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Assessment Of The Posture Adopted By Office Workers Using L-Shaped Desks In Two Arrangements.

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ABSTRACT

This study aims to compare the posture of the head, upper back and upper limbs of office workers who use L shaped desks in two different ways: straight and concave part of the desk. Posture data were collected from 16 subjects by means of inclinometry and the results indicatethat regardless the position of VDUon the L table there are no differences in relation to the posture of head, upper back, and upper limbs in office workers.

KEYWORDS: Furniture, Office Work, Posture, Ergonomics.

1. Introduction

There is evidence of an association between computer use and musculoskeletal injuries (Ijmker et al., 2007). During computer use, forearm support has been recommended as an alternative to reduce static overload in the cervical and shoulder regions (Aaras et al., 1998; Visser et al., 2000; Delisle et al., 2006; Straker et al., 2009).

In this context, the curved design of L-shaped desks would provide adequate forearm support (Straker et al., 2009). However, the lack of training and guidance on the use of these desks results in different positions of the monitor and keyboard on the desk: workers may position themselves at the concave edge, the straight edge, or between these two positions (Moriguchi et al., 2014). Workers using the straight part of the L-shaped desk for computer use exhibit asymmetric support of the upper limbs compared to those using the concave part (Moriguchi et al., 2014). Through observational analysis, these workers also appear to have a higher risk of poor posture. However, direct measures are needed to confirm this hypothesis.

Therefore, this study aims to compare the head, upper torso, and upper limb posture of office workers using an L-shaped desk and positioning the computer in two different configurations: on the concave part and on the straight part of the desk.

2. Methods

2.1. Study Location And Participants

The study was conducted in the Department responsible for Distance Education at a University. Sixteen women working in the administrative sector of this department were evaluated. They primarily use computers, alternating between typing and mouse usage.

Inclusion criteria were being female, aged between 18 and 60 years, having a routine office work (at least 4 hours per day for 5 days a week), agreeing to participate in the study by signing the informed consent form. Exclusion criteria were BMI greater than 30 kg/m², being left-handed, not having a fixed workplace, and having undergone surgery in the last 6 months.

The research project was submitted to the Ethics Committee for Research with Human Subjects at the University.

Among the 16 evaluated workers, 8 positioned the computer on the concave part of the desk (GC) (Figure 1A), and 8 workers positioned the computer on the straight part (GR) of the L-shaped desk (Figure 1B and 1C). Furthermore, GR was subdivided based on the arrangement of the screen, keyboard, and mouse on the right or left side (Figure 1B and 1C). In Figure 2, participants during data collection can be observed.

Figure 1. Desk layouts, depicting different modes of use."

Figure 1A: Use of the concave part of the L-shaped desk. Figure 1B and 1C: Use of the straight part of the desk, subdivided into 1B: right support and 1C: left support.

Figure 2. Various ways of using the L-shaped desk...

Figure 2A: Use of the concave part of the L-shaped desk. Figures 2B and 2C: Use of the straight part of the desk, subdivided into 2B: right support and 2C: left support.

2.2. Equipment And Instruments

Initially, a questionnaire was administered, gathering information on gender, age, weight, height, hand dominance, education level, occupational history, presence of physical pain or discomfort, and lifestyle habits. Data on body mass, height, as well as anthropometric measurements and the positioning of the mouse, monitor, and keyboard were collected on an assessment form. A tape measure and ruler were used for anthropometric measurements and furniture evaluation.

Four triaxial inclinometer sensors and a data acquisition unit (Logger Teknologi HB, Akarp, Sweden) with a sampling frequency of 20 Hz were employed to assess postures and movements of the cervical spine, head, thoracic spine, and shoulders. Prior to data collection, the sensors were calibrated according to technical recommendations on a flat surface parallel to the ground for each of their faces, held for a period of 5 seconds (Hansson et al., 2001; Moriguchi et al., 2011).

A digital camera (Sony, 14.1 megapixels) was used for capturing photographs.

2.3. Evaluation Protocol

Initially, the questionnaire was administered to characterize the workers and apply the inclusion and exclusion criteria. Subsequently, anthropometric and furniture measurements were taken in both groups while the workers performed their usual activities. The workplace measurements obtained included seat height, seat width, table height, table width and length, distance from the popliteal fossa to the chair, distance from the monitor to the eyes, monitor height, and distance from the monitor, mouse, and keyboard to the front edge of the desk.

Anthropometric measurements were obtained with the worker sitting in a chair adjusted to a position where the hips and knees are at a 90° flexion, and their feet are flat on the ground. The following measurements were taken: eye level height, elbow height, shoulder height, thigh length, thigh height, and popliteal fossa height. The alignment between anthropometric and furniture measurements was defined according to Panagiotopoulou et al. (2004).

Head, cervical spine, thoracic spine, and shoulder postures were recorded during work using inclinometry. The inclinometer sensors were attached to the subjects using tapes and elastic bands. The head sensor was fixed at the center of the volunteer's forehead; the upper trunk sensor was fixed to the right of the seventh cervical vertebra (C7), and the shoulder sensors were fixed over the insertion of the deltoid muscle bilaterally.

For sensor calibration in volunteers, the following postures were adopted: the neutral reference position for the head and upper trunk (0 degrees of flexion-extension and inclination) consisted of the subject's upright posture, with the gaze fixed on a mark positioned at eye level 2 meters away from the subject. The indicative reference position for movement was the flexion of the head and thoracic spine. The neutral position for the upper limbs was reproduced with the subject seated, with the axilla supported on the backrest of the chair and the free arm in a vertical position. Supporting a 2 kg dumbbell ensures that the arm will be kept perpendicular to the ground. The indicative reference position for the direction of upper limb movements was the abduction of the arms to 90 degrees in the scapular plane (Moriguchi et al., 2011)

2.4. Data Analysis

Data were descriptively analyzed using measures of central tendency and variability. Kolmogorov-Smirnov tests were applied to test the normality of data distribution, and Levene's test was used to test homogeneity between group variances. The difference between groups was tested using a one-way MANOVA. The 10th, 50th, and 90th percentiles of head, upper trunk, and cervical spine flexion and inclination, as well as upper limb (UL) elevation, were compared. A significance level of 5% (α=0.05) was considered.

Regarding the time spent in the angular sectors of 30°, 60°, and 90°, differences between groups GC and GR were tested using the Mann-Whitney test, and between groups GC, GRD, and GRE using the Kruskal-Wallis test, as parametric assumptions were not met. Thus, the significance level was adjusted for the Bonferroni correction (α_{Bonf}=0.016). The data were analyzed using the SPSS 17.0 program.

3. Results

The personal and demographic data of the subjects are presented in Table 1, and the adequacy of anthropometric measurements to the furniture is shown in Table 2.

Table 1. Personal and demographic data of individuals included in the concave (GC) and straight (GR) groups. *Data presented as mean (standard deviation).

	GC (n=8)	**GR**(n=8)	**Total**(n=16)

Age (years) *	27,6 (3,2)	31,0 (4,4)	30,0 (7,2)
Weight (kg)*	61,2 (10,2)	74,7 (9,4)	66,8 (11,7)
Height (cm)*	161,0 (6,3)	166,8 (9,5)	163,4 (7,2)
Work experience (months)*	30,1(29,5)	39,3(21,6)	39,4(36,7)
Proportion of symptomatic individuals	4/8	4/8	8/16

Table 2. Adequacy of anthropometric measurements to furniture in the concave (GC) and straight (GRD and GRE) groups. Data presented as n (%).

	GC	GRD	GRE	Total
Chair Height				
Appropriate	0 (0)	1 (25)	0 (0)	1 (6)
Inappropriate	8 (100)	3 (75)	4 (100)	15 (94)
Table Height				
Appropriate	4 (50)	2 (50)	4 (100)	10 (62)
Inappropriate	4 (50)	2 (50)	0 (0)	6 (38)
Monitor height				
Appropriate	2 (25)	2 (50)	3 (75)	7 (44)
Inappropriate	6 (75)	2 (50)	1 (25)	9 (56)

The chair height was inadequate for all workers in the GC and GRE groups and for the majority of workers in the GRD group. Regarding the desk height, it was suitable for all workers in the GRE group and for half of the workers in the GC and GRD groups. The monitor height was inappropriate for the majority of the GC group and for half of the GRD group. The GRE group showed greater adequacy in this aspect. No significant differences were found between the groups (GC and GR) for head posture (P=0.06), upper trunk (P=0.36), and cervical spine (P=0.72) (Table 3). There were also no significant differences between the groups in the posture of the right (P=0.49) and left shoulder (P=0.80) and in the time spent in shoulder angles greater than 30º (P=0.62), 60º (P=1.00), and 90º (P=1.00) (Table 4).

Table 3. Mean values and standard deviation of head posture, cervical spine, and upper trunk in the concave part group (GC) and straight part group (GR), as well as for the straight part group with support on the right side (GRD) and left side (GRE), and for the total sample.

	GC	GR	GRD	GRE	Total
Head flexion					
10th percentile	4,2(5,3)	-2,4(5,0)	-3,3(2,2)	-1,6(3,1)	-1,0(5,2)
50th percentile	8,9(6,0)	5,7(4,7)	3,8(2,7)	7,7(1,7)	7,3(5,4)
percentil 90	22,8(6,9)	19,1(4,5)	15,9(2,0)	22,2(1,2)	20,9(5,9)
Head inclination					
10th percentile	-4,5(3,9)	-7,6(3,8)	-5,3(1,3)	-9,9(1,8)	-6,0(4,1)
50th percentile	8,5(2,9)	-1,2(2,5)	-0,1(0,9)	-2,3(1,5)	-1,7(2,9)
90th percentile	6,3(4,3)	4,0(3,4)	4,3(1,4)	3,8(2,2)	5,2(3,9)
Cervical spine flexion					
10th percentile	-8,9(7,4)	-15,2(8,0)	-16,9(2,9)	-13,6(5,2)	-12,1(8,1)

50th percentile	1,4(8,4)	-5,2(8,4)	-8,3(3,3)	-1,9(4,8)	-1,8(8,8)
90th percentile	14,7(8,4)	9,6(6,9)	6,2(2,3)	13,0(3,8)	12,2(7,9)
Cervical spine inclination					
10th percentile	-3,0(6,2)	-4,1(5,6)	-1,9(0,8)	-6,2(1,9)	-3,5(4,9)
50th percentile	3,9(4,2)	3,0(2,7)	4,2(1,1)	1,8(1,4)	3,5(3,4)
90th percentile	10,1(3,5)	9,1(3,7)	9,6(2,1)	8,6(1,8)	9,6(3,5)
Upper trunk flexion					
10th percentile	1,0(7,6)	4,4(6,0)	6,3(2,8)	2,4(3,3)	2,7(6,8)
50th percentile	8,2(5,4)	11,2(6,2)	12,1(3,8)	10,3(2,7)	9,7(5,8)
90th percentile	14,1(4,1)	17,6(7,0)	17,3(4,7)	17,9(2,7)	15,8(5,9)
Upper trunk inclination					
10th percentile	-7,2(4,3)	-7,9(2,7)	-7,6(1,9)	-8,2(0,8)	-7,5(3,5)
50th percentile	-2,7(5,0)	-4,2(2,5)	-4,1(1,7)	-4,3(0,9)	-3,5(3,9)
90th percentile	1,3(4,7)	-0,6(2,3)	-1,0(1,2)	-0,2(1,2)	0,3(3,7)

Table 4. Mean values and standard deviation of the posture of the right and left shoulders and the duration of stay in angular sectors of 30º, 60º, and 90º in the concave part group (GC) and straight part group (GR), as well as for the straight part group with support on the right side (GRD) and left side (GRE), and for the total sample.

	GC	GR	GRD	GRE	Total
Right shoulder					
10th percentile	37,3(6,6)	31,2(11,3)	39,0(4,9)	23,4(3,0)	34,3(9,5)
50th percentile	45,5(3,4)	41,0(7,9)	44,8(4,0)	37,1(3,3)	43,2(6,3)
90th percentile	51,2(3,3)	47,0(6,9)	48,6(3,4)	45,4(2,8)	49,1(5,7)
Left shoulder					
10th percentile	32,3(11,8)	32,3(11,3)	34,5(6,5)	30,1(5,4)	32,3(11,1)
50th percentile	44,5(4,7)	43,5(8,4)	46,3(4,5)	40,8(3,9)	44,0(6,6)
90th percentile	53,3(4,3)	52,2(6,7)	52,9(4,4)	51,5(2,5)	52,8(5,5)
Right shoulder duration (degrees)					
30º	95,9(4,0)	82,9(16,0)	92,9(5,1)	73,0(7,6)	89,4(13,1)
60º	1,9(2,3)	1,3(1,0)	1,1(0,7)	1,4(0,2)	1,6(1,7)
90º	0,2(0,4)	0,1(0,1)	0,03(0,0)	0,1(0,02)	0,1(0,2)
Left shoulder duration (degrees)					
30º	89,7(11,7)	84,4(17,3)	88,8(5,2)	80,0(11,6)	87,1(14,5)
60º	2,2(2,5)	5,9(11,3)	9,5(8,1)	2,3(0,8)	4,0(8,1)
90º	0,1(0,2)	0,2(0,2)	0,1(0,05)	0,2(0,1)	0,1(0,2)

The comparison between the GC, GRD, and GRE groups indicated a difference in the posture of the right shoulder only for the 10th percentile (P=0.01), with post hoc testing showing a difference between GC and GRE (P=0.02) and between GRD and GRE (P=0.03). No differences were found for head, cervical, and upper trunk postures when the three groups were compared (P=0.17, P=0.94, and P=0.79, respectively).

Regarding the time spent in angular sectors, there was a significant difference between the groups for the right shoulder in amplitudes up to 30º (P=0.04). Post hoc testing indicated that the difference occurred between the GC and GRE groups (P=0.011), with the lowest values found in the GRE group.

4. Discussion

The results obtained indicated no significant difference in the posture adopted by workers according to the computer's positioning on the "L"-shaped desk. These results were unexpected, as it was believed that asymmetry in forearm support could lead to postural asymmetries.

Based on these findings, the hypothesis was raised that the variation in support sides within the GR group could cancel out postural asymmetries. Thus, the GR group was subdivided into GRD and GRE. This analysis indicated that the GRE group showed lower values for the elevation of the right shoulder at the 10th percentile. All volunteers were right-handed, meaning they used the mouse with their right hand. Therefore, when supporting to the right side (GRD), the elevation of the right shoulder was higher. However, for the GRE group, this support did not interfere with the elevation of the right shoulder, as the support was on the opposite side. In the GC group, support was provided on both sides, also increasing the elevation of the right shoulder. This difference did not appear in the left shoulder, possibly due to the right-handed dominance in all women. Thus, we can interpret that support is related to higher elevation of the dominant shoulder in situations where the workstation is not properly adjusted.

Therefore, the evaluation of posture during 1 hour of office work did not confirm the findings obtained by Moriguchi et al. (2014), which were obtained through observational means. One aspect that may have contributed to this finding was the global assessment of exposure without division by activities, such as mouse use and typing.

The design of the "L"-shaped desks should facilitate the use of the concave part, ensuring better forearm support and reducing biomechanical overload. Moriguchi et al. (2014) found that the symmetry of the upper arm was associated with the monitor's position on the desk; symmetry depends on how the "L"-shaped desk is used. Six out of eight workers who positioned the keyboard and monitor on the concave edge of the desk showed symmetric forearm support, whereas, in the use of the straight part, five out of six workers showed asymmetric forearm support. Additionally, the same study found that higher comfort levels were associated with the use of the concave edge of the desk (Moriguchi et al., 2014).

Straker et al. (2009) found that using a concave desk, compared to a straight desk, resulted in greater variability and range of motion, as well as greater variation in muscle activity, suggesting an advantage of this type of desk compared to a straight desk.

In another study by Straker et al. (2008), the curved desk resulted in a small decrease in head flexion; however, the activity of the cervical erector muscles and upper trapezius increased.

Dumas et al. (2008) evaluated the posture in a straight desk, also comparing it with support for bilateral forearm support placed on a straight desk, simulating a concave desk situation. The authors also found no significant differences in different desk conditions for shoulder abduction and flexion, as found in the present study. Trunk position was considered neutral in both situations, with trunk flexion decreasing, but not significantly, with the use of the concave support. Left trunk rotation significantly decreased with the use of the concave desk.

Unlike this study, comparing posture on a straight desk and a concave desk, the results of Delisle et al. (2006) show that shoulder flexion and abduction were greater with the use of the concave desk compared to the straight desk.

An aspect to be considered is that the studies by Delisle et al. (2006), Dumas et al. (2008), Straker et al. (2008), and Straker et al. (2009) were conducted in a laboratory environment, where the furniture was adjusted based on each volunteer's anthropometric measurements. In the present study, conducted in an occupational environment, no furniture adjustments were made, which may have influenced the results, as the GC group showed greater chair height inadequacy, potentially causing higher shoulder elevation in this group.

Furthermore, previous studies assessed the posture of individuals at different desks, not in different situations of the same "L"-shaped desk.

5. Conclusions

The results of the present study indicate that the arrangement of the monitor and keyboard on a desk with a curved design does not appear to influence the postural exposure of workers.

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