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THE PREDICTORS OF TYPING PERFORMANCE IN OFFICE EMPLOYEES WITH NECK PAIN; NECK DISABILITY, MUSCLE ACTIVITY, POSTURE, AND DEMOGRAPHICS

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ABSTRACT

Introduction: It is important to determine the predictors affecting performance to protect the professional performance and increase productivity. In the present study, the purpose was to show the relations between typing performance and neck disability, Upper Trapezius (UT) muscle activation, posture, and demographic characteristics in office employees who have neck pain. **Methods:** The demographic data were obtained from 21 office employees (10 women, 11 men) who used computers for at least 4 hours a day, and neck pain-related disability levels were determined with the Neck Disability Index (NDI). The participants were given a 10-minute typing task in their working environments, during which right and left UT muscle activation was recorded with Surface Electromyography (sEMG). Work posture was evaluated with Rapid Upper Limb Assessment (RULA) and Forward Head Posture (FHP) was evaluated with Cervical Range of Motion (CROM) Device. **Results:** Right and left UT muscle activation was found to be higher in women. NDI and right UT muscle activation were correlated positively. Typing performance was correlated positively with work-hour, and negatively with age, job experience, and RULA-Score. The hierarchical regression analysis showed that right UT muscle activation, RULA score, age, and body mass index may be among the predictors of typing performance. **Conclusion:** To maintain and improve the current performance, approaches must be determined for employees and workplaces, considering variables such as muscle activation, working posture, age, and body mass index.

KEYWORDS: Office employees, neck pain, typing performance, muscle activity, posture.

INTRODUCTION

The job, wage, and success evaluations of employees are determined by their performance, and maintaining performance and productivity can be an important source of stress for individuals who have been working for many years.[1] In our present day, office employees are expected to adapt quickly both physically and mentally to portable and replaceable "offices" with flexible working hours, maintain and even increase performance and productivity. It was reported in previous studies that the performance of office employees is related to demographic characteristics such as age, gender, and work experience, as well as working posture, current musculoskeletal system complaints, and musculoskeletal adaptations, developed for work.[2-6]

Computer-based works that last long hours and with insufficient work breaks increase the static load on the proximal muscle groups and the dynamic load on the distal muscle groups creating a risk factor for cumulative trauma disorders and pain in the head, neck, and upper extremities.[4,7,8] As a matter of fact, it was reported that keyboard use that lasts more than 4 hours a day increases the risk of neck and shoulder pain approximately 4 times.[7,9] It has been shown that factors such as age, gender, body mass index (BMI), computer work experience, working hours/day with the computer, task difficulty, irregular head, and body posture, and having a previous history of complaints, etc. are associated with the musculoskeletal system-related pain in computer employees, and they mostly complain of neck, shoulder, upper and low back pain.[4,7,10]

An increase is observed especially in the activation of the trapezius muscle in computer work.[11] Keyboard activity is associated with increased trapezius muscle (right and left) effort, and mouse activity causes much lower changes in trapezius muscle effort. Also, the orientation of the head to flexion and internal rotation of the shoulders increases during keyboard activity.[12] The deviation of the head from its neutral posture is most commonly seen in the forward head posture (FHP). When working with a computer screen, there is an increase of approximately 10% in the FHP of the head when compared to the relaxed posture; however, there is no significant change in the posture with time-at-work.[13] It was speculated that FHP is more common in people with neck pain.[14] and that FHP, which is quite common in computer employees, may also cause deterioration of postural balance.[15]

Determining the predictors that are effective on performance and ergonomic approaches to be developed for these predictors must be individual and adaptable to every environment, time, and equipment. In this context, the purpose of the present study was to show the relations between neck disability, UT muscle activation, posture, and demographic characteristics with typing task performance in office employees who have neck pain by using their equipment in their workplaces. We hypothesized that UT muscle activation, working posture, and age might be the main predictors of typing performance in office employees with neck pain.

MATERIALS AND METHODS

Participants

All participants provided informed, written consent to participate in the study that was performed according to the Declaration of Helsinki and approved by the Clinical Research Ethics Board of Marmara University (Protocol number: 09.2018.282) prior to partaking. Twenty-one office employees (10 women and 11 men) with neck pain participated in the study. The mean age of the participants, whose ages ranged from 26 to 63, was 36.57 (SD 11.9). Inclusion criteria consisted of computer use of at least 4 hours a day and full-time work experience of at least 1 year without any health concern, upper-body injury, and surgery. Also, the participants were questioned with which hand they wrote and it was seen that all of them were right-handed. Those who did not meet the inclusion criteria and those who could not complete the study because of pain, discomfort, etc. were excluded from the study (Dropouts; n=3 because of pain and discomfort, n=1 because of incomplete evaluations not completed on their own will). Data collection and experimental sessions were conducted in the participant's own actual work environment. During the pre-interviews conducted with the participants, the demographic data such as age, height, weight, body mass index (BMI), work experience (years), daily working time (hours), etc. were recorded (Table 1). The participants were also asked to complete the Neck Disability Index (NDI) to assess the level of disability associated with neck pain.

Table 1. Participant characteristics and gender comparisons.

	All *(n=21)*	Female *(n=10)*	Male *(n=11)*	P
Age (years)	36.57 (11.9)	34.4 (10.23)	38.55 (13.42)	0.387 [a]
BMI (kg/m^2)	26.34 (4.49)	24.5 (4.14)	28.01 (4.3)	0.073 [b]
Job Experience (year)	14 (12.88)	12 (11.30)	15.82 (14.46)	0.605 [a]
Working Hour per a Day	6.95 (2.13)	7.3 (2.06)	6.64 (2.25)	0.349 [a]
NDI	9.33 (4.85)	11.5 (4.74)	7.36 (4.23)	0.072 [a]
Typing Performance (word count/10 min)	196.71 (48.25)	193.4 (39.66)	199.73 (56.74)	0.773 [b]
RULA-score	5.43 (1.21)	5.5 (1.08)	5.36 (1.36)	0.803 [b]
FHP (cm)	22.34 (1.46)	21.96 (1.71)	22.68 (1.16)	0.387 [a]
sEMG-UT-Right (%MVIC)	14.4 (10.95)	20.5 (10.81)	8.85 (7.97)	0.01 [a]
sEMG-UT-Left (%MVIC)	15.98 (19.39)	21.44 (22.35)	11.02 (15.67)	0.02 [a]

Data are presented as mean and standard deviation (SD). Body Mass Index (BMI), Neck Disability Index (NDI), Rapid Upper Limb Assessment (RULA), Forward Head Posture (FHP), Surface Electromyography-Upper Trapezius (sEMG-UT), Maximum Voluntary Isometric Contraction (MVIC).
[a]Mann-Whitney U test
[b]Independent Samples t test

Neck disability index (NDI)

NDI is a self-reported scale measuring neck pain and disability in 10 different situations and functions such as degree of pain, daily living, lifting, reading, headache, concentration level, work, driving, sleep, and leisure activity. The total score ranges between "0" and "50", with increasing scores indicating increasing disability: "0-4 no disability, 5-14 mild disability, 15-24 moderate disability, 25-34 severe disability, and ≥35 complete disability".[16,17]

Experimental protocol

The participants were asked to write/copy a printed text that was prepared in advance in Microsoft Office Word Program in their own working areas with the office equipment they always used. All participants were using desktop, keyboard, basic mouse and flexible office chair. During the typing task, muscle activation of the right and left Upper Trapezius (UT) was recorded with Surface Electromyography (sEMG), and work posture was evaluated with Rapid Upper Limb Assessment (RULA), which is an observational assessment method. Typing task performance was determined as the number of words written in 10 minutes. After the typing performance measurement was completed, the participant was asked to continue with the typing task during which Forward Head Posture (FHP) was evaluated with the Cervical Range of Motion (CROM) Device.

Typing performance measurement

All participants were informed before starting the task and no intervention/warning was made during the task. The printed plain text was printed again in the Microsoft Office Word Program by using only the primary functions of the keyboard keys and ignoring capital/lowercase letters, beginning of paragraphs, and punctuation. The participants were asked to write the words without errors for 12 minutes, at the speed they were used to during their work, but at their best performance. The first two minutes were considered as a warm-up (pre-practice), and the number of words written exactly in 10 minutes after the end of the 2nd minute was recorded without considering 1-2 letter errors.

Surface-Electromyography (sEMG)

The placement and location of the electrodes were performed according to the Surface EMG for Noninvasive Assessment of Muscles (SENIAM) project recommendations and the recommendations of the Consensus for Experimental Design in Electromyography (CEDE) project.[18] For each side, two 1 cm width Bipolar Ag/AgCl surface electrodes (pre-gelled, self-adhesive) were placed on the skin that shaved, abraded locally, and cleaned with 70% isopropyl alcohol to reduce the impedance. Electrodes were placed on UT at the midpoint of the line between the acromion and the 7th cervical vertebra, with a 2 cm inter-electrode distance and parallel to the muscle fibers.[19] (Figure 1 A and B).

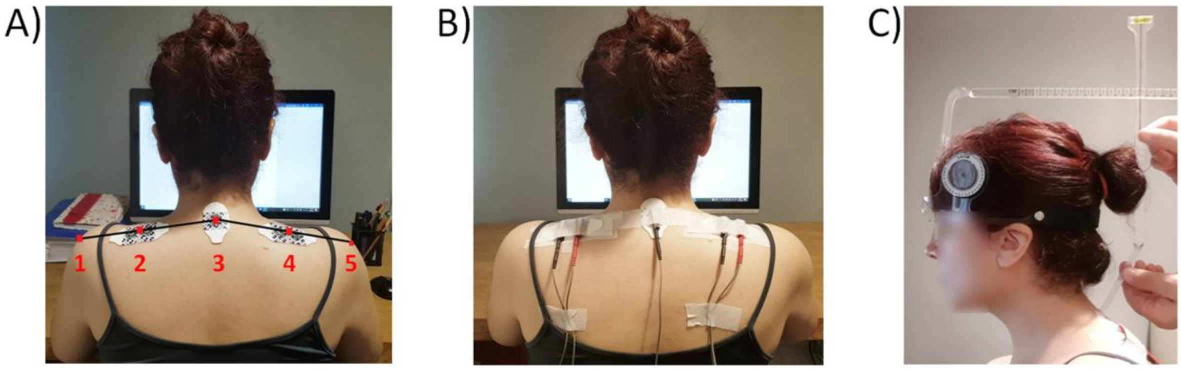

Figure 1: (A and B) The placement and location of the surface EMG electrodes. Regions numbered in figure 1A: the left and right acromion (1 and 5), the 7th cervical vertebra (3), the midpoints of the line between the acromion and the 7th cervical vertebra (2 and 4). (C) Cervical Range of Motion Device (CROM).

The measurements were made by using the NeuroTrac™ ETS MyoPlus Pro2 (Verity Medical Ltd., Romsey, Hampshire, UK) Device and the data processing (EMG signal processing) was performed with NeuroTrac™ EMG Software v5.0 (Verity Medical Ltd. UK). The common-mode rejection ratio was greater than 80 Db. The EMG signals were band-pass filtered (-3dB bandwidth and 18-370 Hz) and were then converted (2000 samples p/sec)with 16-bit resolution. By using the Moving-Window Averaging Algorithm, they were then processed into up to 32 samples p/sec of the averaged EMG RMS values. The normalized data for EMG were identified for each side separately with the Maximum Voluntary Isometric Contraction (MVIC). The mean values of the EMG data (mV) collected from both sides of UT muscles during 10 minutes typing task were utilized to obtain the normalized data (%MVIC). Data analyzes were performed with normalized values. The MVIC was performed in 3 repetitions for 6 seconds for each side UT in the manual muscle testing position and arms at 90^{o} abduction before the clinical evaluations. The highest value was recorded as MVIC and normalized %MVIC data were determined by dividing the mean sEMG value by MVIC.[19]

Rapid upper limb assessment (RULA)

RULA was developed by McAtamney and Corlett in 1993 to evaluate work-related upper limb musculoskeletal disorders and risk factors related to study areas.[20] The posture score was recorded for each body part on the worksheet by observing the working posture of each participant during the computer task. There are 2 separate sections in this method, Arm and Wrist Analysis, and Neck, Trunk, and Leg Analysis. Whether the arms, forearms, wrist, neck, trunk positions, and legs/feet support are sufficient is scored by determining whether the posture is static, and the presence of intermittent or static loading. Total RULA Score is between 1-7, and an increased score indicates worsening of work posture. According to the total RULA score, 4 Action Levels are recommended. RULA-1 (Scores 1-2) indicates that the current working posture is at an acceptable level if it is not maintained or repeated for a long time, RULA-2 (Scores 3-4) indicates that more research is required and changes may be needed, RULA-3 (Scores 5-6) indicates that research and changes must be made soon, and finally, RULA-4 (Score 7) indicates that research and changes are necessary immediately.

Forward head posture (FHP) assessment

FHP was evaluated during the typing task with a Cervical Range of Motion Device (CROM, Deluxe model, USA). The validity and reliability of CROM were demonstrated in the evaluation of head movements in all directions.[21] Its plastic main body that looks like glasses is placed on the nose and ears. The CROM has 2 arms, the Horizontal Forward Arm that extends horizontally over the head from the main body, and the Vertebral Locator Arm, which has an embedded Water Gauge at its upper end, is placed on the C7. The sagittal distance from the intersection of the vertebral locator arm and the horizontal forward arm to the bridge of the nose was recorded (cm) (Figure 1 C). Before recording, it was checked whether the Vertebral Locater Arm was in the correct position with the Water Gauge and whether there was any flexion/extension in the craniocervical joint with the inclinometer on the sagittal plane.

Statistical analysis

Statistical analyzes were made with the IBM SPSS version 22.0 (IBM Corporation, Armonk, NY). The data were presented as mean and Standard Deviation (SD). All the data were tested for normal distribution by using the Shapiro-Wilk Test. The comparison of different parameters between two groups was made by using the Parametric Independent *t*-Test or the Non-Parametric Wilcoxon Test. Gender distribution according to RULA categorical values was presented as *n* and %. Again, according to RULA, the differences in the study variables were analyzed with One-Way ANOVA, and the paired group comparisons were conducted with the LSD Post-Hoc Test. The relations between the variables were examined by calculating the Pearson Correlation Coefficient. Hierarchical Regression Analysis was conducted to examine the predictors of typing performance. The demographic variables were added to the model in Step1 (Age, Job Experience (years), Working Hour per a Day, and BMI); posture (RULA, FHP) in Step 2; neck pain (NDI) in Step 3; and UT muscle activation in Step 4 (%MVIC). The minimum significance levels were set at $p<0.05$.

RESULTS

The mean age of all participants was 36.57 (SD 11.9), body mass index was 26.34 (SD 4.49), year of job experience was 14 (SD 12.88), and working hours per day was 6.95 (SD 2.13). The mean Neck Disability Index (NDI) score of the participants was 9.33 (SD 4.85), which corresponded to the “mild disability (5-14)” level according to the NDI score. The mean Rapid Upper Limb Assessment (RULA) score of the participants (mean 5.43, SD 1.21) was at action levels of RULA-3 (Score 5-6), which indicates that research and changes should be made soon. The typing task performance of the participants was 196.71 (SD 48.25) words on average for 10 minutes (Table 1). When the findings of 10 women and 11 men in the sample were compared, it was found that the %MVIC measurements of the right and left UT differed at significant levels ($p=0.01$, $p=0.02$, respectively), and the %MVIC was higher in women. No gender-related differentiations were detected in terms of other investigated variables ($p>0.05$) (Table 1).

According to the action levels of RULA, we do not have any participants in RULA-1 (score 1-2). Therefore, all participants were divided into 3 subgroups according to their RULA scores: RULA-2, RULA-3, and RULA-4. Gender distribution to the RULA groups was quite similar. Significant differences were detected between RULA subgroups in terms of typing performance ($p=0.019$) and the typing performance of RULA-4 group was lower than RULA-2 ($p=0.005$). There were no significant differences between RULA subgroups in terms of other investigated variables (Table 2).

Table 2: Comparisons according to action levels of RULA.

	RULA -2 (R2)	**RULA -3 (R3)**	**RULA -4(R4)**	
	n (%)	n (%)	n (%)	
Gender				
Women (n=10. 47.6%)	2(40%)	6(54.5%)	2(40%)	
Men (n=11. 52.4%)	3(60%)	5(45.5%)	3(60%)	
	Mean(SD)	Mean(SD)	Mean(SD)	p-value*
Typing Performance (word count/10 min)	238.4 (38.77)	195.91 (47.44)	156.8 (18.62)	0.019 R2-R3: 0.069 R2-R4: 0.005 R3-R4: 0.092
Age(year)	34.6(13.74)	35.18(11.15)	41.6(12.92)	0.579
Job Experience (year)	13(15.75)	11.82(11.48)	19.8(13.99)	0.531
Working Hour per a Day	7.4(3.05)	7.27(1.95)	5.8(1.3)	0.475
BMI (kg/m^2)	27.25(5.32)	25.77(4.96)	26.67(2.99)	0.831
RULA-Score	3.8(0.45)	5.45(0.52)	7(0)	<0.001
FHP (cm)	21.82(0.72)	22.5(1.81)	22.5(1.23)	0.683
NDI	12.4(3.97)	9(4.88)	7(4.85)	0.207
sEMG-UT-Right (%MVIC)	13(8.03)	16.32(13.19)	11.5(8.8)	0.705
sEMG-UT-Left (%MVIC)	9.71(13.51)	22.55(23.79)	7.81(5.52)	0.274

Rapid Upper Limb Assessment (RULA), Body Mass Index (BMI), Forward Head Posture (FHP), Neck Disability Index (NDI), Surface Electromyography-Upper Trapezius (sEMG-UT), Maximum Voluntary Isometric Contraction (MVIC).
**One-Way ANOVA; LSD for group comparisons.

Correlation analyses revealed that typing performance was negatively related with age, job experience, and RULA-Score; but positively with work-hour (respectively, r= -0.58, p=0.006; r=-0.531, p=0.013; r=-0.57, p=0.007; r=0.479, p=0.028). Typing performance was not significantly correlated with FHP, neck pain, or muscle activation of the right or left UT (respectively, r=0.14, p=0.546; r=0.294, p=0.195; r=-0.229, p=0.318; r=-0.035, p=0.881). However, sEMG-UT-Right scores were negatively correlated with BMI and FHP, and positively with neck pain (respectively, r=-0.641, p=0.002; r=-0.462, p=0.035; r=0.442, p=0.045).

Considering the correlations of muscle activation of right UT with FHP and neck pain, we suspected that strong correlations of typing performance with demographic variables general body posture might suppress the impact of head posture and neck pain on performance. Therefore, we examined the unique contribution of study variables in a hierarchical regression model in which demographic variables (i.e. age, working-hour, and BMI) in the first step, variables related to posture (i.e. RULA-Score and FHP-Work) in the second step, neck pain in the third and muscle activation of right UT in the fourth step regressed on typing performance (Table 3). We discarded job experience and muscle activation of left UT from the analysis since the former was too strongly correlated with age and the latter was not significantly correlated to any other study variables.

Table 3: A hierarchical regression of typing performance on participant characteristics and study variables.

	B	SE	Beta	p	95% BCa CI	
Model 1						
Constant	202.635	72.144				
Age	-1.973	0.845	-0.487	0.032	-3.633	-0.542
Working Hour per a Day	6.958	4.413	0.317	0.133	-4.176	13.481
BMI	0.704	2.161	0.066	0.749	-4.355	4.191
R^2 (%)= 42.1%, p=0.023. Age: 26.3%, Working Hour: 15.8%, BMI: 0.06%						
Model 2						
Constant	234.493	121.337				
Age	-1.654	0.728	-0.408	0.038	-3.617	-0.164
Working Hour per a Day	2.531	4.161	0.115	0.552	-10.023	11.587
BMI	-1.181	2.070	-0.110	0.577	-5.678	3.203
RULA-Score	-20.335	6.960	-0.509	0.011	-34.814	-4.936
FHP	6.575	6.027	0.199	0.293	-9.146	19.456
R^2 (%)= 63.2%, ΔR^2 (%)= 21.1%, p=0.034, Model 1: 42.1%, RULA-Score: 18.2%, FHP: 2.9%						
Model 3						
Constant	258.253	125.323				
Age	-1.735	0.740	-0.428	0.034	-3.378	-0.456
Working Hour per a Day	3.151	4.255	0.143	0.471	-15.377	20.479
BMI	-1.664	2.159	-0.155	0.454	-6.236	3.061
RULA-Score	-22.505	7.445	-0.563	0.009	-44.409	4.057
FHP	7.240	6.123	0.219	0.257	-8.424	21.898
NDI	-0.826	0.948	-0.166	0.398	-3.118	0.965
R^2 (%)= 65.1%, ΔR^2 (%)= 1.9%, p=0.398, Model 2: 63.2%, NDI: 1.9%						
Model 4						
Constant	486.671	132.304				
Age	-0.948	0.673	-0.234	0.182	-2.580	0.861
Working Hour per a Day	1.488	3.557	0.068	0.682	-11.984	18.241
BMI	-5.616	2.283	-0.523	0.029	-11.657	-0.763
RULA-Score	-22.737	6.134	-0.569	0.003	-42.243	2.550
FHP	1.636	5.438	0.049	0.768	-12.253	15.628
NDI	0.513	0.919	0.103	0.586	-2.254	3.834
sEMG-UT-Right (%MVIC)	-2.795	1.012	-0.634	0.016	-5.684	-0.374
R^2 (%)= 78%, ΔR^2 (%)= 12.9%, p=0.016, Model 3: 65.1%, sEMG-UT-Right: 12.9%						

Body Mass Index (BMI), Rapid Upper Limb Assessment (RULA), Forward Head Posture (FHP), Neck Disability Index (NDI), Surface Electromyography-Upper Trapezius (sEMG-UT), Maximum Voluntary Isometric Contraction (MVIC).

Hierarchical regression analysis revealed that the only significant predictor of typing performance was the age at the first step, indicating that working-hour was not a significant predictor when participants' age was statistically controlled. The second step significantly contributed to the explained variance, and age and RULA-score were significant predictors. The third step did not significantly contribute to the model. The fourth model, however, significantly increased the explained variance and the Beta coefficient revealed that increased muscle activation was related to decreased typing performance when other variables were controlled in the model. In the final model, it was seen that the significant effect of age disappeared when muscle activation was controlled, and BMI, which formerly had a negative relation, had a significant impact.

DISCUSSION

In the present study, the predictors affecting the typing performance of office employees and the relations between these predictors were examined. The results showed that typing performance was negatively correlated with age, work experience, and work posture, and positively correlated with work-hour. NDI and right UT muscle activation were correlated positively. According to the RULA categories, the performance decreased as the work posture worsened. Gender-related differentiation was observed only in UT muscle activation, and both right and left UT muscle activation were found to be higher in females. In the Hierarchical Regression Model, on the other hand, the results indicated that poor work posture, change in UT activation, and increase in BMI with aging explained a significant part of the decline in performance.

Office employees who have an average work experience of 14 years and a working time of approximately 7 hours per day have "mild disability" according to the NDI, as well as the need for research and changes in working postures according to the RULA scoring in the near future. UT muscle activation was higher in female office employees at significant levels when compared to men, and the relatively higher NDI score (p=0.072) in females was correlated positively with right UT muscle activation (Table 1). Although the differentiations between male and female office employees were tried to be associated with biological differences as well as working time, work experience, and work technique, the gender differentiation is not very clear in muscle activity. Cagnie et al. showed that the risk of neck pain was 2 times higher in female office employees than in men, and 2.61 times higher in people over 30 years of age when compared to young people. They also reported that there was a strong relationship between prolonged neck forward bent posture, frequency of sitting, repetitive movements, and neck pain.[22] In a 1-year longitudinal study, Hush et al. showed that female gender was one of the predictors of neck pain, and increased exercise and cervical region mobility were protective against neck pain.[23] Also, uncomfortable working posture increases the musculoskeletal symptoms of the head/neck and upper back region, and these symptoms are more common in women.[24] On the other hand, Marker et al. reported that UT muscle activity was higher in pain-free office worker women when compared to men; however, they did not differ in terms of Active Amplitude Probability Distribution Function (APDF).[25] Blangsted et al. reported that shorter muscular resting periods were more determinative on UT muscle activity in office employees than gender.[26]

Participants' typing performance was significantly lower in RULA-4 indicating that impaired general body posture worsens performance (Table 2). Typing performance showed a positive correlation with work-hour; and a negative correlation with age, job experience, and RULA-Score. In general, correlations indicated that elder employees whose job experience was higher had much poorer typing performance than younger ones. In line with the findings of RULA group comparisons, impairment in general work-posture was related to lower typing performance. Employees working for longer periods in a day had better performance. High working hours probably increase performance because of repetition/practice; however, poor working posture and advanced age affect performance negatively.

Hierarchical regression analysis revealed that typing performance predictors in office employees might be age, BMI, RULA score, and right UT muscle activation (Table 3). The decline/deterioration in cognitive, sensory, and physiological functions because of aging causes poor performance in computer-based jobs as well as in many business models. A much more significant loss of performance is observed in complex tasks, especially with the weakening of cognitive skills. On the other hand, decreased performance because of aging can be minimized with task-specific training, interface design modifications, and alternative work/rest schedules.[2,27] In addition to aging, deficiencies in working ability are associated with factors such as sedentary lifestyle, obesity, musculoskeletal system inadequacy/disorders, high mental work demands, physical workload, and physical inadequacies of the working environment.[2,4,6] Working posture is also among the important factors that affect performance. As a matter of fact, it is suggested that a high RULA score, which is associated with the risk of musculoskeletal disorder (MSD), can be reduced with ergonomic training and regulations, and allow increased performance.[3,4,28]

Increased EMG activity is considered an indicator of attention-related activity and/or fatigue. It is also considered that the high EMG amplitude in office employees who have to do long and frequently repetitive computer tasks in inappropriate posture will indicate the risk of developing MSD; therefore, this may result in a decreased performance.[5,29,30] In their study that investigated the effects of postural changes on muscle activity during computer work, Botter et al. showed that there was an increased activity of only the trapezius muscle, more prominently in the upper-right trapeziusv.[30] In office employees without neck pain, UT-muscle activity during computer tasks is lower, and right and left UT muscle activity is more symmetrical; however, UT-muscle activity is higher and asymmetrical in proportion to the severity of the pain.[31]

In the present study, FHP was not found to be associated with typing performance or other variables investigated. FHP may impair postural control by causing inappropriate proprioceptive information input from the neck muscles in individuals who have neck pain; however, there are also studies reporting that postural control does not differ in individuals who have natural and forward head postures.[32] Kocur et al. showed that FHP did not affect the stiffness, tone, and elasticity properties of the upper trapezius, sternocleidomastoid, and splenius capitis muscles in healthy and asymptomatic office employees.[33]

The inability to evaluate performance predictors of office employees with a larger sampling and for more variables that might be associated with performance (computer use patterns, workplace stressors, biomechanical and psycho-social characteristics, etc.) can be considered as the limitations of this study. However, the fact that the present study was planned to be conducted in the participants' own working environment and during working hours is the strength of the study, but it has caused decreased participation because it can affect the workload and schedule of the participants. Also, although it seems like another limitation of the study that only the work posture evaluation was made, there is a study showing that there is no difference between repeated measurements made with RULA and a single measurement in those who work in static posture for a long time.[34]

CONCLUSION

It was found that inappropriate working posture, changes in UT muscle activation, and BMI explained a significant part of the decline in performance with increasing age. With aging, there is a need to develop appropriate working strategies to protect work efficiency and reduce biomechanical and psychosocial stress on the employee.

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CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

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