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Mismatch between Office Furniture and Anthropometric Measures in Ghanaian Institutions

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ABSTRACT: Workers spend about six to eight hours per day sitting down while doing their institution work.Mismatch between anthropometric dimensions and consumer products may cause health problems in human body.This study aimed to investigate whether institutions furniture dimensions match with Ghanaian worker's anthropometric characteristics in the Kumasi district of the Ashanti region in Ghana. A sample of 261 workers (163 males & 98 females) ageing between 24 to59 years were selected and analyzed on the basis of their anthropometry, 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.. It is possible that the high mismatch percentage found between furniture and workers' anthropometry can be associated to the fact that the acquisition and selection of the furniture was made without any ergonomic concern or criteria.

KEYWORDS: InstitutionFurniture, Anthropometric dimensions, Percentiles, Mismatch and Ergonomics

I. INTRODUCTION

Anthropometric data is a collection of the dimensions of the human body and are useful for apparel sizing, forensics, physical anthropology and ergonomic design of the workplace [1]. Anthropometric data vary considerably for individuals within a family or a nation and between nations [2]. Therefore, reliable anthropometric data for a target population were necessary when designing for that population otherwise the product may not be suitable for the user [3]. The use of anthropometry in design may improve the well-being, health, comfort, and safety of the user of the product [4-5]. The measurements necessary to determine the dimensions of school/institution furniture that will enable students/workers to maintain the correct sitting posture are popliteal height, knee height, buttock to popliteal length and elbow height [6, 7, 8]. Popliteal height is the main anthropometric dimension used in school/institution and other chair design and specification to determine appropriate seat height [9]. In designing a chair to suit a population, the popliteal-floor height is used to ensure that members of the population are able to sit with their feet supported on the floor, and without undue pressure behind the knees. Likewise, comparing the popliteal-floor height of an individual to the seat height of the available chairs can assist in selecting the most suitable size for that individual. Workplace furniture design and user anthropometry have become an important consideration in designing ergonomically appropriate furniture [10-11].

Mismatch between anthropometric dimensions and consumer products may cause such health problems in human body as musculoskeletal disorders, concentration deficit, and so on [12]. Some studies have shown a significant mismatch between consumer products and users' anthropometric dimensions [13, 8]. To achieve the aim of the study, the authors compare public institution workers' anthropometric measures to institution furniture dimensions and determine whether there is match or mismatch between them.

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Ergonomics is a science that is focused on the study of human fit, and decreased fatigue and discomfort through product design [14]. Ergonomics combine the knowledge obtained from the study of anatomy (structure of the body), psychology (the study or science of the human mind), physiology (the study of the way in which living bodies work) and anthropometry (the science of the measurement of human bodily dimensions as they relate to the three dimensional space in which the human operator works) to reduce the stress, improve performance, and reduce or eliminate hazards [15].

II. MATERIALS AND METHODS

The study areas are the three institutions: Kwame Nkrumah University of Science and Technology, Kumasi Polytechnicand Ministry of Lands and Natural Resources (made up of Forestry commission, Survey department and Lands commission), all in the Kumasi district of the Ashanti Region in Ghana (Figure 1).

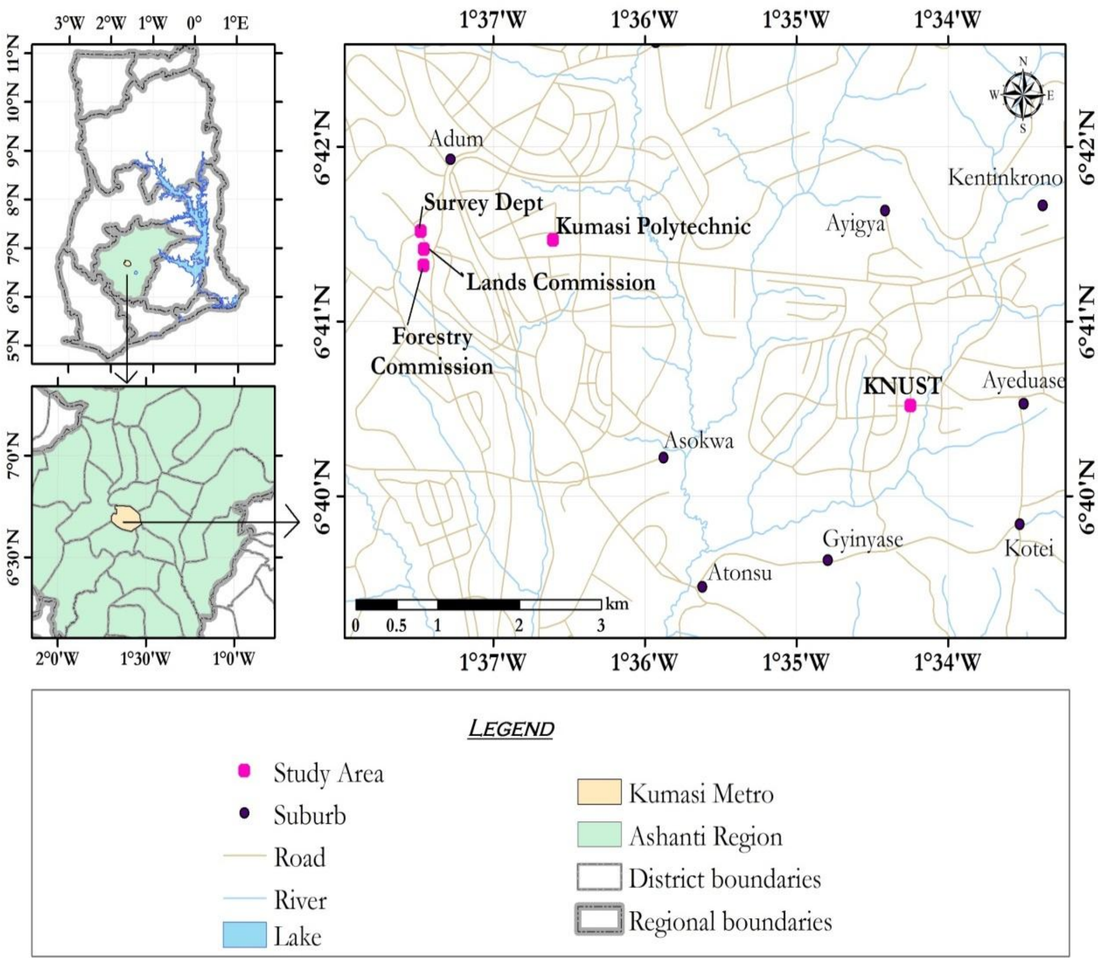

Figure 1: Study Areas

Kwame Nkrumah University of Science and Technology is situated N6.675267 and 1.565422W, Kumasi Polytechnic N6.691119 and W 1.610098, Forestry Commission N 6.688665 and W1.624343, Survey Department, N 6.69195 and W 1.624628, Lands Commission N 6.690225 and W 1.624283. All public workers in the studied institutions were approached and consents were sought from both institutional heads and workers before the data collection. In the institutions, measurements were collected in the administration building from administrative staffs.A total of 261 (163

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males, 98 females) subjects were used in the study. All measurements were taken in relaxed sitting positions. The unit for all the measurements was millimetre.
The institution office furniture used consisted of four models of desks and one model of chair (Figure 2).

MODEL 1: Desk with cabinet **MODEL 2**: Desk with double pedestals with dispensed lower stretcher rail

MODEL 3: Computer desk **MODEL 4**: Desk having flat sides frame with

pedestal unit and without lower stretcher rail

MODEL 5: Office chair
Figure 2: Models of desks and chair used

To consider whether there was mismatch between anthropometric and furniture measurements, Table 1 is used [7]. In the case of desk width and depth, no criteria were defined to compare with the anthropometric measure. Mismatch data

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is determined if the furniture dimensions are outside the mismatch decision: lower or shorter than minimum value and higher or taller than maximum value.Measurements of furniture taken in the offices (at the point of use)included seat height, seat depth, seat to desk height, backrest height, desk clearance, seat width and desk height [16]. Seat height (i.e. popliteal height), seat depth (i.e. buttock popliteal length), desk clearance(the vertical distance from the floor to the bottom of the front edge of the desk), maximum functional elbow height and maximum acceptable desk height are the common measurements considered in furniture design based on ergonomic principles [7]. Both measurements (furniture and anthropometric) took place at the same time.

Table 1: Description of Measurements in Furniture Design

Measurement	Calculation		Mismatch decision
Popliteal height(i.e. seat height)	Office chair	Popliteal height: 88 – 95%	Chair too low if measurement < 88%; Fit (88.01 – 95%); Chair too high > 95%
Buttock-popliteal length (i.e. seat depth)	Office chair	Buttock-popliteal length: 80 – 95%	Seat too shallow < 80%; Fit (80.01 – 95%); Seat too deep > 95%
Knee height and desk clearance	Office desk	Desk clearance minus knee height from the floor	No room for leg movement if Desk – knee < 20mm; Fit if > 20mm
Maximum functional elbow height (EH)	For all subjects	(Vertical elbow height x 0.8517) + (shoulder height x 0.1483)	
Maximum acceptable desk height (MADH)	Chair	EH + seat height	MADH – desk height Negative value = desk too high

Source: [7]

III. RESULTS AND DISCUSSION

The findings of the study are presented in tables and charts below.

Table 2: Dimensions of Office Chair (Model 5) in millimetres

	Seat height	Seat depth	Seat-desk height	Backrest height	Seat width
Mean	472.38	456.93	275.79	438.91	477.25
Std. Dev.	28.694	36.349	40.642	30.729	40.401
Variance	823.374	1321	1652	944.284	1632
Skewness	0.875	0.994	-0.945	-0.576	0.241
Std. Error of skewness	0.151	0.151	0.151	0.151	0.151
Kurtosis	0.295	0.168	1.337	0.533	-1.411
Std. Error of Kurtosis	0.300	0.300	0.300	0.300	0.300
Minimum	430	397	108	350	410
Maximum	565	550	350	530	545

Table 2 shows the average seat height from the three institutions estimated to be 472.38mm with a standard deviation of 28.69 about the mean. The variance of the seat height which is the square of the standard deviation was estimated to be 823.374. Thus the measure of the central tendency (near) gives an idea about the concentration of the values in the central part of the distribution. The measures of dispersion (standard deviation and variance) give the degree of scatter or variation of variables about the central value. The maximum seat height from the sample institutions was 565mm

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and the minimum seat height was estimated to be 430mm. The study further measured the principal characteristic of the seat height distribution by consisting skewness and kurtosis. Skewness was employed to measure the amount of departure from symmetry for each furniture dimensions. The coefficient of skewness for the seat height was estimated to be 0.875. The measure of kurtosis evaluated indicates the degree to which a curve of a symmetrical frequency distribution is peaked or flat-topped. Thus, "Kurtosis refers to the degree of peakedness of the hemp of the distribution". If the coefficient of kurtosis $\beta = 0$,the distribution is said to be normal curve (mesokurtic). If $\beta > 3$, the distribution is said to be more peaked and the curve is known as leptokurtic. If $\beta < 3$, the distribution is said to be flat-topped and the curve is known as platykurtic. It is also observed that, the coefficient of kurtosis of seat height is 0.295 which is clearly less than 3 hence one concludes the seat height distribution of flat-topped. Finally, the Table 2 also shows the measure of central tendency (mean), the measure of dispersion (standard deviation and variance), coefficient of skewness and kurtosis, the minimum and maximum value of all the variable of interest considered in the research.

Table 3: Number and Percentage (%) Workers who matched with Institution Furniture

No	Comparison between anthropometric dimensions and office furniture dimensions	Mismatch Workers	Mismatch %	Fit Workers	Fit %
1	**Kumasi Polytechnic**				
	Seat height (SH) and Popliteal to floor height (PFH)	26	28.89	64	71.11
	Seat depth (SD) and Buttock to popliteal length (BPL)	68	75.56	22	24.44
	Desk clearance (DC) and Knee height (KH)	90	100.0	-	-
	Desk height (DH) and maximum acceptable desk height (MADH)	34	37.78	56	62.22
2	**Ministry of Lands and Natural Resources**				
	Seat height (SH) and Popliteal to floor height (PFH)	8	8.99	81	91.01
	Seat depth (SD) and Buttock to popliteal length (BPL)	47	52.81	42	47.19
	Desk clearance (DC) and Knee height (KH)	89	100.0	-	-
	Desk height (DH) and maximum acceptable desk height (MADH)	5	5.60	84	94.40
3	**Kwame Nkrumah University of Science and Technology**				
	Seat height (SH) and Popliteal to floor height (PFH)	4	4.88	78	95.12
	Seat depth (SD) and Buttock to popliteal length (BPL)	30	36.59	52	63.41
	Desk clearance (DC) and Knee height (KH)	82	100.0	-	-
	Desk height (DH) and maximum acceptable desk height (MADH)	15	18.29	67	81.71

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Table 3 shows that seat height, which should be considered as the starting point for the design of office furniture, was appropriate for workers' popliteal-floor height in only 29%, 9% and 4% of Kumasi Polytechnic, Ministry of Lands and Natural Resources and Kwame Nkrumah University of Science and Technology respectively. Desk height was too high and mismatched 62%, 94% and 82% of the workers in the same order of institutions as stated already. Therefore, it was possible to conclude that the office's furniture was inadequate in almost all the analyzed cases and subjects There are many variations in body size among adults. The body dimensions should match with the furniture used in offices. Therefore, desks and chairs of different sizes should be made available to fit different adults. However, this is often difficult to do for a variety of organizational reasons. Provision of adjustable chairs and desks might appear a suitable solution, but some workers might have great difficulties in adjusting that furniture to their size and liking [17]. Moreover, adjustable seats and desks are costlier than the ordinary one. Many countries are unable to provide such furniture because of financial reasons. Therefore, it will be suitable to make fixed design of office furniture considering the anthropometric data of office workers.

Literature revealed that mismatch of high seat height may result in some of the workers not able to support their feet on the floor, generating increase tissue pressure on the posterior surface of the knee [18] which may discomfort and restrict blood circulation; or unnecessary spinal lean if too low [19]. Both shallow and deep seats were encounted in the study. For shallow seats, workers' thighs would not be supported enough and would generate discomfort [18], while in too deep seats, workers cannot avoid the compression on the posterior surface of the knee and workers will place their buttocks forward on the edge of the seat [20], causing kyphotic postures due to the wrong use of the backrest [18]. According to researchers, a good backrest, fitting the natural spinal curves, stabilizes the spine, facilitates lumbar lordosis and reduces kyphotic postures [21].

For desk clearance and knee height, there were hundred percent matches. The situation of match does not produce mobility constraint because of no contact of the knees with the desk [18]. In this particular study, the considered match criterion for the desk clearance was the knee height plus 20 mm.

As a result of mismatch between desk height and elbow rest height, workers are required to work with shoulder flexion and abduction or scapular elevation, causing more muscle work load, discomfort and pain in the shoulder region [18]. This situation will force workers to lift their arms and shoulders while writing. Also mismatch in elbow to seat height and desk height is significantly related to inappropriate sitting [22]. It is as a result of chair not designed in conjunction with the work surface. Inappropriate desk height refers to both the desk which is above and below compared to elbow rest height. Inappropriate desk height can cause elbow, shoulder and neck pain.

IV. CONCLUSION

On the basis of the type of workers in the public institutions, obtained results and their analysis, the following conclusions can be drawn:

- Very high seats were found in the three institutions.
- Majority of the workers' desk were high.
- It is possible that the high mismatch percentage found between furniture and workers' anthropometry can be associated to the fact that the acquisition and selection of the furniture was made without any ergonomic concern or criteria.
- The study recommended accepted limit of minimum and maximum institution furniture dimensions which could match with worker's anthropometric dimensions.

V. RECOMMENDATIONS

- Owing to the use of ill designed furniture, public workers may face many problems as fatigue, muscular stress and pain/discomfort in different body part.
- Chairs of appropriate seat height should be provided to workers in all the institutions.

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- All administrative staffs should be provided with appropriate desks height required to work to avoid shoulder flexion and abduction or scapular elevation, causing more muscle work load, discomfort and pain in the shoulder region
- There should be the introduction of the compulsory biannual anthropometric measurements in all public institutions for provision of preliminary data that will help the authorities and manufacturers equip offices with appropriately dimensioned furniture.

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