Analysis of Anthropometric Dimensions for Sitting Posture and Chair Design: A Review

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Abstract- The purpose of this paper is to discuss various anthropometric dimensions that must be considered before designing a chair. Chairs are used everywhere from schools, colleges, offices, industry etc. People spent a lot of time sitting on chairs continuously and doing monotonous work. If their sitting posture is not proper it could lead to several health hazards, discomfort, and loss of productivity. Sitting posture of people is deeply affected by the chair design and dimensions. If a chair is designed according to the ergonomic requirements of people the above mentioned problems can be avoided.

Keywords – Anthropometric Dimensions, Sitting posture, Ergonomics.

I. INTRODUCTION

In industries, offices, schools, college's etc. people are often required to work for long hours continuously. This work often requires them to remain in certain positions like sitting continuously and to do monotonous work. This over the period of time not only reduces their efficiency and increases their chances of making mistakes, thereby reducing their productivity but also results in physical discomfort, poor posture etc. To avoid this, proper ergonomically designed sitting arrangement must be provided. The design of the sitting equipment (chair) must be such that it doesn't cause any inconvenience to the people and also provide the necessary comfort. As a result the designing of a chair is very crucial. Researching on abundant experimentation also proved improper sitting posture can hurt one's health, such occupational disease as strain of lumbar muscles, prolapse of intervertebral disc, etc. So comfortable chair which is suitable for body structure must be designed based on analyzing human's sitting posture.

The rest of this paper is organized as follows. Section 2 briefly reviews the literature on ergonomic chair design and anthropometric dimensions. Section 3 includes the analysis of sitting posture. Section 4 consists of chair design elements. Finally, conclusions are presented in Section 5.

II. LITERATURE REVIEW OF ERGONOMIC CHAIR DESIGN AND ANTHROPOMETRIC DIMENSIONS

In the paper "Anthropometric design of furniture for use in tertiary institutions in abeokuta, south-western Nigera" the authors S. O. Ismaila, A. I. Musa, S. B. Adejuyigbe and O. D. Akinyemi have designed chair and tables for higher institutions of learning in Nigeria based on the obtained anthropometric data using SPSS 16.0 statistical package.

In In the paper "Classroom furniture dimensions and anthropometric measures in primary school" the authors Georgia Panagiotopoulou, Kosmas Christoulas, Anthoula Papanckolaou and Konstantinos Mandroukas took the anthropometric measures of the students and the furniture dimensions and compared them in order to identify any incompatibility between them. Further they designed the chair and table according to the needs of the students based on the anthropometric measurements taken using SPSS.

In the paper "Research on Long-Term Office Chair Comfort Based on Posture Transform" the authors Xiangang Bi, Qun Wu, Yangyang Zhao and Haojie Zhou have discussed signal of posture transform to predicting subjective perceptions of long-term chair comfort. The signal of sEMG in the procedure of mutual transformation during six representative postures was recorded, and then analysis of correlation between the change of subject comfort and the index of sEMG show that the long-term comfort of sit could be judged by posture transform**.**

In the paper "Anthropometric Analysis of Classroom Furniture Used in Colleges" the authors Syed Asif, Qutubuddin S M , Hebbal S S have compared the classroom furniture dimensions to the anthropometric dimensions of the students. In this study, it was found that the five different models of furniture used were made without any anthropometric considerations and were found to be incompatible with the user population.

In the paper "An analysis of biomechanical and anthropometric parameters on classroom furniture design" the authors Metin Tunay and Kenan Melemez have found that there is a mismatch in the dimensions of the furniture's provided to the students and that of student's anthropometric dimensions.

In the paper "Evaluation of Students' Working Postures in School Workshop" the authors Adila Md Hashim & Siti Zawiah Md Dawal have concluded that school furniture and workstations should suit the students' body sizes and anthropometric body dimensions. In order to improve working posture and reduce factors that are associated with back pain, participatory ergonomic programs should be introduced in schools in terms of posture training or furniture modification.

In the paper "Anthropometry for Design for the Elderly" the authors Kamal Kothiyal and Samuel Tettey have discussed the design implications for elderly people and provide several examples of application of the anthropometric data. Statistics from around the world show that the proportion of elderly people in the population has been steadily increasing over the last decades. The results of the study are consistent with other studies related to the anthropometry of elderly people conducted in other countries.

III. ANALYSIS OF SITTING POSTURE

In order to design a chair which is suitable for sitting according to the anthropometry of a person, one must analyze the body constitution and sitting posture. While sitting one is supported by spine, buttocks, legs and feet.

A. Pressure on Spine:

Sitting for prolonged periods of time can be a major cause of back pain. Sitting is a static posture, which can add a tremendous amount of pressure to the back muscles and spinal discs. Additionally, sitting in a slouched-over or slouched-down position can overstretch the spinal ligaments and increase the pressure on your spinal discs. Sitting with your back relatively straight and with good support is essential to minimize the load (strain) on your back. Especially when you sit for prolonged periods of time, you need to provide your lower back with support for the inward curve of the lumbar spine (lordosis). Figure-1 shows the distortions of spinal column in different postures. No matter what kinds of postures (standing or sitting); distortions raised will bring discomfort to spinal column more or less.

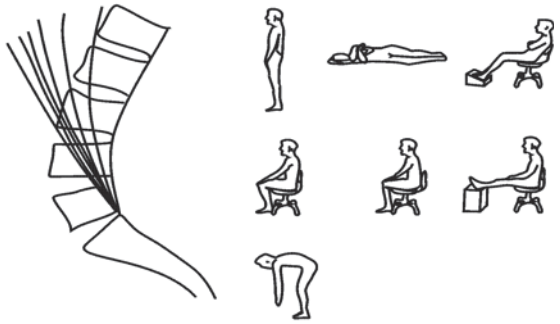

Figure 1. The distortion of spinal column in different postures.

B. The stress on haunch and legs:

In sitting posture, the weight of legs and trunk are supported by seat, actually two little rounded protuberance under pelvic hold most weight of body. The stress that hucklebone protuberance undertakes is the greatest and the stress diminish gradually when goes outboard, till the stress of thigh's underside which connects with the edge of seat is the least. As the main artery in legs pass through thigh's underside and the back of knee, if they are pressed, people will feel discomfort such as tumefaction and anesthesia. Experiment proved that the endure stress of hucklebone

protuberance is 1-2KG per cm^2 and that of thigh's underside is merely 50g per cm^2. So the protuberance of buttocks is the optimal position to undertake stress, the thigh should be avoided to undertake stress.

C. Anthropometric dimensions for sitting posture:

Certain anthropometric dimensions while sitting must be considered before designing of any chair. These anthropometric dimensions are mentioned below:

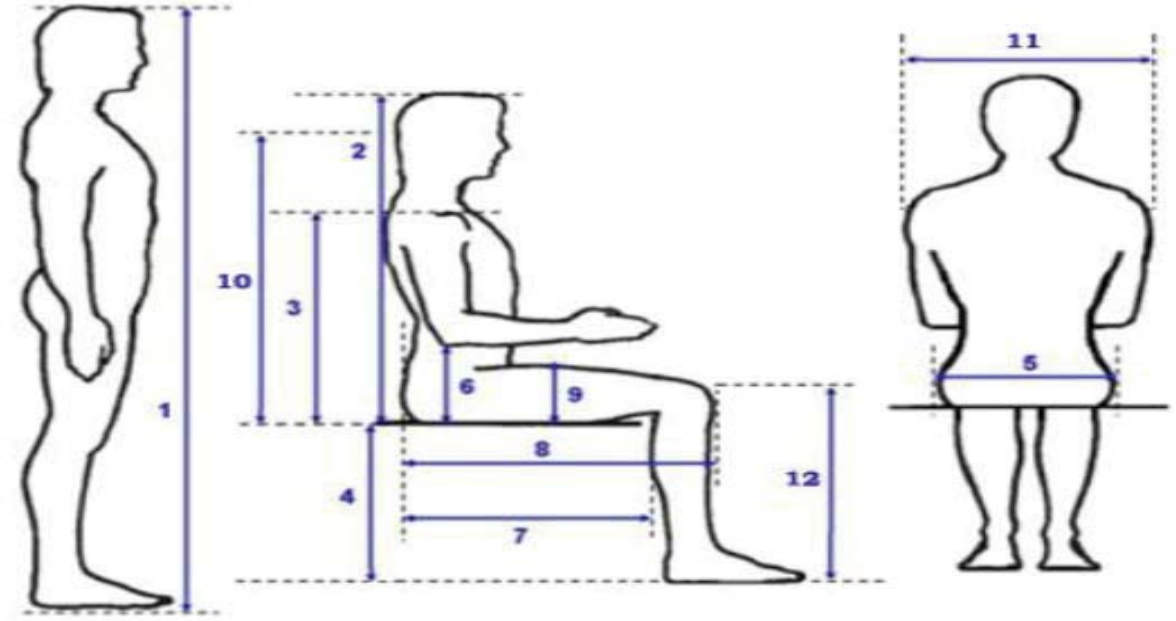

Figure 2. Anthropometry dimensions measured.

1. Stature: Top of the head, standing in erect stretched posture. The vertical distance from the floor to the vertex (i.e. the crown of the head)

2. Sitting height: Top of the head sitting in a normal relaxed posture.

3. Sitting mid shoulder height: Height of upper most point on the middle level of the shoulder.

4. Popliteal height: Height of the underside of the thigh immediately behind the knee.

5. Hip breadth: Maximum horizontal distance across the hips.

6. Elbow rest height: Distance between seat and lower most part of the elbow

7. Buttock popliteal length: Horizontal distance from the most posterior point on the uncompressed buttocks to the back of the lower leg at the knee

8. Buttock knee length: Horizontal distance from the most posterior point on the uncompressed buttocks to most anterior point on the knee

9. Thigh clearance: The vertical distance from the seat surface to the maximum bulge on the anterior surface of the thigh was measured with a shortened anthropometer.

10. Sitting eye height: Height of inner corner of the eye sitting in normal relaxed posture.

11. Shoulder breadth: Maximum horizontal distance across the shoulders,

12. Knee height: Height of uppermost point on the knee.

IV. CHAIR DESIGN ELEMENTS

Chair should be designed according to physiology for comfort, so chair design should include such elements as follows.

- Seat Height: Seat's height means a distance from ground to seat. The seat designed too high will strain muscles of legs and leave them stiff and sore, if the height of seat is so high that our feet lost contact with ground, and then muscles of our back also could be hurt. The height of seat should be designed to be higher than the length of calf.
- Seat depth: The chair seat depth is the horizontal distance from the back of the sitting surface of the seat to its front. The chair seat depth is calculated from the Buttock popliteal depth. There must be a clearance between the back of the knees and the front of the seat. The clearance should exist for approximately 4 to 5 inches, measured from the leading edge of the chair.
- Seat width: The chair width is the horizontal distance from the outer left side of the sitting surface of the seat to the outer right side. Hip breath is the considerable measure in case width. Seat width should hold the whole buttocks and one can adjust sitting posture in an easy manner.
- Backrest height: The backrest height is the vertical distance from the top side of the seat surface to the highest point of the backrest. The backrest height is calculated from sitting shoulder height. Chair back is a central key ergonomic element in chair design whose form and degrees are of importance for sitting posture and normal spine.
- Backrest angle: Sitting in Working chair needs ones bend forward under the support of waist back, so there is no need for shoulder back; while ones have to bend back in resting-chair leaning against shoulder and waist back; the inclination varies in different working conditions. Chairs back in bus can be designed 110 degrees, 95 to 100 degrees for students, 110 to 125 degrees for resting chair.
- Chair arms: Chair arms are very important and are used to support one's arm. They can be specially modified by altering the width of the chair arm or making it flexible as per requirement.
- Chair Feet: It's very important to keep balance for chair, so chair feet are designed to avoid sliding and falling on the ground.

V. CONCLUSION

The result shows that designing a chair involves a lot of considerations. Factors such as the working conditions, type of work, the anthropometric measurements and duration are important factors that must be considered while designing a chair. If the above mentioned factors are not considered then it may lead to human discomfort, health hazard and loss of productivity. So the design process for chair must be done by combining theory and mending data with practice under practical problems.

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