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Correlation between the compatibility of anthropometric design of educational furniture and neck pain in the faculty of physical therapy at Delta University

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ABSTRACT
This study aimed to determine the degree of correlation between the compatibility of the design of educational university furniture with the functional performance of upper limbs and neck pain. 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/ m^2. 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 neck pain by Visual analogue scale (VAS) and the disability of the upper extremity by Upper Extremity Functional Index (UEFI). The results of this study represent there were significant relationships between the compatibility of anthropometric design of educational furniture and neck pain. We could conclude the incompatibility of anthropometric design of educational furniture used in the Faculty of Physical Therapy at Delta University had significant correlation with neck pain.

Keywords: *Anthropometric, design, educational furniture, neck pain, upper limb functions.*

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 of upper limbs and neck pain.

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 on 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, a history of inflammatory joint disease, surgical intervention for neck, back, upper or lower limb and 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:

2.3. 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 neck pain (Swartzberg, 2002).

2.2.4. The Upper Extremity Functional Index (UEFI):

It was used to determine the disability of the upper extremity (Stratford, 2001).

2.3. Procedures:

After Subject permission, each 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, each 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.

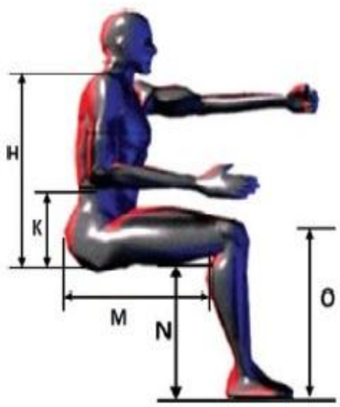

Fig (2a): Anthropometric dimensions measured: elbow-seat height (K); shoulder height (H); buttock-popliteal length (M); popliteal height (N); knee height (O).

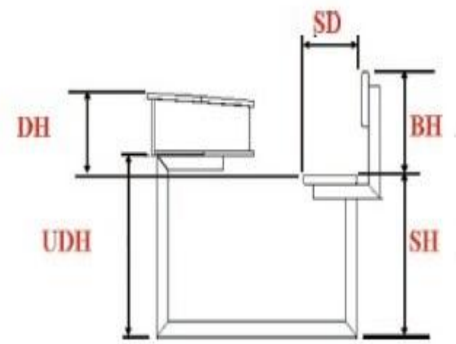

Fig (2b): Furniture dimensions (cm) showing the current SD = seat depth; BH = backrest height; SH = seat height; UDH = under-surface of desk height; DH = desk height.

- **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	$K + (N+2)\cos(30) \leq DH < (N+2)\cos(5) + 0{:}8517K + 0{:}1483H$ 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 cervical 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 Upper Extremity Functional Index (UEFI) questionnaire lists of 20 activities and the subject given a score to each based on the difficulty they have completing that activity. The scores given to the 20 questions were added to give a highest possible score of 80. The lowest possible score is 0. A lower score indicates that the person is reporting increased difficulty with the activities as a result of their upper limb condition (Stratford, 2001).

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 upper limbs and neck pain and their significance levels.

3. Results

3.1. 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), Upper Extremity Functional Index (UEFI) 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), Upper Extremity Functional Index (UEFI) 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)	4.09 ± 2.27	3.05 ± 2.61	2.29 ± 1.40	0.043*
Upper Extremity Functional Index (UEFI)	65.41 ± 9.67	65.16 ± 12.47	69.00 ± 6.11	0.435
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 the functional performance of the upper limbs and neck pain.

Table (7): The correlation between the compatibility of the design of educational university furniture with the functional performance of the upper limbs and neck pain

		Upper Extremity Functional Index (UEFI)		Visual analogue scale (VAS)	
		Correlation coefficient	Sig. (2-tailed)	Correlation Coefficient	Sig.(2-tailed)
Pearson Correlation	Seat height (SH)	0.164	0.219	-0.306*	0.019
	Seat depth (STD)	-0.170	0.202	0.215	0.105
	Backrest height (BH)	-0.171	0.199	0.223	0.093
	Desk–seat height (DH)	0.106	0.428	0.009	0.944

** 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 the functional performance of the upper limbs and neck pain.

Item		Visual analogue scale (VAS)	
		Correlation coefficient	Sig. (2-tailed)
Pearson Correlation	Upper Extremity Functional Index (UEFI)	-0.692**	0.000

** 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 of the upper limbs and neck pain 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) while there were no significant differences between the mean values of the Upper arm length (UAL), Knee height (KH), Buttock-popliteal length (thigh length) BPL and Visual analogue scale (VAS).

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 Upper Extremity Functional Index (UEFI) in all groups. 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 was negative significant correlation between the compatibility of seat height and the Visual analogue scale (VAS) in all groups. Also, there was strong negative correlation between the Visual analogue scale (VAS) and Upper Extremity Functional Index (UEFI) in all groups. These results come in agreement with researches mentioned that students complained of pains in the back, neck or shoulder for which they attributed non-ergonomic furniture (Pheasant, 2016, Murphy et al., 2007, Kendall et al., 2005).

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.

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