with the measurement of human body dimensions and certain physical characteristics.<sup>[11, 12]</sup> So, consideration of different anthropometric dimensions of the primary school boys is essential during selection of dimensions for designing of classroom furniture. The important dimensions for the designing of a writing desk and the relevant user dimensions are shown in Table-5.

The width of the writing desk corresponds to the elbow to elbow distance (writing condition) of the population during sitting condition.<sup>[14]</sup> The 95<sup>th</sup> percentile value is considered in the case of width of fixed writing desk (Fig-1), the

design compromise should be directed well towards the larger user which is considerably greater than the elbow to elbow distance. This may provide extra space for performing works on the desk surface.

For the determination of work surface height, the data of elbow height of the user were used.<sup>[15]</sup> Therefore, data of sitting elbow height from the floor collected from this study might be used for the determination of height of the working surface (desk) for seated children (Fig-1). The design compromise should be directed well towards the smaller user, because large users are not greatly discomforted by desk height which is considerably less than the length of their floor to elbow height.

Conclusion: The results of this study show that the anthropometric data of pupils in primary schools were probably not used when designing the furniture currently in use. While some of the dimensions were low, others were high for the primary school pupils. It is important that if products are to be designed, they should be based on the anthropometric dimensions of the user population to reduce negative effects on the muscle due to poor sitting postures and also reduce neck, shoulder and back pain that may result. The study also provides some additional anthropometric data that may be useful in the design of other products for pupils in primary schools.

Table 3: Mean ± S.D., and (ranges) of different anthropometric dimensions of schoolboys of different age groups.

Dimensions (under traditional sitting) (cm)	8years	9 years	Mean differences (%)	Grand mean and SD	Percentiles		
					5th	50th	95th
Sitting height	63.12±5.60	66.40±5.63	6.6	65.3±3.9	63.6	65.3	66.9
Buttock - Knee length	35.36±5.39	38.22±5.93	4.8	36.7±4.6	35.0	36.7	38.3
Knee- to- knee distance	45.63±5.43	49.49±5.60	8.2	48.6±3.4	46.9	48.6	51.9
Elbow height from floor	21.28±2.03	24.14±3.17	5.9	22.7±2.9	21.0	22.7	24.3
Elbow to elbow length in writing position	35.12±5.14	36.55±5.18	3.7	32.0±1.6	30.3	32.0	33.6
Knee height	13.33±2.17	14.82±2.86	4.5	13.7±3.9	12.0	13.7	15.3
Arm reach	52.45±3.07	53.93±3.53	3.3	53.0±2.4	51.3	53.0	54.6
Span of arms flexed at the elbows (Spine Akimbo)	62.34±3.89	64.80±4.83	4.3	63.6±3.1	62.0	63.6	65.2

Table-4: Mean, SD and percentile values of physical dimensions for designing writing desk.

Parameters	Mean ± SD	5th percentile	50th percentile	95th percentile
Sitting height	60.14±6.80	58.50	60.14	61.79
Knee-knee Dist, sitting	46.61±6.67	44.96	46.61	48.25
Elbow to elbow Dwastance (writing condition)	34.28±4.99	32.64	34.28	35.93
Floor-elbow height, sitting	24.77±2.09	21.33	24.77	28.20
Length of note book	31.06±1.59	29.42	31.06	32.71
Arm reach, sitting	51.65±3.59	50.01	51.65	53.30
Knee depth, sitting	8.13±1.64	6.48	8.13	9.77
Spine akimbo, sitting	59.63±5.98	57.98	59.63	61.27
buttock-knee length, sitting	33.93±8.35	32.28	33.93	35.57
Length of note book,	31.06±1.59	29.42	31.06	32.71

Table 5: Criteria for selecting the dimension of the desk

Anthropometric /other dimensions	Dimensions for writing desk.	Selected percentile	Value of the selected percentile (cm)	Clearance (cm)	Final dimension
Elbow to elbow Distance(writing condition)	Width of the writing desk	95th	35.93	2.0	38.0
Floor-elbow height, sitting	Height of the writing desk	5th	21.33	0	22.0
Length of note book	Depth of the writing desk	95th	32.71	2.0	35.0

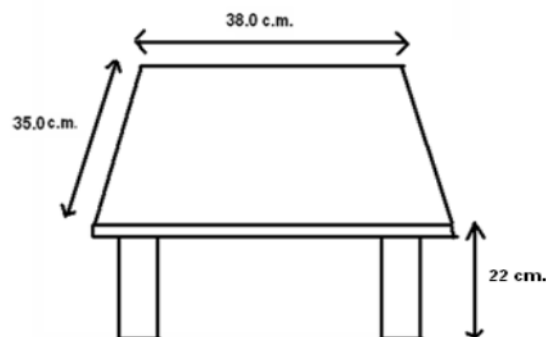


Fig-1: Recommended dimensions of writing desk

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