



Ergonomic Furniture Design for Secondary Girls School in Bangladesh

Md. Rahman*, Md. Hasan, Ms. B. Datta

Department of Industrial and Production Engineering, Faculty of Engineering and Technology, Jashore University of Science and Technology, Jashore-7408, Bangladesh.

ABSTRACT

This study has been carried out to evaluate the number of mismatches between secondary girl student's anthropometry and existing furniture dimensions in Bangladesh. In this study, 375 students (girls) are in classes 6-10 in the age group between 10-15 years that have randomly selected from three secondary girl schools in Bangladesh. Twelve anthropometric measurements and seven existing furniture dimensions were taken to find out the possible mismatch. A defined match criterion equation used to determine the mismatch. Various researchers gave these equations. The result indicates that there is a significant mismatch between anthropometric measurement and furniture dimensions. The highest mismatch percentage for seat height is about 90% for class 9. Therefore, 90% of girls use the seat that is too high (high mismatch). Mismatch percentage for seat depth is 100% for all classes. As a result, seat depth is so small for all students. Seat width is 100% for class 8 and 60% for class 9. The desktop height is about 100% mismatch for all classes. This paper also proposes dimensions for new furniture. The new furniture improves the match percentages from 50% to 100%.

Keywords: Ergonomics, Anthropometry, Mismatch.

Article history: Received: 27 March 2019

Revised: 17 June 2019

Accepted: 20 June 2019

1. Introduction

The students spend about 84% to 88% time of a day in their classroom [1]. This long time they acquire knowledge by sitting sometimes standing. The study showed 41.6% of students felt pain during sitting position in the classroom. About 69.5% of students also suffer from back pain after 1 hour of sitting in the classroom [2].

However, most of the school furniture's are not designed ergonomically in Bangladesh. The administrations of schools provide ready-made furniture. That furniture is very poor in quality and inappropriate for student's dimensions. As a result, students continue their activities in an

* Corresponding author

E-mail address: sumon.just16@gmail.com

DOI: 10.22105/riej.2019.183323.1086

awkward posture. This awkward posture leads to Musculoskeletal Disorders (MSDs) among their body. Musculoskeletal disorders refer to the disorders and injuries of the body musculoskeletal systems. These disorders fall a great effect on their study and quality of life. In this situation, only ergonomics designed furniture can remove these problems. Ergonomics is a science that tells us the interaction between users and equipment. There are numerous researches on school furniture.

Students spend a long period in their schools by sitting position. This leads to Low Back Pain (LBP) [3] and upper back pain [4] of their body region. Watson et al. [5] conducted a cross-sectional study among 1446 children (age range 11-14 years) to the prevalence of low back pain. They showed 24% of students felt low back pain. They also showed that girls feel higher pain than boys do. Parvez et al. [6] conducted a study on Bangladeshi primary students to fit the classroom furniture ergonomically. They found a significant mismatch between school furniture and students' anthropometric dimensions. They proposed new furniture dimensions that reduced mismatch percentage from 90% to 10%. Hoque et al. [7] carried out a study on 300 (150 boys and 150 girls) primary students in Bangladesh to find the mismatch percentages between furniture and anthropometric measurement. They found there is a considerable mismatch between seat heights and desktop heights of the existing furniture. This leads the pain on the posterior surface of the knee and shoulder region of the students. Baharmpour et al. [8] reported that desk height and seat height is higher than the comfortable limit. As the desk is higher for 92.5% of students and seat is higher for 98.4% of students. Besides this, seat depth was suitable for 84.6% of students. These results indicate that the existing furniture causes a negative impact on students on the sitting posture.

Ismaila et al. [9] conducted a study among 200 Nigerian primary school students to design desk and chairs in ergonomically. They found that most of the students used improper furniture. This furniture impact on various body regions of the student. Authors provided some additional anthropometric dimensions for designing the furniture ergonomically. Taifa and Desai [10] came up with comprehensive dimensions for designing adjustable classrooms furniture for engineering students in India. Authors expect that the new furniture helps to reduce musculoskeletal disorders and improve the performance of students in terms of concentration. The office workers spend about 89% time in sitting. Prolonged sitting posture can cause various health problems and musculoskeletal discomfort. Therefore, it is needed to observe sitting behavior. As a result, researchers are designed with a smart office chair. It can display sitting behavior and provide tactile feedback. It also will help to improve sitting behavior [11]. Noshin et al. [12] carried out a study to design an office chair for Bangladeshi people.

They collected anthropometric data from 500 people (250 male and 250 female) and found a lot of variation between body dimensions and furniture dimensions. Therefore, the authors developed an ergonomic office chair on the viewpoint of Bangladeshi people.

About 50% of the total students in Bangladesh are girls [13]. Therefore, there are a large number of secondary schools which are present for girl students. Many researchers study about high schools furniture and students (for both boys and girl combine) body dimensions. However, we are not aware of any research for secondary girl's schools furniture in Bangladesh. We believe it may be present in literature, however, we did not find in the electric database. As a result, the aim of this study is to evaluate the possible mismatch between the student (girls) anthropometric measurements and classroom furniture dimensions. It may also propose a new design of furniture based on the student anthropometric data. This furniture will help to reduce the mismatch percentages and suitable for most of the students.

2. Methodology

The study has carried out to explore the significant mismatch between secondary girl's students and their classroom furniture in Bangladesh. The new design furniture does not fit for all students, but it will be comfortable for most students.

2.1. Sample

In this research work, 375 students from three secondary girl's school were selected randomly. These schools located at Jashore, Bangladesh. The schools are Shamnagor girls high school, Jashore Govt girls school, and Kultia girls high school. Generally, the age range is 10-15 years. All students are physically fit and are in 6-10 classes. To conduct this study, written permission was taken from the author of the schools.

2.2. Measurement Techniques and Procedures

By a standard measurement, tape (steel) took twelve anthropometric measurements of students. The anthropometric measurement was collected while each student was sitting in an erect position on the seat with a flat surface, with barefooted. A handmade wooden scale was used to measure the height of the students. The tape (steel) was also used to measure the existing furniture dimensions. The Statistical Packages for Social Science (SPSS) version 21 also was used to calculate the minimum and maximum values, mean value, percentile value, and the standard deviation value. The demographic characteristics of the students are shown in Table 1.

Table 1. Demographic characteristics of the student's samples.

Age	Class	Students (Girls)
10:<11	6	75
11:<12	7	75
12:<13	8	75
13:<14	9	75
14:<15	10	75
Total		375

2.3. Anthropometric Measurements

Ergonomic furniture is design based on anthropometric measurements. In this study, the following twelve anthropometric measurements were considered to design furniture ergonomically.

Sitting Height (SH): It is the vertical distance from the sitting surface to the top of the head.

Shoulder Height (ShH): This is the vertical distance from the sitting surface to the top of the shoulder at the acromion.

Knee Height (KH): This is the vertical distance from the kneecap to the foot-resting surface.

Elbow Height (EH): The vertical distance from the seated surface to the bottom of the tip of the elbow (olecranon).

Buttock knee Length (BKL): The horizontal distance from the rearmost point of the buttock to the front of the kneecap.

Buttock Popliteal Length (BPL): The horizontal distance from the later surface of the buttock to the posterior surface of the knee

Elbow to elbow breadth/elbow width (EW): Horizontal distance between elbows across the lateral surfaces.

Hip Breadth (HB): The hip breath is the distance between the left to the right side of the lumbar during seated position.

Thigh Clearance (TC): The distance between a sitting surface and top the thigh in seated position.

Popliteal Height (PH): This is the vertical distance from the foot-resting surface to popliteal space.

Eye Height (EH): Vertical distance from the sitting surface to the pupil of the eye.

Stature (St): Distance measured vertically from the floor to top of the head.

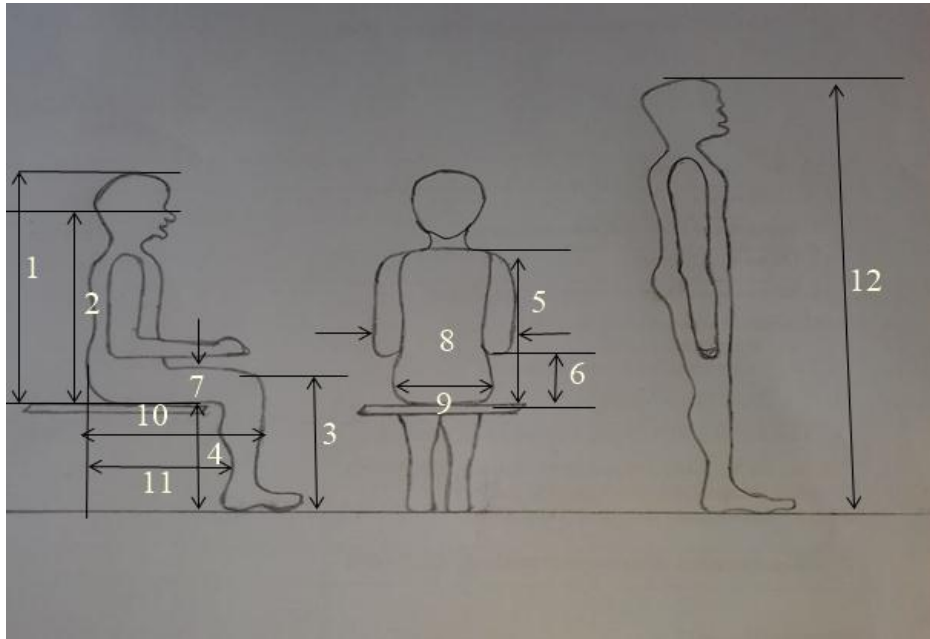


Figure 1. Anthropometric data required in classroom furniture design.

2.3. Existing Furniture Dimensions

Almost, girls' high school of Bangladesh provides benches to use their students in the classroom, these benches are made normally by wood. The benches are same dimension for all classes. The existing furniture dimensions are as follows:

Seat Height (SH): It refers to the vertical distance from the front edge of the seat to floor surface.

Seat Depth (SD): The horizontal distance from front of the sitting surface to back edge of it.

Seat Width (SW): It is the horizontal distance between the side edges of the seat.

Seat to Desk Height (SDH): It is the vertical distance from the sitting surface to the upper edge of the desktop.

Seat to Desk Clearance (SDC): The vertical distance from the top of seat surface to the top of the desktop.

Desk Width (DW): It is the horizontal distance between the side edges of the desk.

Desk Depth (DD): The horizontal distance from one side to other side edge of the desk.

Desk Height (DH): The vertical distance from bottom to top of the desk.

The existing wrong furniture is shown in Figure 2.

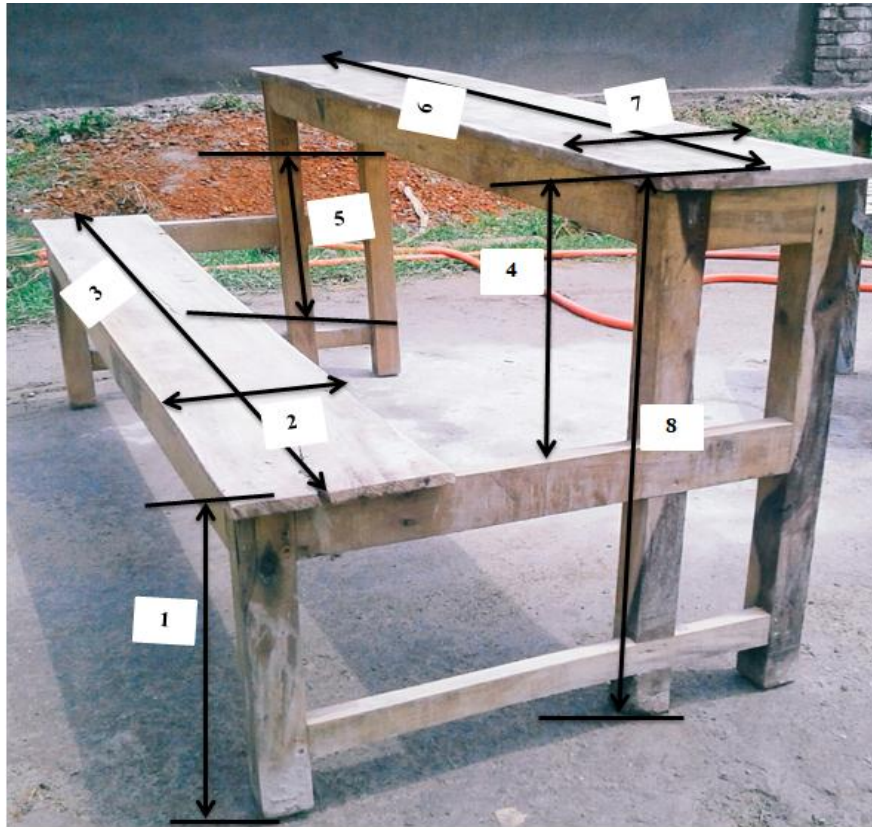


Figure 2. Existing classroom furniture measurements.

3. Classroom Furniture and Body Dimensions Mismatch

To design furniture in ergonomically it is essential to find the match and mismatch between existing furniture and anthropometric measurements. Various relationships have been recommended in the literature to identify the match or mismatch between classroom furniture and anthropometric measurements [14-16]. Among them, the following relationships are considered in this study.

3.1. Popliteal Height (PH) Against Seat Height (SH)

Researchers defined the seat height should be adjusted relative to the popliteal height. It is either >95% or <88% of the popliteal height [17]. Besides the knee angle, the vertical axes should be 5° up to 30°. In this research, 3 cm is added to the popliteal height due to the shoe. Therefore, the following relation could complete the design.

$$(PH + 3)\cos 30^{\circ} \leq SH \leq (PH + 3)\cos 5^{\circ}. \quad (1)$$

Here, PH is popliteal height and SH is seat height.

3.2. Buttock Popliteal Length (BPL) Against Seat Depth (SD)

Authors recommended the seat depth be considered as 5th percentile value of BPL [18]. Researchers also defined the seat depth as that is either <80% or >95% of the buttock popliteal length [17]. The following equation is used in this research.

$$0.80BPL \leq SD \leq 0.95BPL. \quad (2)$$

Here, BPL is buttock popliteal length and SD is seat depth.

3.3. Hip Breadth (HB) Against Seat width (SW)

However, almost secondary girl's school in Bangladesh used benches, as a result students need to lateral drive to relieve tiredness. Based on the literature, seat width should be designed according to the largest percentile of hip breadth [19]. So a matching principle is determined by the following equation.

$$1.10HB \leq SW \leq 1.30HB. \quad (3)$$

Here, SW is seat width and HB is hip breadth.

3.4. Sitting Elbow Height (SHE) Against Desk Height (DH)

Researchers recommended the desk height based on elbow height [20, 21]. It should be set as the 5th percentile sitting elbow height [17]. Some researchers recommended that the desk height should be 3 to 5 cm above sitting elbow height [18, 22]. The relations of those are given below by using the following equation.

$$SEH \leq DH \leq SHE + 5. \quad (4)$$

Here, SHE is sitting elbow height and DH is desktop height.

3.5. Thigh Clearance (TC) Against Seat to Desk Clearance (SDC)

The distance between seats to the desk is very important to design classroom furniture. It leads the students to free movement of legs. Researchers suggested keeping the desk height above 2 cm of the knee height [17].

In this study, a match criterion is recognized according to the relationship between TC and SDC.

$$(TC + 2) < SDC. \quad (5)$$

Here TC is the thigh clearance and SDC is the seat to desk clearance.

4. Results and Discussions

The descriptive statistics of the 250 students (girls) for class 6-10th are shown in Table 2. These statistics include minimum, maximum, average, and percentile values (5%, 50%, and 95%).

Table 2. Anthropometric measure (cm) of students.

Dimension	Class Level	Min	Max	Mean	5th Percentile	50th Percentile	95th Percentile	SD
Sitting Height	6	70	79	75.028	70	76.25	79	3.099
	7	70	86.5	73.5	70.545	78	82	4.086
	8	70	83	77.654	74	77.5	82	2.964
	9	73	85	79.038	74.725	80.05	82	2.719
	10	74	86.7	81.038	74.225	81.1	86.5	4.004
Shoulder Height	6	47	58	51.784	48	53	55	2.637
	7	48	62	50.5	49	55	60	3.299
	8	48	59	53.188	49.45	53	56.55	2.399
	9	50	60	54.186	51.835	54	58.55	2.078
	10	51	76	56.954	52	55.55	63.425	4.354
Knee Height	6	43	56	48.996	44	47.1	56	4.198
	7	32	53	41	36	47	53	5.813
	8	36	54	48.398	40.975	48	53.33	3.650
	9	45	58	50.182	45.725	50.85	53.91	3.062
	10	35	54.5	46.922	36	50.1	54	6.607
Sitting Elbow Height	6	15	36	21.061	18.725	20.25	25	2.891
	7	16	24	19.5	17.36	22	23.775	2.066
	8	15	36	21.061	18.725	20.25	25	2.891
	9	20	27.8	22.198	20	22	24.275	1.598
	10	20.5	28	23.972	21.225	24	27.775	1.739
Buttock Knee Length	6	37	46	41.608	37.225	42	45.865	2.583
	7	4	53	40	38	42	53	7.655
	8	38	58	49.034	41	50	57.82	5.153
	9	45.8	58.8	52.31	46.725	53	58	3.507
	10	40	53	42.6	40	42.75	44.32	2.481

Dimension	Class Level	Min	Max	Mean	5th Percentile	50th Percentile	95th Percentile	SD
Buttock Popliteal Length	6	33	48	40.144	35	40	47	3.738
	7	38	47.8	41.25	39.225	44	47	2.665
	8	38	50	42.89	40	42	49	2.722
	9	39	50.1	43.358	40	43	49.275	2.712
	10	39	48.5	44.418	39.635	46	47.91	3.095
Popliteal Height	6	31	48	38.328	31.9	36	47	5.026
	7	32	47	38.5	34	37	46	4.062
	8	39	54	44.088	40	43.5	50.55	3.400
	9	39.7	47	42.898	40	43	45.775	1.946
	10	34	50	43.974	38.725	44.5	50	4.422
Elbow to Elbow Breadth	6	29.8	44	38.274	30	42	43	5.412
	7	31	46	36	32	38	42.55	3.784
	8	32	51	38.89	32.45	38	49.685	4.932
	9	35.2	51	39.914	35.5	38	50	4.341
	10	35	56.1	41.212	35.725	40.5	55.665	5.287
Hip Breadth	6	24	38	30.366	25	31	35.55	3.703
	7	25	37.8	31	26	35	37	3.733
	8	26	43	34.26	30	34	42	3.649
	9	28	43	33.998	29.27	32.5	42.11	4.294
	10	30.5	70.5	35.478	31	34.9	40.665	5.671
Thigh Clearance	6	9	13	10.25	9.5	11.5	12.5	1.009
	7	9	13	10.25	9.5	11.5	12.5	1.009
	8	9	15	11.454	9	11	14.055	1.561
	9	9	15	11.674	9.68	11.85	14.32	1.494
	10	9	17	11.714	9	11.5	14.755	1.480
Sitting Eye Height	6	57	69	63.42	59	63.5	68	3.315
	7	60	74	62.5	60	65	70.65	3.274
	8	60	80.5	65.876	63	65	70.55	3.479
	9	58	80.5	67.578	62	64.8	79	6.327
	10	41.8	76	66.678	42.2	69.4	75.5	9.107
Stature	6	138	162	148.558	139	149.8	162	7.235
	7	140.5	162	141.75	142	154	160.275	6.458
	8	142	168.5	155.902	148.45	156	166.1	5.548
	9	147	170	158.316	148	158.25	168.55	7.186
	10	143	188.2	157.358	145	159	166.275	8.244

The dimensions of the existing classroom furniture are shown in Table 3.

Table 3. Dimensions (cm) for existing classroom furniture.

Furniture dimensions	Schools			
	School-1	School-2	School-3	Average
Seat height	48	46	47	47
Seat width	27	28	29	28
Seat depth	24.5	25	24.5	24.7
Seat to desk height	29	30	28	29
Seat to desk clearance	14	13	15	14
Desk width	29	28	29	28.7
Desk depth	36	37	35	36

Table 4 represents the mismatch percentage between the existing classroom furniture dimensions and the anthropometric measurements of school students. The results of this study show the considerable mismatch between student's body dimensions and existing classroom furniture. The highest mismatch percentage for seat height is found to be 90% for class 9. Therefore, 90% of girls used the seat that was too high (high mismatch). Mismatch percentage for seat depth is 100% for all classes. As a result, seat depth is so small for all students. Seat width is about 100% for class 8 and 60% for class 9. The desktop height is about 100% mismatch for all classes. Maximum seat to desk clearance matches for all classes. There is no back and hand rest support in the existing furniture. As a result, they feel discomfort attained of the class. They also face the problem during reading and writing.

Table 4. Match/Mismatch percentages for existing benches.

Furniture Dimension	Class Level	Match (%)	Low Mismatch (%)	High Mismatch (%)	Total Mismatch (%)	
					Total	Mean
Seat Height	6	14	0	86	86	79.2
	7	16	0	84	84	
	8	22	2	76	78	
	9	10	0	90	90	
	10	42	0	58	58	
Seat Depth	6	0	100	0	100	100
	7	0	100	0	100	
	8	0	100	0	100	
	9	0	100	0	100	
	10	0	100	0	100	
Seat Width	6	12	88	0	88	86.8
	7	4	96	0	96	
	8	0	100	0	100	
	9	40	60	0	60	
	10	10	90	0	90	
Desktop Height	6	0	0	100	100	94.8
	7	0	0	100	100	
	8	6	0	92	94	
	9	0	0	100	100	
	10	20	0	80	80	
Seat to Desk Clearance	6	98	2	0	2	7
	7	95	5	0	5	
	8	92	8	0	8	
	9	90	10	0	10	
	10	90	10	0	10	

Incorrect seat height dimension causes student's feet unable to reach the footrest. It also leads to force the student to lift their arms on the desk. It causes musculoskeletal disorders on shoulders.



Figure 3. Existing furniture condition.

According to the anthropometric measurements of the students (girls), we proposed the new furniture dimensions. Table 5 represents the proposed furniture dimensions. It also represents the match/mismatch percentages of anthropometric measurements.

Along with this study, it can be seen that as compared to the existing design, the proposed dimensions match better than previous and percentage has improved about 50% to 100%.

By comparing existing and proposed dimensions, it shows that the value of the mismatch decreased from class 6-10 are seat height (56.8%), seat depth (80.4%), seat width (84.4%), desk height (94.4%), and seat to desk clearance (0%) which is shown in Figure 4.

Table 5. Proposed dimensions (cm) for benches match/mismatch percentages for school students.

Furniture Dimension	Dimension	Class Level	Match (%)	Low Mismatch (%)	High Mismatch (%)	Total Mismatch (%)	Total	Mean
Seat Height	34-38	6	64	34	2	36		
	42-46	7	50	0	50	50	22.4	
	41.5-45.5	8	90	10	0	10		
	41-45	9	100	0	0	0		
	48.5-52.5	10	84	0	16	16		
Seat Depth	34.9-36.1	6	70	6	24	30		
	38.13-40.33	7	76	0	24	24	19.6	
	37.9-40.1	8	88	0	12	12		
	38.9-41.1	9	86	0	14	14		
	38.36-40.74	10	82	18	0	18		
Seat Width	29.55-41.55	6	100	0	0	0		
	31-43	7	100	0	0	0		
	36-48	8	98	0	2	2	2.4	
	31.11-36.11	9	90	10	0	10		
	34.67-46.67	10	100	0	0	0		
Desktop Height	15-25	6	100	0	0	0		
	17-27	7	100	0	0	0	0.4	
	15-25	8	100	0	0	0		
	17-27	9	98	0	2	2		
	19-29	10	100	0	0	0		
Seat to Desk Clearance	16	6	100	0	0	0		
	16	7	100	0	0	0	0	
	17	8	100	0	0	0		
	19	9	100	0	0	0		
	21	10	100	0	0	0		

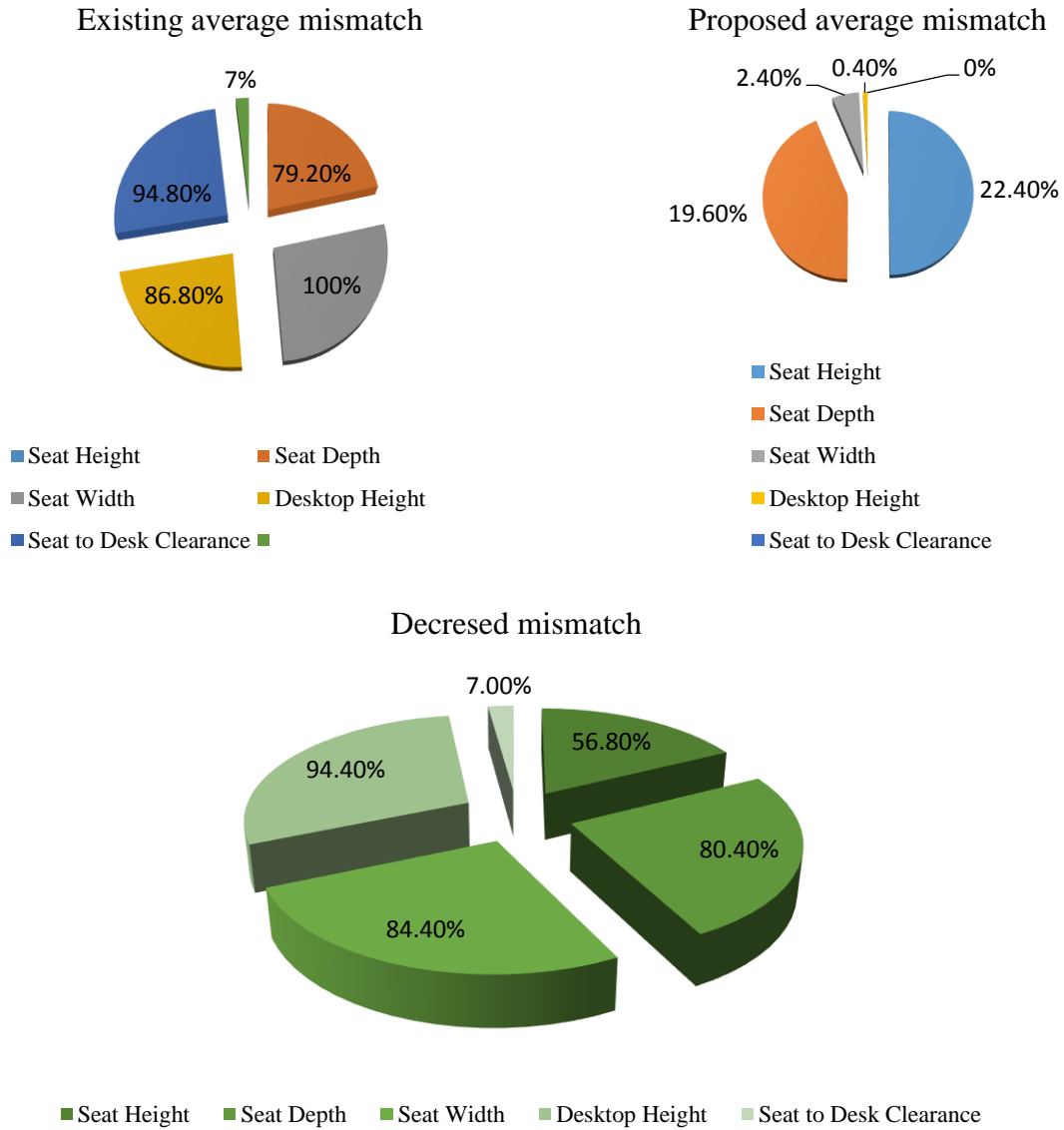


Figure 4. Comparison between existing and proposed dimensions (6-10 classes).

The new designed furniture is shown in Figure 5.

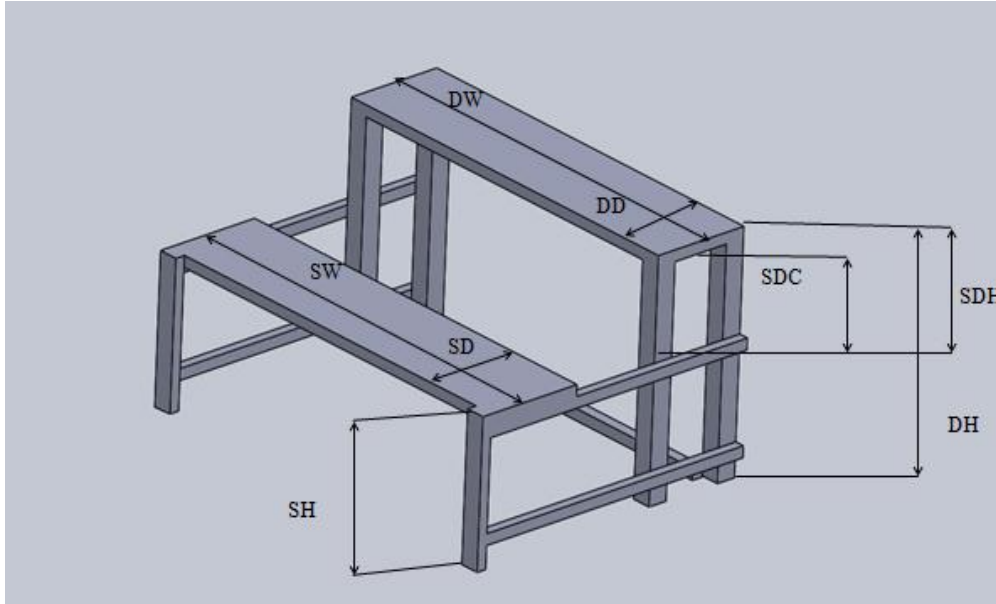


Figure 5. New designed furniture.

SH=Seat Height, SW=Seat Width, SD=Seat Depth, SDH=Seat to Desk Height, SDC=Seat to Desk Clearance, DH=Desk Height, DD=Desk Depth, DW=Desk Width.

5. Conclusions

The study evaluated the possible mismatch between classroom furniture dimensions and anthropometric characteristics of Bangladeshi secondary school students (girls). The study provided evidence that there is a considerable mismatch between anthropometric measurements of the students and the classroom furniture available to them. A considerable mismatch found between body dimensions (popliteal height, buttock-popliteal length, hip breadth, sitting shoulder height, sitting elbow height, and thigh clearance) of the school students and the existing classroom furniture dimensions (seat height, seat depth, seat width, desk height, and seat to desk clearance). The existing furniture was not appropriate for girls (especially seat height and desk height), which may arise against discomfort, fatigue, pain, and musculoskeletal problem during the study. In this thesis work, we tried our best to propose a new dimension for classroom furniture based on the anthropometric data. This new designed furniture reduced mismatch percentages and allowed students to sit more comfortably. For determining the seat height, the shortest distribution characteristics (5th percentile) data used. The acceptable range of seat height for class 6-10 are 34-38, 42-46, 41.5-45.5, 41-45, and 48.5-52.5 (with an allowance) that will be appropriate for 78% of students and also the range of desktop height for class 6-10 are 15-25, 17-27, 15-25, 17-27, 19-29 cm (with an allowance) that will be appropriate about 99% of students.

References

- [1] Farahani, A., & Shakib, M. (2009). A survey on some skeletal disorders and proportionality of anthropometric features to school furniture dimensions in primary students. *World journal of sport sciences*, 2(4), 266-71.
- [2] Troussier, B. (1999). Comparative study of two different kinds of school furniture among children. *Ergonomics*, 42(3), 516-526.
- [3] Grimmer, K., & Williams, M. (2000). Gender-age environmental associates of adolescent low back pain. *Applied ergonomics*, 31(4), 343-360.
- [4] Murphy, S., Buckle, P., & Stubbs, D. (2004). Classroom posture and self-reported back and neck pain in schoolchildren. *Applied ergonomics*, 35(2), 113-120.
- [5] Watson, K. D., Papageorgiou, A. C., Jones, G. T., Taylor, S., Symmons, D. P., Silman, A. J., & Macfarlane, G. J. (2002). Low back pain in schoolchildren: occurrence and characteristics. *Pain*, 97(1-2), 87-92.
- [6] Parvez, M. S., Parvin, F., Shahriar, M. M., & Kibria, G. (2018). Design of ergonomically fit classroom furniture for primary schools of Bangladesh. *Journal of engineering*. <https://doi.org/10.1155/2018/3543610>
- [7] Hoque, M., Parvez, S., Basahel, A., & Ahasan R. (2018). Anthropometry and mismatch issues with the elementary school children in Bangladesh. *Ergonomics international journal*, 9(5).
- [8] Baharampour, S., Nazari, J., Dianat, I., & AsghariJafarAbadi, M. (2013). Student's body dimensions in relation to classroom furniture. *Health promotion perspectives*, 3(2), 165.
- [9] Ismaila, S. O., Akanbi, O. G., Oderinu, S. O., Anyanwu, B. U., & Alamu, K. O. (2015). Design of ergonomically compliant desks and chairs for primary pupils in Ibadan, Nigeria. *Journal of engineering science and technology*, 10(1), 35-46.
- [10] Taifa, I. W., & Desai, D. A. (2017). Anthropometric measurements for ergonomic design of students' furniture in India. *Engineering science and technology, an international journal*, 20(1), 232-239.
- [11] Roossien, C. C., Stegenga, J., Hodselmans, A. P., Spook, S. M., Koolhaas, W., Brouwer, S., ... & Reneman, M. F. (2017). Can a smart chair improve the sitting behavior of office workers?. *Applied ergonomics*, 65, 355-361.
- [12] Noshin, L., Sen Gupta, H., & Kibria, M. G. (2018). Office chair design: a systematic approach of ergonomic design based on the anthropometric measurement of Bangladeshi people. *International journal of research in industrial engineering*, 7(2), 224-234.
- [13] Bangladesh's first internet newspaper. (n.d.). Retrieved July 24, 2019 from <https://bdnews24.com/bangladesh/2019/02/02/2.1-million-students-sit-for-ssc-examinations>.
- [14] Weiner, J. S., & Lourie, J. A. (1969). *Human biology, a guide to field methods*. ERIC.
- [15] Abeysekera, J. D. A. (1985). Design requirements and dimensions for a comfortable work seat for Sri Lankans. *Journal of the national science foundation of Srilanka*, 13(1).
- [16] Pheasant, S. (1991). *Ergonomics, work and health*. Macmillan International Higher Education.
- [17] Parcels, C., Stommel, M., & Hubbard, R. P. (1999). Mismatch of classroom furniture and student body dimensions: empirical findings and health implications. *Journal of adolescent health*, 24(4), 265-273.
- [18] Gouvali, M. K., & Boudolos, K. (2006). Match between school furniture dimensions and children's anthropometry. *Applied ergonomics*, 37(6), 765-773.
- [19] Evans, W. A., Courtney, A. J., & Fok, K. F. (1988). The design of school furniture for Hong Kong schoolchildren: An anthropometric case study. *Applied ergonomics*, 19(2), 122-134.
- [20] YMT, K. R. (2003). Revision of the design of a standard for the dimensions of school furniture. *Ergonomics*, 46(7), 681-694.
- [21] Dianat, I., Karimi, M. A., Hashemi, A. A., & Baharmpour, S. (2013). Classroom furniture and anthropometric characteristics of Iranian high school students: proposed dimensions based on anthropometric data. *Applied ergonomics*, 44(1), 101-108.
- [22] Castellucci, H. I., Arezes, P. M., & Viviani, C. A. (2010). Mismatch between classroom furniture and anthropometric measures in Chilean schools. *Applied ergonomics*, 41(4), 563-568.