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Research Article

Evaluation of the Ergonomic Properties of Seats in Two Selected Faculties of Nigerian University

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ABSTRACT

Background: The pattern of various seat differs in many ways, however, the ergonomic design of chairs ensures proper weight distribution of the occupant. Therefore, for classroom furniture to perform the function for which it was designed, namely weight bearing and stabilisation of the body both in static and dynamic seating, it has to be ergonomically designed.

Objective: To evaluate the ergonomic properties of furniture in two selected Faculties; the Faculty of Law (FL) and the Faculty of Health Science (FHS) of a Nigerian university.

Materials and Methods: Forty furniture (20 furniture each from the two Faculties) in the University of Nigeria, Enugu State, South-east Nigeria were randomly selected. Ten parameters were measured. The mean, standard deviation, arithmetic difference, percentage match and mismatch were calculated using an established standard.

Result: In five of the ten parameters considered, there are mismatch to (seat height, seat width, desk clearance, seat-to-desk distance and lumbar support) for FL and eight (seat height, seat depth, seat width, desk clearance, lumbar support, seat to desk, desk height, pan tilt) for FHS when compared to standard. Therefore, 50% match was seen in FL and 20% in FHS. T-Test shows significant difference between seat parameters in FL and FHS.

Conclusion: More than 50% of the classroom furniture in FL was more ergonomically accurate compared to the 20% ergonomically accurate furniture in FHS. Furniture in the FL posed less ergonomic hazard than FHS. Replacement of these furniture are therefore recommended.

Keywords: Ergonomics; Hazard; Musculoskeletal disorders; Seat parameters; University

INTRODUCTION

All over the world, seats vary reasonably in pattern and design, however the function is remarkably similar. All seats are designed to fixate and sustain the human body aligned in static and dynamic sitting positions [1]. Seats designed without ergonomic consideration places the body in a state of misalignment [2]. Often, the state of misalignment of the body is a learned process or habit that starts at an early age as a child in the classroom and worsens with time. Also, some prolonged activities such as sitting, standing with its associated stress often results to misalignment of the body. In overall, the misalignment of the body results to a variety of musculoskeletal problems that become chronic and interfere with accomplishing the tasks of everyday life [3].

Musculoskeletal Disorders (MSDs) are one of the most pervasive occupational hazards and are frequently encountered with improper postures such as prolonged sitting of about two hours without intermittent standing [4]. Since a student on the average spends about seven to ten hours sitting in a day, and approximately 15,000 hours sitting during school years [5], it is no wonder that studies have proven that MSDs are commonly found in students as well as other occupations [6-11]. Ergonomics deals with fitting work or study environment to the worker or student in order to achieve maximum productivity and prevent health deficits. It can also improve well-being, grades, comfort and decrease musculoskeletal disorders, and future chronic MSDs leading to a healthier student and a healthy society [12].

From the first authors' experiences of using of the furniture, and the opinion of students of the two faculties, reports of backache, back discomforts, and neck pain was noted. Amongst these reports

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above, evidence has shown that low energy and fatigue, reduced lung capacities, can be experienced through their constant use of ergonomically poor furniture [13]. For instance, Yousef et al. [14] reported that 59.1% of students had neck and back pains after class sessions. The prevalence of neck and back pain after a prolong time while seating, resulted in less amount of time student spent reading, and subsequently, it could be one of the possible factors that could influence students' performance during examinations.

It is believed that understanding the ergonomic principles of the classroom furniture is a starting point to provide evidence that would influence the university policy pertaining to seats and chairs to be ergonomically sound. We adopted an ideal ergonomic furniture dimension of anthropometric estimated from of British adults aged 19-65 which encompasses 5th to 95th percentile of all adults [15]. We adopted these anthropometric estimates because of the unavailability of comprehensive anthropometric estimates for Nigerians. This study therefore aims (a) to identify the different ergonomic properties of classroom furniture in selected faculties at a Nigerian University; (b) to identify the extent to which the furniture in the selected Faculties are ergonomically designed to match a selected ergonomic furniture design standard set by Pheasant [15] and Christoforo [16]; and (c) to ascertain the direct adverse implications on the users. This idea was built based on the self-report of students of back pain and neck pain after prolonged seating. Thus, the researchers hypothesised that there will be no significant difference between seat parameters in the two faculties considered. The findings will help determine if this complains of low back pain and neck pain is as a result of poor ergonomically designed seats or poor sitting posture of the student.

MATERIALS AND METHODS

The study was a cross-sectional descriptive study that employed random sampling. There are 20 classrooms, ten in each faculty (Faculty of Law and Faculty of Health Sciences) with a total of 240 classroom furniture in these two faculties located in University of Nigeria, Enugu state, Nigeria. We randomly selected 40 furniture from each of the 20 classrooms, two from each classroom by fish bowl method of random sampling. The target population for this study included all typical furniture in classrooms of both faculties totalling 240.Only furniture in classrooms were included only, excluding any in offices, libraries and laboratories.

This study was carried out in Faculty of Law (FL) and Faculty of Health Science (FHS) in a Nigerian University. These faculties were selected because they are the faculties that have the proposed "ergonomically' sound furniture across the campus. The dimensions listed below were measured using Goniometric tape. Two authors measured the dimension of the classroom furniture independently. An inter-rater coefficient was calculated, pearson's coefficient was 0.95. This is within the recommended range for excellent agreement [17].

The dimensions of the classroom furniture that were measured are the following (Table 1):

1. Chair height: This is the total height of the chair including backrest [18].
2. Seat height: Vertical distance from the floor to the highest point on the front of the seat [18].
3. Seat depth: Horizontal distance of the sitting surface from the back of the seat to the front of the seat [18].
4. Desk height: Vertical distance from the floor to the top of the front edge of the desk [18].
5. Desk clearance: Vertical distance from the floor to the bottom of the front edge of the shelf under the writing surface. This should be approximately ¾ the chair length, and when seated it should not be lower than 2cm to achieve maximum relaxation [18].
6. Pan tilt: This is the degree of upward tilt of the pan of the seat [18].
7. Lumbar support: This is the level of inward curve of the seat at the level of the lumbar spine [18].
8. Seat angle: This is the angle of inclination of the backrest from the seat [18].
9. Seat to Desk: Distance between the seat and desk [18].
10. Seat width: Horizontal distance from one edge of the seat to the other for a single individual [18].

Ethical consideration and permission were obtained from the Health Research and Ethics Committee of the University of Nigeria Teaching Hospital and the Dean of both faculties prior to the commencement of the study.

The percentage match and mismatch of furniture parameters of both faculties was determined using the criteria adapted from Parcells et al. [19] as follows; (a) a mismatch of furniture parameters was defined as any furniture parameter that was either <80% or >100% closeness to the standard [15,16]. A match however, was defined as any furniture parameter that was either >80% or <100% close to standard. The hypothesis for this study was that there is no significant difference between furniture in FHS and FL, to be determined using t-test.

Data analysis

The data was analysed using SPSS 20.0 version. The research questions and hypotheses were analysed using the descriptive statistics of mean and standard deviation. Inferential statistics of t-test was used to test for significance. Alpha level was set at <0.05.

RESULTS

Of the ten furniture properties considered, the following five (chair height, seat angle, desk height, pan tilt, and seat depth) properties were a perfect or very closely matched the standard and this amounted to a 50% match of furniture in the FL and the other five properties (seat height, seat width, desk clearance, seat-to-desk distance and lumbar support)showed a gross mismatch with seat-to-desk distance recording the highest (27.6%) mismatch (Table 2).

For furniture in the FHS as shown in Table 3, only two (chair

Table 1: Guidelines for Design of Ergonomically Ideal Classroom Seats. Adopted from Christoforo, [16]; Pheasant, [15]

Seat parameters	Chair height	Seat height	Seat depth	Backrest	Seat width	Seat to desk	Lumbar support	Pan tilt	Desk clearance	Desk height
Values	90 cm	40 cm	40 cm	105 deg	70 cm	40 cm	5 cm	5 deg	60 cm	76 cm

Table 2: Percentage match and mismatch between furniture parameters of Faculty of Law and standard by Pheasant (1998).

	Law		Standard	Percentage	Mismatch	Match
	N	XL	XS	XL/XS	<80>100	>80<100
Chair height	20	86.85	90	96.5	3.5	16.5
Seat height	20	41.50	40	103.8	3.8	0.0
Seat angle	20	103.20	105	98.3	1.7	5.3
Seat depth	20	39.10	40	97.75	2.25	17.75
Seat Width	20	43.60	40	109	9	0.0
Pan tilt	20	4.70	5	94	6	14
Desk clearance	20	70.60	60	117.7	17.7	0.0
Desk height	20	71.80	76	94.5	5.5	14.5
Seat to desk	20	51.05	40	127.6	27.6	0.0
Lumbar support	20	2.70	5	54	26	0.0

Key: Xl-mean value for faculty of law; Xs-Mean values for standard.

Table 3: Percentage match and mismatch between furniture parameters of Faculty of Health Science and standard by Pheasant (1998).

	FHST		Standard	Percentage	Mismatch	Match
	N	Xh	XS	XL/XS	<80>100	>80<100
Chair height	20	77.80	90	86.4	13.6	6.4
Seat height	20	43.00	40	107.5	7.5	0.0
Seat angle	20	101.90	105	97.0	3.0	17
Seat depth	20	28.80	40	72	8	0.0
Seat Width	20	-	40	-	-	-
Pan tilt	20	2.20	5	44	36	0.0
Desk clearance	20	70.90	60	118.1	18.1	0.0
Desk height	20	76.40	76	100.5	0.5	0.0
Seat to desk	20	26.60	40	66.5	13.5	0.0
Lumbar support	20	-	5	-	-	-

Key: Xh-mean value for Faculty of Health Science; Xs-Mean values for standard.

Table 4: Paired Samples T-test values for the different furniture parameters considered in both faculties and the level of significance.

Properties	Mean	S.D	df	S.E Mean	95% Confidence Interval of the Difference		t-cal	t-critic
					Upper	Lower		
Chair height	9.05	5.871	19	1.313	6.30	11.79	6.893	2.093*
Seat height	1.500	0.431	19	0.991	3.57	0.57	1.514	2.093
Seat angle	1.30	0.614	19	0.808	0.39	2.99	1.609	2.093
Seat depth	10.30	3.585	19	0.802	8.62	11.97	12.849	2.093*
Pan tilt	2.50	1.539	19	0.344	1.78	3.22	7.265	2.093*
Desk clearance	0.30	0.039	19	1.992	4.47	3.87	0.151	2.093
Desk height	4.60	2.247	19	2.068	8.92	0.27	2.225	2.093*
Seat to desk	24.45	10.221	19	2.286	19.66	29.23	10.698	2.093*
Lumbar support	2.70	0.923	19	0.206	2.26	3.13	13.077	2.093*
Seat width	43.60	30.829	19	2.539	20.13	18.13	15.356	2.093*

Key: *Significant; t-cal (t-calculated); t-critic (t-critical is derived from table and its value is 2.093).

height and seat angle) of the ten parameters observed were perfect or closely matched the standard, and this amounted to 20% match, on the other hand, Eight (seat height, seat depth, seat width, desk clearance, lumbar support, seat to desk, desk height, and pan tilt) did not match the standard.

Paired Samples t-test values for the different furniture parameters considered in both faculties and the level of significance was shown in Table 4. No significant difference was seen in the mean of three parameters; seat height, seat angle and desk clearance of both faculties. On the other hand, the difference perceived in the mean of the seven parameters; chair height, seat depth, pan tilt, desk height, seat width, seat to desk distance and lumber support was significant and therefore not due to chance.

DISCUSSION

The purpose of this study was to evaluate the ergonomic properties

of furniture in two selected faculties in a Nigerian university and explore the determinants of their relationship with the standard ergonomic furniture design.

The finding of this study shows the percentage mismatch of the furniture in FL with that of the standard. It can be seen that of the ten furniture features considered, faculty of law had mismatch in five parameters compared to standard set by Pheasant [15] and Christophoro [16]. The highest recorded mismatch was 27% and the lowest was 1.7% mismatch, with the cumulative match of 68.25%. These findings showed that of the ten parameters considered, five were (chair height, seat angle, desk height, pan tilt, seat depth) perfectly or very closely matches the standard up to 65% match, while the other five parameters (seat height, seat width, desk clearance, seat to desk, lumbar support)were considered mismatch falling below 80% and above 100% [18]. Therefore, this finding shows that the new furniture in FL was about 50% close to the ergonomic standard. The mismatch of these parameters has certain implications. First, a mismatch in seat height, seat width and desk clearance results in smaller (below 90 degree) angulations at the hip joint, and also creates smaller sitting room and leg space for each student. This mismatch is likely to cause hip and back pains among students as indicated in the study by Kumar, [20]. Second, insufficient lumbar support results in sitting with a round back, which if prolonged have been known to cause non-specific low back pain [5]. Finally, poor desk to seat ratiocreates an uncomfortable distance between the seat and desk, forcing the student to lean forward in attempt to use the desk, sustained usage in this position often results in forward head posture [21-25]. This posture affects the centre of mass of the students while sitting and often cause neck pains [25].

The findings also showed the percentage mismatch of the furniture in FHS with that of the standard. While two parameters (chair height and seat angle) had close match to the standard, eight parameters had a mismatch with the highest being 36% mismatch and the lowest being 0.5% mismatch and the cumulative match is 23.4%. This means that furniture in FHS was 20% close to standard. It had a match in seat angle and seat height. However, seat height, desk width, seat depth, pan tilt, desk clearance, desk height, seat to desk distance and lumbar support were all mismatch when compared to standard. The mismatch of these parameters has specific implications to long term users. Poor pan tilt implies inadequate support for the thighs, increased pressure on the Ischial tuberosities while seated for long periods of time. As a result, students are prone sitting on the edge of the chair to assess the table as a result of increased length between the seat and desk [21]. Absence of lumbar support also resulted in sitting with a round back and have been known to cause muscle imbalance with a number of other lower and upper back issues [5,26]. Notably, the furniture in both faculties lack flexibility, since the desks are permanently attached to the chairs. Good ergonomic classroom furniture should be easy to rearrange and adjustable to fit the anthropometric characteristics of different user and be adjustable to fit the class curriculum.

We failed to accept our null hypothesis that there will be no significant different between the furniture in the FHS and FL. There was no significant difference in three parameters; seat height, seat angle and desk clearance, however there was significant difference in the rest seven parameters considered. This implies that the expected MSDs and their presentations giving these predisposing factors differ between the two facilities. While students in FL are more at risk to neck, arm and shoulder pains (based on the mismatch), those in FHS are more at risk to developing upper and low back pains, thigh cramps, and increased pressure on Ischeal tuberosity. This is in line with Jones et al. [27]who attributed these MSDs to a number of factors including poor sitting, resulting inapproximately 13 per cent of students having significant incidence of recurrent MSDs.

CONCLUSION

In conclusion, the findings of this study reveals that there was significant difference between the furniture in both faculties (FL and FHS) and when compared to an ideal ergonomic furniture, there are mismatch to the five parameters (seat height, seat width, desk clearance, seat-to-desk distance and lumbar support) for FL and eight (Seat Height, Seat Depth, Seat Width, Desk Clearance, Lumbar Support, Seat To Desk, Desk Height, Pan Tilt) for FHS. These accounts for 50% match for furniture in FL and 30% for furniture in FHS in relation to standard.

Study implication

Classroom furnitures are often designed by designers or architects, yet they lack any detailed knowledge of the human body and what happens in static or dynamic sitting. Therefore, when next the university is about to build classroom furniture for the school, ergonomic experts should be consulted to input knowledge on ergonomics. For now students experiencing such musculoskeletal problems are advised not to spend too much time when using this furniture, or to seek the more ergonomic in FL. More research work be done in other universities to check the ergonomic accuracy compared to a standard. The result of this research work be treated with importance as they reveal the conditions in which students study and action be taken by the University authorities to correct this problems.

CONFLICTS OF INTERES

No conflicts of interest were reported.

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