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Correlation between the compatibility of anthropometric design of educational furniture and low back pain in the faculty of physical therapy at Delta University: Cross sectional design

Amira H. Mohammed[1]*, Mohammed. R. M[2], Mohammed. H. S[2], Zakaria. A. A[2].

[1*]*Department of Physical Therapy for Pediatric Disorders, Faculty of Physical Therapy, Delta University for Science and Technology, Gamasa, Egypt.*
[2]*Student in Faculty of Physical Therapy, Delta University for Science and Technology, Gamasa, Egypt.*

***Corresponding author. Address: 69 Al Kaser Al-Ani Street, Cairo City. Tel +2(02) 01144495063. E-mail addresses: amira.hussien@deltauniv.edu.eg (A. H. Mohammed).**

ABSTRACT

Objective: This study aimed to determine the degree of correlation between the compatibility of the design of educational university furniture with the functional performance and pain in low back.

Methods: Fifty eight students participated in this study from all sexes (36 males and 22 females) with age ranged from 18 to 21 years. Their body mass index ranged from 18.5 to 24.9 kg/ m2. They were divided into three groups (group I, group II and group III) based on the type of educational furniture be used. All subjects in three groups and the educational furniture were conducted for anthropometric measurements by using Tape measurement. They were assessed for low back pain by Visual analogue scale (VAS), and functional disability by Oswestry low back pain disability questionnaire.

Results: The results of this study represent there were no significant relationships between the compatibility of anthropometric design of educational furniture and the pain and functional performance of low back pain

Conclusion: We could conclude the incompatibility of anthropometric design of educational furniture used in the Faculty of Physical Therapy at Delta University had no significant effects on the pain and functional performance of low back pain.

Keywords: *Anthropometric, design, educational furniture*

1. Introduction

Young youth spend from the third of their day assuming sitting position in university life (Parcells et al., 1999). There are different types of university furniture designs. Each one of these design should be meet the ergonomic principles to be healthier (Shah et al., 2013, Mohamed et al., 2010). The mismatching of university furniture design contributes to the several musculoskeletal problems including muscle spasm, neck pain and incorrect posture (Hoque et al., 2014, Trevelyan and Legg, 2010, Murphy et al., 2007, Lee et al., 2001, Jeong and Park, 1990, Westgaard and Aaras, 1984). Unsuitable measurements of ergonomic design of educational furniture may

negatively affect the physical status of their students, especially in reading and writing (Sepehri et al., 2013). In the Faculty of Physical Therapy at Delta University for Science and Technology, there are three types of educational furniture used by students. The first type was used in lectures hall (fig 1a). The second type was used in practical sections (fig 1b). Finally, the third type used in laboratory labs (fig 1c). So, this study aimed to determine the degree of correlation between the compatibility of the design of educational university furniture with the functional performance and pain in low back.

Figures (1a, 1b &1c): Types of educational furniture in the Faculty of Physical Therapy at Delta University for Science and Technology.

2. Material and methods

2.1. Subjects:

Fifty eight students participated in this study from all sexes (32 males and 22 females) with age ranged from 18 to 21 years. Their body mass index ranged from 18.5 to 24.9 kg/ m^2. They were divided into three groups (group I, group II and group III) based the type of educational furniture be used. This study was conducted in the period from February 2019 to April 2019.

They were recruited from several study levels in Faculty of Physical Therapy at Delta University for Science and Technology, Egypt, according to the following criteria:

- Group I: Twenty two students from all sexes (13 males and 9 females) used the first type of educational university furniture used in lectures hall (fig 1a).
- Group II: Nineteen students from all sexes (11 males and 8 females) used the second type of educational university furniture used in practical sections (fig 1b).
- Group III: Seventeen students from all sexes (12 males and 5 females) used the third type of educational university furniture used in laboratory labs (fig 1c).

Subjects in all groups did not have injuries in neck, back, upper or lower limb, inflammatory joint disease, surgical intervention for neck, back, upper or lower limb, neuropediatric or developmental disorders. Subjects in all groups were not athletes. Students had signed a consent form about the purpose of the study, its benefits and inherent risks, their committee with regard to time and money and Agreement to participate.

2.2. Instrumentations:

2.2.1. Tape measurement:

It was used to determine the subject's dimensions and educational furniture dimensions in centimeters (cm).

2.2.2. Weight scale:

It was used to determine the weight for every subject in kilograms (kg).

2.2.3. Visual analogue scale (VAS):

It was used to measure the intensity of back pain (Swartzberg, 2002).

2.2.4. Oswestry low back pain disability questionnaire:

It was used to determine the low back functional outcome (Fairbank and Pynsent, 2000).

2.3. Procedures:

After Subject permission, the subject conducted the following procedures:

- **Detection of the subject's weight and body mass index (BMI):**

- The tape measurement was installed on the wall by using pins. The stature was determined as the vertical distance between the floor and the top of the head and measured with the subject standing erect against the wall and looking straight ahead, (Castellucci et al., 2010).
- After the stature of the subject's had been measured, the subject was asked to stand on a weight scale to determine his weight in kilograms. The BMI was calculated as the ratio of the subject's height (in meter) and weight (in kilogram) i.e. weight/ height^2. The normal subject's BMI value should range from 18.5 to 24.9 kg/ m^2, (Sethi et al., 2011).

- **Detection of the subject's dimensions and educational furniture dimensions:**

-All dimensions were taken after four hour from the starting of the day use of the educational furniture for each type.

-The subjects assumed sitting position on the educational university furniture with the standardized instruction: "knee and elbow bent at 90°, feet supported on the floor and look straight ahead", fig (2 a), (Agha, 2010).

-The user furniture dimensions were measured as mentioned in table (1), fig (2a), (Agha, 2010).

Table (1): The user- furniture dimensions (sitting position).

Item	Definition
Elbow seat height (EH)	Measured with the elbow flexed at 90°, as the vertical distance from the bottom of the tip of the elbow to the student's seated surface
Shoulder height (H)	Measured as the vertical distance from the top of the shoulder at the acromion process to the student's sitting surface.
Upper arm length (UAL)	Difference between the elbow height and shoulder height.
Knee height (KH)	Measured with knee flexed at 90°, as the vertical distance from the foot resting surface to be top of the knee cap, just above the patella.
Popliteal height (PH)	Measured with a 90°, knee flexion, from the foot resting surface to the popliteal space, which is the posterior surface of the knee
Buttock-popliteal length (thigh length) BPL	Measured with the knee flexed at 90°, as the distance from the posterior surface of the buttock to the posterior surface of the knee or popliteal surface.

- Educational furniture dimensions (desk and bench) dimensions were measured as mentioned in table (2), fig (2b), (Agha, 2010).

Table (2): The educational furniture dimensions (sitting position).

Item	Definition
Seat height (SH)	Measured as a distance from the floor to the highest point on the front of the seat.
Seat depth (STD)	Measured from the back of the sitting surface of the seat to its front.
Backrest height (BH)	The vertical distance from the desk seat to the top edge of backrest.
Desk–seat height (DH)	The vertical distance from the seat to the top of the front edge of the desk.
Under-surface of desk height (UDH)	The vertical distance from the floor to the bottom of the front edge of the shelf under the writing surface.

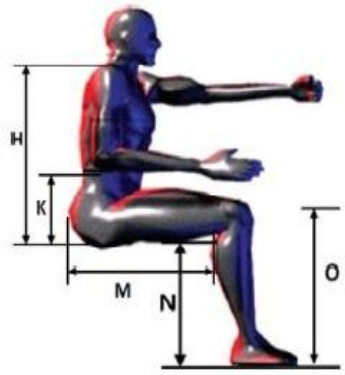

Fig (2a): Anthropometric dimensions measured: elbow-seat height (K); shoulder height (H); buttock-popliteal length (M); popliteal height (N); knee height (O).

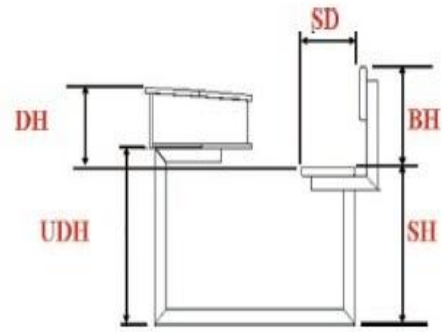

Fig (2b): Furniture dimensions (cm) showing the current SD = seat depth; BH = backrest height; SH = seat height UDH = under-surface of desk height; DH = desk height.

- **Relationship between educational furniture dimensions and the user body dimensions:**

The educational furniture dimensions and the user furniture dimensions were used to define the range in which each furniture dimensions is considered appropriate. It was done according to the following five ergonomics equations table (3), (Agha, 2010).

Table (3): Relationship between educational furniture dimensions and the user body dimensions

No	Relation	Ergonomics equation
1	Seat height to popliteal height	$(N+2)\cos 30° \leq SH < (N+2)\cos 5°$ Where SH is seat height and N is popliteal height.
2	Seat depth to the popliteal- buttock length	$80\%M \leq SD < 95\%M$ Where SD is seat depth and M is popliteal–buttock length.
3	Backrest height	$60\%\ H \leq BH < 80\%\ H$ Where BH is backrest height and H is shoulder height (scapula height).
4	Desk height	$K + (N + 2)\cos(30) \leq DH < (N + 2)\cos(5) + 0{:}8517K + 0{:}1483\ H$ Where DH is desk height, K is elbow–seat height, N is popliteal height and H is shoulder height.
5	Under-surface of desk height	$(O+2) + 2 \leq UDH$ Where UDH is the under-surface of desk height and O is the knee height

- **Detection the back pain and the functional ability of the upper extremity.**

The subject was asked to mark on the visual analogue scale (VAS) and determine the degree of pain he/she felt. Then he/ she was conducted to the Oswestry low back pain disability questionnaire lists of a 60 item patient questionnaire which assesses the amount of restriction pain imposes on 10 domains (Pain Intensity, Personal Care, Lifting, Walking, Sitting, Standing, Sleeping, Sex Life, Social Life, and Traveling). It was used to measure a patient's permanent functional disability. The test is considered the 'gold standard' of low back functional outcome tools (Fairbank and Pynsent, 2000).

2.4. Statistical analysis:

The mean value and standard deviation were calculated for each variable measured during the study. The percentage of compatibility for each item of the educational furniture dimensions to the user furniture dimensions was calculated. The Bivariate Correlations procedure computed Pearson- a parametric test, to test the correlation between the compatibility of the design of educational university furniture with the functional performance of the low back and pain and their significance levels.

3. Results

3.1.1. Descriptive data of three groups:

The distribution of males and females in the group (I) was 53.8% and 46.2%; respectively. The distribution of males and females in the group (II) was 46.4 % and 53.6%; respectively. Also, the distribution of males and females in the group (III) was 75% and 25%; respectively. The mean values ± standard deviations of the age, height, weight, body mass index (BMI), visual analogue scale (VAS), Oswestry low back pain disability questionnaire and the subject's dimensions indicated were represented in table (4). The mean values ± standard educational furniture dimensions indicated were represented in table (5).

Table (4): Descriptive analysis for the age, height, weight, body mass index (BMI), visual analogue scale (VAS), Oswestry low back pain disability questionnaire and the subject's dimensions three groups.

Item	Mean values ± standard deviations			Significance
	Group I	Group II	Group III	
Age	19.50 ± 0.60	19.21 ± 0.85	19.47 ± 0.51	0.344
Height	171.55 ± 9.83	168.37 ± 10.34	172.59 ± 7.62	0.363
Weight	65.80 ± 9.97	61.00 ± 8.48	66.32 ± 8.45	0.121
Body mass index (BMI)	22.16 ± 2.20	21.37 ± 1.64	22.58 ± 1.45	0.137
Visual analogue scale (VAS)	4.27 ± 2.78	4.16 ± 2.34	3.889 ± 1.63	0.043*
Oswestry low back pain disability questionnaire	19.64 ± 12.83	14.05 ± 7.31	15.98 ± 11.67	0.260
Elbow seat height (EH)	26.00 ± 3.37	21.11 ± 3.51	24.53 ± 4.32	0.000*
Shoulder height (H)	58.73 ± 3.68	53.89 ± 2.66	58.59 ± 4.21	0.000*
Upper arm length (UAL)	32.82 ± 4.79	32.79 ± 4.59	34.06 ± 4.16	0.636
Knee height (KH)	50.05 ±7.94	52.21 ± 2.74	53.65 ± 2.62	0.114
Popliteal height (PH)	46.73 ± 4.23	46.58 ± 2.97	51.35 ± 4.26	0.000*
Buttock-popliteal length (thigh length) BPL	47.41 ± 2.68	46.37 ± 3.77	47.62 ± 4.56	0.540
*significant.				

Table (5): Descriptive analysis for the subject's dimensions and educational furniture dimensions in three groups.

Item	Mean values ± standard deviations		
	Group I	Group II	Group III
Seat height (SH)	44.00 ± 0.00	47.50 ± 0.00	58.00 ± 0.00
Seat depth (STD)	33.00 ± 0.00	42.50 ± 0.00	0.00 ± 0.00
Backrest height (BH)	31.00 ± 0.00	38.50 ± 0.00	0.00 ± 0.00
Desk–seat height (DH)	32.00 ± 0.00	26.00 ± 0.00	33.00 ± 0.00
Under-surface of desk height (UDH)	72.00 ± 0.00	72.00 ± 0.00	72.00 ± 0.00

3.2. The percentage of compatibility for each item of the educational furniture dimensions to the user furniture dimensions.

The percentage of compatibility for each item of the educational furniture dimensions to the user furniture dimensions, table (6).

Table (6): Relationship between educational furniture dimensions and the user body dimensions

Relation		Group I		Group II		Group III	
		No	Per	No	Per	No	Per
Seat height to popliteal height	Compatible	11	50%	12	63.16%	0	0%
	Incompatible	11	50%	7	36.84%	17	100%
Seat depth to the popliteal- buttock length	Compatible	0	0%	13	68.42%	0	0%
	Incompatible	22	100%	6	31.58%	17	100%
Backrest height	Compatible	1	4.55%	1	5.26%	0	0%
	Incompatible	21	95.55%	18	94.74%	17	100%
Desk height	Compatible	1	4.55%	0	0%	0	0%
	Incompatible	21	95.55%	19	100%	17	100%
Under-surface of desk height	Compatible	22	100%	19	100%	17	100%
	Incompatible	0	0%	0	0%	0	0%

3.3. The correlation between the compatibility of the design of educational university furniture with pain and the functional performance of the low back.

Table (7): The correlation between the compatibility of the design of educational university furniture with pain and the functional performance of the low back.

		Oswestry low back pain disability questionnaire		Visual analogue scale (VAS)	
		Correlation coefficient	Sig. (2-tailed)	Correlation Coefficient	Sig.(2-tailed)
Pearson Correlation	Seat height (SH)	-0.097	0.468	-0.069	0.605
	Seat depth (STD)	-0.005	0.969	0.060	0.656
	Backrest height (BH)	0.002	0.990	0.061	0.650
	Desk–seat height (DH)	0.152	0.256	-0.020	0.880

** Correlation was significant at the 0.01 level (1-tailed)/* Correlation was significant at the 0.05 level (2-tailed).

Table (8): The correlation between pain and the functional performance of the low back.

Item		Visual analogue scale (VAS)	
		Correlation coefficient	Sig. (2-tailed)
Pearson Correlation	Oswestry low back pain disability questionnaire	0.184	0.167

** Correlation was significant at the 0.01 level (1-tailed)/* Correlation was significant at the 0.05 level (2-tailed).

Discussion

This study is the second topic in our research project to determine the effect of university furniture on the functional performance of the upper and back limbs and the measurement of pain ratio for all neck and lower back. It was conducted to determine the degree of correlation between the compatibility of the design of educational university furniture with the functional performance and pain in low back for students in the Faculty of Physical Therapy at Delta University. The age of the subjects participated in this study ranged from eighteen to twenty one years old as it represented the age of university life.

The result of this study showed that there were no significant differences between the mean values of the age, height, weight and body mass index (BMI) in all groups which supported there were matching between all groups. Also, the results of this study represented significant differences in the Elbow seat height (EH), Shoulder height (H) and Popliteal height (PH) and Visual analogue scale (VAS) while the were no significant differences between the mean values of the Upper arm length (UAL), Knee height (KH) and Buttock-popliteal length (thigh length) BPL. The results of this study showed that there was significant incompatibility of anthropometric design of educational furniture in the Faculty of Physical Therapy at Delta University.

The result of this study showed that there were no significant differences between the mean values of the Oswestry low back pain disability questionnaire in all groups. But the scoring of the Oswestry low back pain disability questionnaire in all group were in the range from 21% - 40%. It was considered as moderate disability according to the interpretation of the Oswestry low back pain disability questionnaire. These incompatibilities in the most of anthropometric designs of educational furniture may be had undesirable impact on the musculoskeletal system, posture and respiratory system in our youth.

The result of this study showed that there no significant correlation between the incompatibility of the design of educational university furniture and the Visual analogue scale (VAS) in all groups. Also, there was no significant correlation between the Visual analogue scale (VAS) and Oswestry low back pain disability questionnaire in all groups. These results come in agreement with researches mentioned that students complained of pains in the low back, neck or shoulder for which they attributed non-ergonomic furniture (Pheasant, 2016, Trevelyan et al., 2007, Kendall et al., 2005, Parcells et al., 1999).

Conclusion

We could conclude that there is incompatibility of anthropometric design of educational furniture used in the Faculty of Physical Therapy at Delta University.

Disclosure

Author(s) have not declared any conflict of interest.

References

Agha. S. R.: School furniture match to students' anthropometry in the Gaza Strip. Ergonomics, 2010; 53(3): 344–354.

Castellucci. I, Gonçalves. M. A and Arezes. P. M.: Ergonomic Design of School Furniture: Challenges for the Portuguese Schools. Applied human factors and ergonomics, 2010, 3rd international conference, USA.

Fairbank JCT & Pynsent, PB: The Oswestry Disability Index. Spine, 2000; 25(22):2940-2953.

Hoque. A.S.M., Parvez. M.S., Halder. P.K. and Szecsi. T.: Ergonomic design of classroom furniture for university students of Bangladesh, Journal of Industrial and Production Engineering, (2014). DOI: 10.1080/21681015.2014.940069.

Jeong, B. Y. and K. S. Park, "Sex differences in anthropometry for school furniture design," Ergonomics, 1990; 33, 1511–1521.

Kendall FP, McCreary EK, Provance PG, Rodgers MM, Romani WA. Muscles: testing and function with posture and pain. 5th ed. Philadelphia, United States: Lippincott Williams & Wilkins; 2005.

Lee, A., K. K. Tsang, S. H. Lee and C. Y. To, "Older school children are not necessarily healthier: Analysis of medical consultation pattern of school children from a territory-wide school health surveillance," Public Health, 2001; 115, 30–37.

Mohamed Thariq, M. G., H. P. Munasinghe and J. D. Abeysekara, "Designing chairs with mounted desktop for university students: Ergonomics and comfort," International Journal of Industrial Ergonomics, 2010; 40, 8–18 .

Murphy, S., P. Buckle and D. Stubbs, "A cross-sectional study of self-reported back and neck pain among English schoolchildren and associated physical and psychological risk factors," Applied Ergonomics, 2007; 38, 797–804.

Parcells, C., M. Stommel and R. P. Hubbard, "Mismatch of classroom furniture & student body dimensions: Empirical findings & health implications," Journal of Adolescent Health, 1999: 24, 265–273.

Pheasant S. Human anthropometry ergonomics and design. . hoobineh M Mouoodi Trans . 5th ed. Tehran nashr-emaraz; 2016.

Sethi. J, Sandhu. J. S and Vijay. I. V.: Effect of Body Mass Index on work related musculoskeletal discomfort and occupational stress of computer workers in a developed ergonomic setup. Sports Medicine, Arthroscopy, Rehabilitation, Therapy & Technology, 2011; 3:22.

Sepehri. S., Habibi. A.H., and Shakerian. S.: The relationship between ergonomic chair and musculoskeletal disorders in north of Khuzestan's students. Euro. J. Exp. Bio., 2013; 3(4): 181-187.

Shah, R. M., M. A. U. Bhuiyan, R. Debnath, M. Iqbal and A. Shamsuzzoha, "Ergonomics issues in furniture design: A case of a tabloid chair design," In A. Azevedo (ed), Advances in Sustainable and Competitive Manufacturing Systems, Lecture Notes in Mechanical Engineering, Springer, 2013; 91–103.

Swartzberg. R.: A symptoms based approach for diagnosis and treatment of low back pain. WB Saunders, Philadelphia, 2002, pp: 234.

Trevelyan, F. C. and S. J. Legg, "The prevalence and characteristics of back pain among school children in New Zealand," Ergonomics, 2010; 53, 1455–1460.

Westgaard, R. H. and A. Aaras, "Postural muscle strain as a causal factor in the development of musculo-skeletal illnesses," Applied Ergonomics, 1984; 15, 162–174.