Proceedings of 8th International Conference on Mechanical Engineering and Renewable Energy 2025
10-12 December, 2025, Chattogram, BANGLADESH

SciEn Conference Series: Engineering Vol. 4, 2026, pp 397-402 https://doi.org/10.38032/scse.2026.4.182

Ergonomic Design of Office Furniture Based on Anthropometric Measurement: A Case Study on KUET

S. Razaul Karim Raju[1,*], *Md. Golam Kibria*[1], *Md. Abu Bakkar Sikder*[2], *Md. Abu Syed Keron*[3] *and Rishikesh Chowdhury*[2]

[1]Department of Industrial Engineering and Management, Khulna University of Engineering and Technology, Khulna, Bangladesh
[2]Department of Mechanical Engineering, Chittagong University of Engineering & Technology, Chattogram, Bangladesh
[3]Department of Mechanical Engineering, Super Petrochemical Limited, Bangladesh

ABSTRACT

This paper explores the science behind improved interaction between employees and their use of furniture in an office setting, particularly when sitting in the same position for extended periods. It is also capable of designing safe and secure office furniture, by which a worker can maximize their effort and feel comfortable. This paper proposes a methodology and guidelines for the design of ergonomically fitted office furniture for office employees at KUET. Fifteen anthropometric measurements of 135 employees were used to improve the design and adjustability of twelve features of office furniture. The design and motion study of recommended adjustable office furniture was performed by using Solid Works. This paper also shows the comparison between the designed and existing office chair and desk of KUET. The main objective of this paper is to design ergonomic office furniture that will reduce musculoskeletal discomfort, fatigue, and ensure the human comfort of office employees at KUET.

Keywords: Anthropometric Measurements, Ergonomic Design, Musculoskeletal Disorders, Office Furniture

1. Introduction

Modern offices are designed through desk-and-chair setups, whose prolonged use contributes to rising occupational health and safety concerns. These issues often reduce employee performance and satisfaction, whereas research consistently links improved workplace ergonomics and physical environments to higher productivity. Ergonomics is the science and technology of fitting the activities and environment to the abilities, dimensions, and needs of people to improve performance while enhancing comfort and health, and safety [1]. Office designs vary throughout various organizations. Every office has similar lighting and heating setups, furniture and space configurations, and noise levels. The goal of this research is to create an ergonomic workstation and chair. Over time, office furniture designs evolved further, and by the middle of the 19th century, mass production and the Industrial Revolution had made it possible to produce chairs and tables in a wide range of sizes and shapes [2]. Anthropometry and ergonomics have been used to develop new furniture forms, which include task, or office desks and chairs, by incorporating adjustability in order to accommodate a wider range of people and the population. This is not only aimed at suiting a range of users, but also a range of postures [3]. In order to accommodate a larger population, anthropometry and ergonomics have been utilized to produce new furniture forms, such as task or office desks and chairs, by including adjustability. This is intended to accommodate a variety of postures in addition to a variety of users [4]. Even though many designs have made adjustability a top priority, by the early 1960s, the usefulness of adjustable furniture was up for debate when there were more than two dimensions to change and users were having trouble figuring out what fit best, a problem that is frequently made worse by weariness. Based on the anthropometric information that the designers had access to, a number of manufacturers started mass producing contemporary furniture by the early 1990s, particularly chairs in various sizes and proportions [5]. Anthropometric or human body measurements are used to determine the precise proportions of chairs and desks.

2. Methodology

2.1 Sample Selection

It is unrealistic to design office furniture that universally 'fits all,' yet equally impractical to create custom-made pieces for individual employees. This research, therefore, proposes ergonomic design guidelines suitable for all offices at KUET. For the experimental analysis, 135 male employees and 20 male teachers aged 25–40 were randomly selected from the departmental offices, central computer center, administration building, and medical center. Standard anthropometric techniques were employed to record body dimensions, with all measurements taken in relaxed, upright postures on a flat surface at a 90° flexion angle. To ensure accuracy, subjects wore T-shirts and shorts, and excessive clothing such as jackets, overalls, socks, and shoes was removed.

2.2 Description of Anthropometric Measurements

Total 15 anthropometric measurements are taken and description is given below:

*Corresponding Author Email Address: razaulkarim1624@gmail.com Published By: SciEn Publishing Group

1. Sitting Height (SH): This is the vertical distance from the tip of the head to the surface of the sitting object (stool). Using an anthropometric, the subjects were measured when sitting erect with their heads in the Frankfort plane, with their thighs parallel and the feet in line with the thighs, at a knee flexion angle of 90. The subjects' shoulders and upper arms are relaxed, and the forearms and hands are extended forward horizontally with the palms facing each other [6]. The sitting height is shown in figure 1.
2. Sitting Eye Height (SEH): This is the vertical distance from the sitting surface to the outer corner of the right eye [7]. The eye height is shown in figure 1.
3. Sitting Shoulder Height (SSH): This is the vertical distance from the top of the shoulder at the acromion process to the subject's sitting surface. The sitting shoulder height is shown in figure 1.
4. Sitting Elbow Height (SEH): This is the vertical distance from the bottom of the tip of the elbow (olecranon) to the subject's seated surface. The elbow height was measured at an elbow flexion angle of 90. The sitting elbow height is shown in figure 1.
5. Sitting Thigh Height (STH): This is the vertical distance between the surface of the stool and the highest point on the top of the right thigh. Using an anthropometric, the thigh clearance of the subjects was measured when sitting with their thighs parallel and the feet in line with the thighs, at a knee flexion angle of 90. The sitting thigh height is shown in figure 1.
6. Shoulder-Elbow Length (SEL): The vertical distance from the floor to the underside of the right elbow to the right acromion, with the elbow fixed at 90 degrees and the upper arm hanging vertically[8]. Shoulder-elbow length is shown in figure 1.
7. Elbow-Fingertip Length (EFL): The distance from the back of the right elbow to the tip of the extended middle finger, with the elbow fixed at 90 degrees. Elbow-fingertip length is shown in Figure 1.
8. Waist Depth (WD): Horizontal distance from the lower edge of the steering wheel to the seat back that is shown in figure 1.
9. Shoulder Breadth (SB): The maximum horizontal breadth across the shoulders between the lateral margins of the right and left deltoid muscles. Shoulder breadth is shown in figure 1.
10. Buttock-Popliteal Depth (BPD): This is the distance from the posterior surface of the buttock to the posterior surface of the popliteal surface. The buttock-popliteal length was measured at the knee. Buttock-popliteal depth is shown in figure 1.
11. Buttock-to-Knee Depth (BKD): This is the distance from the posterior surface of the buttock to the posterior surface of the knee [9]. The buttock-popliteal length was measured at a knee flexion angle of 90. The buttock-knee depth is shown in figure 1.
12. Sitting Knee Height (SKH): This is the vertical distance from the foot resting surface to the top of the knee cap [10]. This is measured just above the patella at a knee flexion angle of 90. The knee height is shown in figure 1.
13. Sitting Popliteal Height (SPH): This is the vertical distance from the popliteal space, which is the posterior surface of the knee, to the foot resting surface [11]. The popliteal heights of the subjects were measured at a knee flexion angle of 90. The popliteal height is shown in figure 1.
14. Distance Between Armrest (DBA): The horizontal distance between the right and left forearms**.**
15. Hip Breadth (HB): The hip breadth is the distance between the right side of the pelvis and the left side, measured when seated [12]. The hip breadth is shown in figure 1.

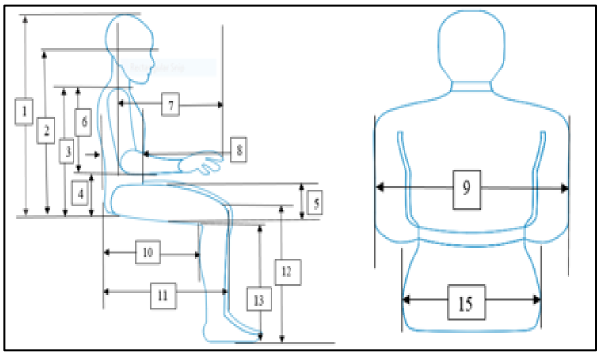

Fig. 1: Anthropometric measurements of human sitting posture.

2.3 Data Analysis

The collected anthropometric data were analyzed statistically using Microsoft Excel, and normal distribution curves of the collected anthropometric measurements were drawn to describe the standard deviation, where the level of significance was set at 0.05. The anthropometric data were analyzed using mean, minimum value, maximum value [13], standard deviation, 5th percentile, 50th percentile, and 95th percentile. The assessments of several features of existing office chairs are described by the bar chart, which is drawn through the Edraw Max software, where the percentage of the total assessments is also described.

2.4 Designing in Solid works

The recommended design of the office chair and desk is designed using Solid Works. All dimensions of the designed chair and desk are calculated according to the anthropometric measurements of human sitting posture. The motion study of the several adjustable features of the designed office chair, such as sitting surface height, sitting surface depth, armrest height and length, backrest height and angle, lumber height, etc., is performed by using Solid Works. The motion study of the several adjustable features of the designed office desk, such as desk height, desk clearance, is also performed by using Solid Works.

3. Data Collection and Analysis

3.1 Anthropometric Measurements of The Office Employee’s

The anthropometric measurements of the employees at KUET are presented in table 1 as means, percentiles (5th, 50th, and 95th). Furthermore, the mean and standard deviations are also included. The anthropometric dimensions and percentiles of various sitting postures are used to determine design values for an application.

3.2 Features and Dimensions of Existing Office Chair

The dimensions and features of existing chair at KUET are represented in table 2. Figure 2 demonstrates the existing office chair that is used by the employees at KUET.

Table 1: Dimensions of anthropometric measurements of human sitting posture for male (inch)

SL No.	Measurements	Total no. of employee, N= 135				
		Percentile			Mean	St. Deviation
		5th	50th	95th		
1	SH	29.8	32.1	34.6	32.24	1.479
2	SEH	25.7	27.7	30.2	27.93	1.349
3	SSH	19.3	21.1	23.2	21.19	1.185
4	SEH	6.8	8.6	10.4	8.575	1.022
5	STH	4.5	5.1	6.3	5.16	0.5751
6	SEL	11.6	12.8	14.2	12.84	0.8364
7	EFL	16.9	17.9	19.2	18.01	0.6952
8	WD	9.1	10.4	12.2	10.55	0.9272
9	SB	16.8	18.4	20.2	18.48	0.9369
10	BPD	16.6	18.0	19.3	18.03	0.7966
11	BKD	20.4	22.5	24.2	22.35	1.134
12	SKH	18.1	19.5	21.7	19.69	1.107
13	SPH	14.6	15.8	17.7	15.95	1.002
14	DBA	18.7	20.5	22.3	20.5	1.032
15	HB	13.7	14.7	15.8	14.72	0.6583

Table 2: Dimensions of existing office chair and desk

Feature	Dimension (inch)	Attribute
Seat Surface Height	18.0	Fixed
Seat Surface Depth	19.0	Fixed
Seat Surface Width	21.0	Fixed
Backrest Width	20.5	Fixed
Backrest Height	22.0	Fixed
Backrest Lumbar	7.0	Fixed
Backrest Angle	100^0	Fixed
Armrest Height	8.7	Fixed
Armrest Length	14.5	Fixed
Armrests Distance	20.5	Fixed
Desk Height	32.0	Fixed
Desk Depth	36.0	Fixed
Desk Clearance	26.0	Fixed

Fig. 2: Front view and side view of existing chair that is used at KUET

Figure 3 demonstrates the existing office desk that is used by the employees at KUET.

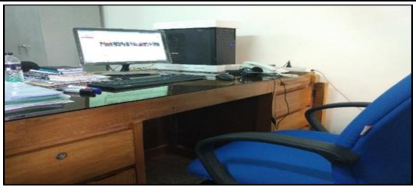

Fig. 3: Existing office desk that is used at KUET.

3.3 Assessment of Existing Chair

A total of 10 questions were prepared for the assessment of the present conditions of the office chair. Total 60 employees revealed their opinion about the present conditions of the existing office chairs. The questions were prepared with only “Yes” and “No” answers. The results of the assessment are described below:

1) Comfort for the Intended Period of Use: Almost 36.67% (percent) of employees described their office chairs are comfortable, and almost 63.33% (percent) of employees described their office chairs are not comfortable for an intended period of time.

2) Lower Back Support: Almost 38.33% (percent) of employees described their office chairs lower back (lumber support) that is adequately supported, and almost 61.67% (percent) of employees described their office chairs lower back (lumber support) that is not adequately supported.

3) Sufficiently Padded and Shaped to Prevent Pressures: Almost 41.47% (percent) of employees described their office chairs are sufficiently shaped, and almost 58.33% (percent) of employees described their office chairs are not sufficiently shaped to prevent uncomfortable pressure on thighs.

4) Sufficient Ranges and Types for Movement: Almost 30.00% (percent) of employees described their office chairs as having sufficient provision for movement, and almost 70.00% (percent) of employees described their office chairs are not sufficiently allowing for movement at the workplace.

5) Chair Height Adjustability: Almost 31.67% (percent) of employees described their office chairs height are height-adjustable, and almost 68.33% (percent) of employees described their office chairs are not properly adjustable.

6) Backrest Adjustability: Almost 26.67% (percent) of employees described their office chairs backrests are adjustable, and almost 73.33% (percent) of employees described their office chairs backrests are not adjustable.

7) Armrest Adjustability: Almost 56.67% (percent) of employees described their office chairs' armrests are adjustable at the required height, and almost 43.33% (percent) of employees described their office chairs' armrests are not adjustable.

8) Adequate Arm Movement on the Armrest: Almost 45.00% (percent) of employees described their office chairs' armrests are providing adequate space, and almost 55.00% (percent) of employees described their office chairs' armrests are not providing adequate space.

9) Physical Obstruction While Using the Chair: Almost 71.67% (percent) of employees described that they have faced several kinds of physical obstructions for using the existing chair, and almost 28.33% (percent) of employees described that there are no physical obstructions for using the chair.

Figure 4 describes all of the assessments of several features of existing office chairs that are used by the employees of KUET.

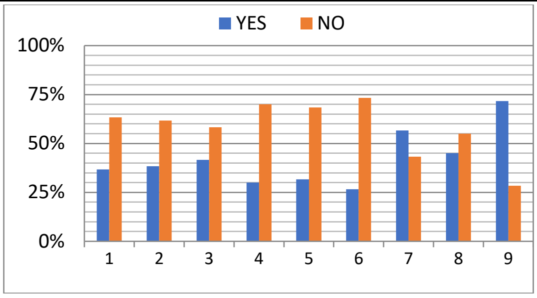

Fig. 4: Assessment of existing chairs at KUET

10) Employee Satisfaction with the Existing Office Chair: Almost 22% (percent) Employees are satisfied, and 36% are dissatisfied with the existing chair. Almost 27% employees are neutral, and 15% Employees are undecided about the existing office chair that is shown in figure 5.

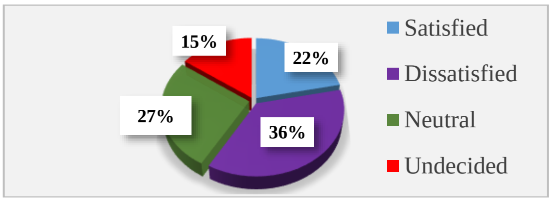

Fig. 5: Response on employee's satisfaction with office chair.

4. Discussions and Calculations

4.1 Features of the Office Chair

The study is about the requirements of anthropometric measurements, and percentiles of various body dimensions of human sitting postures are used to recommend a design for an application.

a) Seat Surface Height (SSH): The popliteal height is considered for designing seat surface height; the 5th percentile is used as the minimum and 95th percentile is used as maximum allowable seat height [6, 7]. Shoe allowance [8] 1.5 inches is added to the popliteal height.

b) Seat Surface Depth (SSD): The Buttock to popliteal depth is considered for designing seat surface depth; the 5th percentile is used as the minimum and 95th percentile is used as maximum allowable seat surface depth [6, 7].

c) Seat Surface Width (SSW): The hip breadth is considered for designing seat surface width; the 95th percentile [6, 7] is used as the minimum allowable seat surface width. Movement allowance 2.0 inches is added with the hip breath.

d) Backrest Width (BW): The hip breadth is considered for designing backrest width; the 95th percentile [6, 7] is used as the minimum allowable backrest width. Movement allowance 2.0 inches is added with the hip breath. The backrest width is equal to the seat surface width.

e) Backrest Height (BH): The Sitting shoulder height should be considered for designing backrest height; the 5th percentile is used as the minimum and 95th percentile is used as maximum allowable backrest height [6, 7].

f) Backrest Angle (BA): Backrest angle is used to add additional comfort for the operator of the office. The angle may be considered 90 degrees to 120 degrees [8] with respect to the seat pan for office work.

g) Backrest Lumbar Height (BLH): The sitting elbow height should be determined for designing backrest lumbar height; the 5th percentile is used as the minimum and 95th percentile is used as maximum allowable backrest lumbar support [6, 7].

h) Armrest Height (AH): The sitting elbow height is determined for designing armrest height; the 5th percentile is used as the minimum and 95th percentile is used as maximum allowable height of the armrest [6, 7].

i) Armrests Distance (AD): The distance between armrests is the determinant for designing armrests distance; the 5th percentile is used as the minimum and 95th percentile is used as maximum allowable distance of armrests [6, 7].

j) Armrest Top Surface (ATS): A supportive structure on the side of a chair.

k) Caster: Wheels that are used bottom of chair to move.

Figure 6 demonstrates the recommended sitting posture, optimal body angles, and appropriate distances, along with the arrangement of the chair, desk, monitor, and keyboard. Such configurations support efficient human function in the office, enhancing safety, comfort, and performance while reducing health risks.

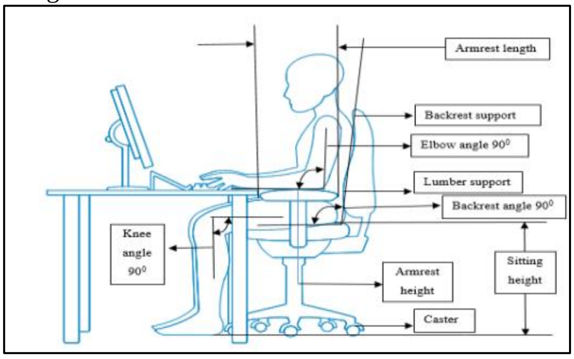

Fig. 6: Ergonomic sitting work posture

Figure 7 shows minimum dimensions (inch) of recommended office chair that is designed by using solidworks for KUET employees.

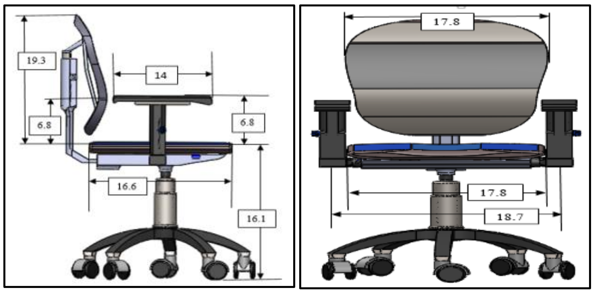

Fig. **7:** Minimum dimensions of recommended office chair

Figure 8 demonstrates maximum dimensions (inches) and the range of recommended office chairs that are designed using Solid Works for KUET employees.

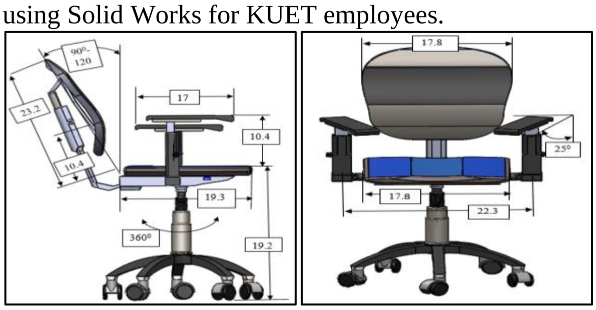

Fig. 8: Maximum dimensions and ranges of recommended office chair

4.2 Features of Office Desk

The study is about the determinants of anthropometric measurements and percentiles of various body dimensions of human sitting postures before the office desk is used to recommend a design for an application.

a) Desk Height (DH): The Popliteal height and Sitting elbow height should be considered for measuring desk height; the 5^{th} percentile is used as the minimum and 95^{th} is used as maximum of both anthropometric measures for allowable desk height [6, 7]. Shoe allowance [8] 1.5 inches is added to determine the desk height.

b) Desk Depth (DD): The shoulder-elbow length and elbow-fingertip length should be considered for measuring desk depth; the 5th percentile [8] of both anthropometric measures is used as the minimum allowable desk depth.

c) Desk Width (DW): No specific anthropometric measurements are required for determining desk width.

d) Desk Clearance (DC): The popliteal height and sitting thigh height should be considered for measuring desk depth; the 5^{th} percentile is used as the minimum and 95^{th} is used as maximum of both anthropometric measures for allowable desk depth. Shoe allowance [8] 1.5 inch and thigh movement allowance 1.3 are added to determine the desk clearance.

Figure 9 demonstrates the minimum and maximum dimensions (inches) of the recommended office desk that is designed by using Solid Works (2013) for KUET employees.

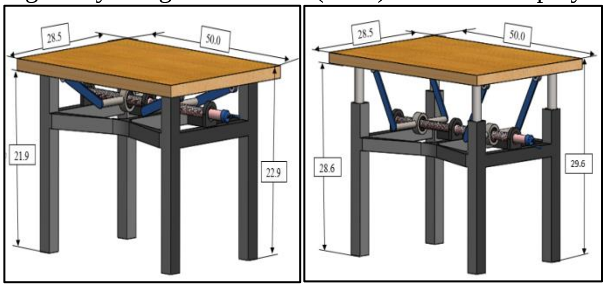

Fig. 9: Minimum and maximum dimensions of recommended office desk.

5. Result

The proposed office chair and desk, specifications of which are presented in Tables 3 and 4, are designed with full adjustability in height and angle.

Table 3: Adjustable ranges of recommended office chair features.

Features	Min (inch)	Max (inch)	Adjustable Range (inch)	Attribute
SSH	16.1	19.2	16.1 to 19.2	Adjustable
SSD	16.6	19.3	16.6 to 19.3	Adjustable
SSW	17.8	17.8	17.8	Fixed
BW	17.8	17.8	17.8	Fixed
BH	19.3	23.2	19.3 to 23.2	Adjustable
BA	90^0	120^0	90^0 to 120^0	Adjustable
BLH	6.8	10.4	6.8 to 10.4	Adjustable
AH	6.8	10.4	6.8 to 10.4	Adjustable
AL	14.0	17.0	14.0 to 17.0	Adjustable
AD	18.7	22.3	18.7 to 22.3	Adjustable
ATS	0^0	25^0	0^0 to 25^0	Adjustable
Caster	0^0	360^0	0^0 to 360^0	Rotate

The primary objective of this study is to develop a flexible, comfortable, and ergonomically optimized chair that promotes employee health, safety, and satisfaction while minimizing physical constraints experienced by KUET personnel. Likewise, the recommended desk allows height adjustment according to individual requirements, with sufficient depth to ensure complete hand reach to the far edge of the working surface.

Table 4: Adjustable ranges of recommended office desk features

Features	Min (inch)	Max (inch)	Adjustable Range (inch)	Attribute
DH	22.9	29.6	22.9 to 29.6	Adjustable
DD	28.5	28.5	28.5	Fixed
DW	50.0	50.0	50.0	Fixed
DC	21.9	28.6	21.9 to 28.6	Adjustable

Figure 10 demonstrates ergonomic combination of office chair and desk recommended for KUET office employees.

Fig. 10: Ergonomic combination of recommended office chair and desk.

6. Conclusion

This study uses Solid Works motion analysis and anthropometric measurements to provide an ergonomic redesign of office furniture for KUET staff members. Twelve adjustable elements of desks and chairs were improved using data from 135 employees, producing designs that better meet user needs than the furniture that is currently in place. It is anticipated that the suggested remedies will lessen fatigue, ease musculoskeletal pain, and improve general comfort during extended seated activities. The study highlights how crucial it is to employ localized anthropometric data when creating workplace furniture that is user-centered, safe, and effective.

7. References

[1] Tunay M. and Melemez K.: ‘An analysis of biomechanical and anthropometric parameters on classroom Furniture design’, *African Journal of Biotechnology*, 7 (2008) 8, 1081-1086.

[2] Parcells C., Stommel M. and Hubbard R. P.: ‘Mismatch of classroom furniture and students body dimensions: Empirical findings and health implications’, *Journal of Adolescent Health*, 24 (1999), 265-273.

[3] Helander, M. (2006). *A guide to human factors and ergonomics.* New York: CRC PressTaylor& Franci Group.

[4] R. Mehta and A. Sharma, “Anthropometric assessment for ergonomic design of university classroom furniture

in India," *International Journal of Industrial Ergonomics*, vol. 91, p. 103399, Apr. 2022.

[5] F. Rossi and T. Ahmed, "Postural comfort evaluation in adjustable and non-adjustable office chairs: An experimental study," *Applied Ergonomics*, vol. 108, p. 103887, Jan. 2023.

[6] M. Santos, J. Lee, and P. Tan, "Mismatch between furniture dimensions and anthropometric characteristics in Southeast Asia," *Human Factors in Design*, vol. 12, no. 4, pp. 55–66, 2021.

[7] M. Rahman, A. Hossain, and M. Ali, "Development of a digital anthropometric database for Bangladeshi industrial workers," *Journal of Occupational Safety and Ergonomics*, vol. 31, no. 2, pp. 149–160, 2024.

[8] J. Park, S. Kim, and H. Lee, "Cross-cultural anthropometric comparison for ergonomic product design," *Ergonomics*, vol. 66, no. 7, pp. 989–1003, 2023.

[9] T. O. Adamu and S. O. Aluko, "Ergonomic evaluation and redesign of office furniture for improved posture and comfort," *Heliyon*, vol. 10, no. 1, e17129, Jan. 2024.

[10] N. F. Yusoff, M. S. Jaafar, and N. Hashim, "Evaluation of seating comfort and musculoskeletal discomfort among office workers," *International Journal of Human Factors and Ergonomics*, vol. 11, no. 2, pp. 145–158, 2023.

[11] S. Choudhury, M. Saha, and K. Roy, "Anthropometric considerations for ergonomic furniture design: A case study in Bangladesh," *Engineering Science and Technology, an International Journal*, vol. 34, pp. 200–210, 2024.

[12] P. Nguyen and L. Tran, "Design of sustainable office furniture based on local anthropometric data," *Journal of Sustainable Design and Manufacturing*, vol. 7, no. 3, pp. 189–198, 2022.

[13] H. W. Huang and C. L. Tsai, "An ergonomic approach to office furniture design using virtual anthropometry," *Computers & Industrial Engineering*, vol. 176, p. 109053, Sept. 2023.