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**Title Page**

# Effects of Risk Factors Related to Computer Use on Musculoskeletal Pain in Office Workers

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Abstract

Purpose: In recent years, work-related musculoskeletal disorders(MSDs) are increasing due to overuse of desktop computer. This investigation was planned to examine musculoskeletal pain in office workers.

Materials and Methods: 362 participants(female:50.8%; male:49.2%; mean age:37.35±8.43years) were included. Sociodemographic factors were recorded. Participants were questioned for their daily working time, computer usage time and years, whether musculoskeletal pain was related to their job or whether pain disturbed their activities of daily living(ADLs). Working postures were observed and pain severity was evaluated with Visual Analog Scale(VAS).

Results: Participants were found to have more frequently upper back pain(69.6%), neck(66%) and lower back pain(LBP)(64.1%) during the last 12 months. 60.5% of the participants were reported pain after they started work. LBP(32.9%),

back(28.2%) and neck(22.9%) pain were found to restrict participants' daily life. We found positive correlations between daily computer use and neck, back, and LBP($r$=0.179 $p$<0.001; $r$=0.166 $p$=0.002, respectively).

Conclusions: Most painful areas of participants using desktop computers were upper back, neck, lower back and shoulder respectively, and the pain in these regions affected ADLs negatively. These pain mostly occurred after current job and these individuals experience more intense pain. Ergonomic approaches could reduce WMSD and make them more independent in ADLs and prevent chronicity.

Keywords: musculoskeletal pain; office worker; computer use

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## 1. Introduction

The widespread use of computers in the workplace brings with it the musculoskeletal problems associated with computer use in employees. The introduction of computers into workplaces increased productivity, led to changes in work organizations and the development of new risk factors, leading to many health problems, including work-related musculoskeletal disorders (MSDs) [1].

Work-related MSDs; It is defined as the damage or disease of muscles, nerves, tendons, joints, cartilage and spinal discs that develop as a result of exposure to risk factors in the working environment [2]. The common feature of WMSD is; may be the result of the work, or may be exacerbate due to work, and may lead to restrictions in the

work environment or non-work activities [3,4]. Lower back, neck and shoulders are the most prone areas for the development of musculoskeletal symptoms among computer users [2,3]. Scientific reports show that computer users often report complaints about back and neck pain. However, pain complaints in other anatomical regions (upper extremity, upper back and knee) are common among computer users as well [4].

The relationship between computer use and MSDs has been shown in several studies [5–7], and the prevalence rates of musculoskeletal pain for 12 months were 55-69% for neck, 31-54% for lower back, 15-52% for upper extremities [2]. Main symptoms include pain, swelling, stiffness, numbness, tingling, weakness, impaired coordination, loss of function, skin colour and temperature changes [8,9]. Some studies report evidence of increased muscle activity in people using computers during long periods of rest and sleep. EMG studies support the increase in muscle activity. In addition, it is shown that the existing pain becomes chronic, limiting the range of motion of the joint and causing the individual to can not perform his / her ADLs completely [8,9].

Risk factors for MSDs include psychosocial, organizational and physical aspects of the work (computer usage time, computing skills, poor posture, repetitive movements, regular breaks and exercise performance) as well as demographic and other personal characteristics [2]. It is accepted that the development and chronicity of these diseases are affected by physical activities and / or working postures and working conditions in the workplace [8,9]. Office work often includes activities associated with long-term static posture such as reading and writing, repetitive work movements, incorrect hand positioning, and inappropriate lower arm support [1]. The most important factors in the occurrence of WMSD in computer users; it consists of repetitive movements such as using a keyboard, entering data, mouse clicks and static posture, the use of the body in the wrong positions, and inadequate ergonomic conditions of the workplace [10,11].

Tittiranonda et al. reported that there is a relationship between WMSD and specific risk factors such as repetitive and long-term activities, poor posture and localized mechanical stress in computer users [12].

Developing health problems continue to adversely affect the health of the workers and the economy of the countries due to their high treatment cost [1,13]. It has been reported that MSDs in computer users decrease work efficiency and cause people to get sick leave [10,11]. According to the UK Labour Force Survey (2015); a total of 9.5 million working days were lost as a result of work-related MSDs with a loss of 17 days per person. It was determined that 40% of the cases causing work-related loss of time were work-related MSDs. According to the US Bureau of Labour Statistics (2014) report, work-related MSDs accounted for 32% of all injuries and illnesses, and the incidence of work-related MSDs was found to be 33.8% among 10,000 full-time working days. It was also reported in another study that the average time required for workers with WMSD to return to work was 13 days [13].

Our study aims to determine the problems and risk factors that may occur in musculoskeletal system of individuals working in office settings and to investigate the relationship between work and how it affects pain duration and ADLs.

## 2. Method

### *2.1.Study Design and Subjects*

This is a cross-sectional study designed to investigate the work-related musculoskeletal problems of office workers using computers in the university. The number of staff working in the university as office workers was 1544. The population of the study was also the sample. All procedures performed in studies involving office workers were in accordance with the ethical standards of Pamukkale University Ethics

Committee for Non-Interventional Clinical Investigations (decision no: 60112787-020/28431, dated 05/05/2015) and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

The inclusion criteria were 18-60 years of age, using a computer, without chronic disease, having not undergone any operation involving the musculoskeletal system in the last 1 year and without any disability. Individuals who did not meet the inclusion criteria and did not want to participate in the study were excluded. According to these criteria, the study was completed with 362 office workers.

Sociodemographic factors of age, gender, height, weight, body mass index (BMI) was recorded.

In order to figure out risk factor related to work, the participants were questioned about their computer usage, work related factors, pain and pain related discomfort in ADLs, working postures of office workers were observed.

Work related questions were performed by us, these questions;

- daily working time (hours / day),
- daily computer usage time (hours / day),
- weekly computer usage time (hours / week),
- total work time in the workplace (years)

We have benefited from the literature when deciding questions about risk factors [5,7].

Subjects marked the painful areas on the body diagram and the Visual Analog Scale (VAS) was used to question the severity of pain in these areas. In order to question the relationship between pain and work, it was recorded whether the existing pain occurred after starting work and whether these pains influenced ADLs. In addition, the duration of pain was questioned, and individuals were classified as acute and chronic pain. As a result of the observation, postures of individuals during computer use were

examined. After the observational examination performed during the study, the posture of individuals who flexed more than 20 degrees for the neck was recorded as inappropriate posture [14]. For the thoracolumbar region, the kyphotic posture was recorded as inappropriate posture [15]. After, individuals were recorded as working in an appropriate and inappropriate posture for cervical and thoracolumbar regions.

### *2.2.Statistical analysis*

The results were analysed using the Statistical Package for Social Science (SPSS) version 22.0. The Kolmogorov–Smirnov test was used to determine whether the continuous variables were normally distributed. Continuous variables were shown as mean ± standard deviation, and categorical variables were given as number and percentage. Among the variables determined as risk factors; The comparison of pain with the current work was evaluated with Mann Whitney U test, the effect of daily computer usage time on pain in all regions with Spearman's Correlation test. The effect of cervical and thoracolumbar improper posture on spinal pain was evaluated by Chi Square test. The statistical significance level in the statistical test results was accepted as $p < 0.05$.

## 3. Results

In this study, 362 office workers (50.8% female, 49.2% male; Mean Age: 37.35 ± 8.43) were included. We found that office workers in this study sample works average of 6.69 ± 1.83 hours/day and 30.82 ±7.30 hours/week with computer. Average time worked in current job found as 10.08 ± 6.27 years. Most frequent pain regions were found as upper back (69.6%), neck (66%) and lower back (64.1%) (Table 1 and Table 2).

[t]Table 1 near here[/t]

[t]Table 2 near here[/t]

Office workers who had pain after their current job experienced more severe pain than those who had pain before starting work in all regions ($p$ <0.001) (Table 3).

[t]Table 3 near here[/t]

Additionally, we found pain in lower back region (32.9%) is restricted ADLs more than other regions (Table 4).

[t]Table 4 near here[/t]

Office workers who had chronic pain in all regions experienced more severe pain ($p$ <0.05) (Table 5).

We also found that improper posture of cervical and thoracolumbar regions during work time have negative effect on neck ($p$ <0.05) and upper back ($p$ <0.05) pain but not in LBP ($p$ >0.05) (Table 6).

[t]Table 5 near here[/t]

[t]Table 6 near here[/t]

Correlation analysis showed that daily computer usage time had little but positive correlation with all painful regions except left shoulder/arm ($p$ <0.05) (Table 7).

[t]Table 7 near here[/t]

## 4. Discussion

This study was planned to investigate the severity, incidence, related factors and postures of musculoskeletal pain in office workers using desktop computers. As a result of the study, we found that the most painful areas of office workers using desktop computers were upper back, neck, lower back and shoulder respectively, and the pain in these regions affected daily life negatively.

Daily computer usage time of the individuals was positively correlated with the pain severity of lower back, neck / upper back and upper extremity. As a result of observational postural analysis, individuals who did not fit the appropriate monitor and

sitting posture had experienced more neck and upper back pain, but that the use of computers in inappropriate posture did not adversely affect LBP.

### 4.1. Musculoskeletal symptom outcomes

When we investigate the studies examining musculoskeletal pain in office workers who using computers in Australia [14], Iran [15], Turkey [5,13], Lithuania [4], New Zealand [16], United Kingdom [17], and Estonia [2], we saw that the studies shown similar results. Although the data obtained in the studies showed slight changes in the ranking, office workers experienced neck, upper back, lower back and upper extremity pain, which ranged from 20% to 67.85%. In our study, the incidence rates of musculoskeletal pain were higher than in some studies in the literature. When other studies in the literature are examined, some studies have reported the prevalence of musculoskeletal pain in the last 12 months [2,4,14,16], and some studies have reported the prevalence of last 30 days [17] or last 7 days [5,13]. Nevertheless, in a study conducted by Ardahan et al. in Turkey, they investigate the prevalence of pain in last 7 days and found similar pain prevalence results as 67.85% for neck, 66.33% for upper back and 59.49% for lower back. We think that the similarity in these data may be the result of the same socio-cultural population [13]. As in our study, we think that being examined a long prevalence period of 12 months reflects more realistic results for this population in our country. As a result of the analysis, we found that musculoskeletal pain occurring in the above-mentioned areas during computer use adversely affects daily life. In our study, we found that the highest musculoskeletal pain rate due to computer use was LBP (28.2%) followed by neck (22.9%) and shoulder (18.8%) in terms of affecting participants' daily lives. Madan et al. reported that in terms of causing disability in their ADLs office workers in the United Kingdom mostly suffers from 22% LBP, followed by arm pain with 19% and hand/wrist pain with 15% [17]. In another study conducted by Harcombe et al., office workers, nurses and postal officers were examined and stated that

musculoskeletal pain experienced by participants made basic daily activities difficult or impossible by 17% [16]. In a meta-analysis about how neck and LBP caused disability, Lee et al. mention that the factors affecting the relationship between pain and disability were listed as self-efficacy, psychological distress and fear according to the effect size [18]. These factors constitute the psychological basis of the computer use-induced disability. As mentioned in a study conducted by Jensen et al (2002), being a woman, working year in current job, and age constitutes individual factors and repetitive movements and tasks, computer usage time and disturbances from screen reflections constitutes physical factors [19]. In our study, we found that daily computer use was associated with the severity of pain in the areas that most cause disability. This situation has led us to think that with the increase in daily computer usage, pain severity may increase and consequently, by restricting ADLs, it may cause a disability.

### 4.2. Working hours using computer

Ardahan et al. showed that office workers using computers over 7 hours a day had a higher rate of musculoskeletal pain in all regions [13]. In contrast, a study conducted in Turkey [5], daily computer usage time has been stated to be effective only on the prevalence of LBP, but while in another study in Lithuania [4], has only been shown to be associated with shoulder pain.

In a study by Juul-Kristensen et al., it was shown that the time spent working with the computer did not affect the prevalence of musculoskeletal pain but only negatively affected the severity of LBP [20]. Although the effects of computer use on the musculoskeletal system are shown in the literature, the results are contradictory in terms of affected areas. In the light of the data obtained in our study, we found that the severity of musculoskeletal pain occurring in many regions was positively correlated with daily computer usage time. We think that the severity of musculoskeletal pain may increase in office workers who are exposed to more static load and postural disturbances with

increasing computer usage time. However, the lack of sufficient evidence in the literature and the limited number of studies investigating the effect of computer use on the severity of musculoskeletal pain prevent us from reaching a precise conclusion.

### 4.3. Pain duration of office workers

In this study, it was found that office workers whose pain lasted longer than 3 months experienced more severe pain in all regions than those with acute pain. In the literature, the number of studies examining the relationship between pain duration and pain severity is limited. Madeleine et al. Studied this relationship in 2013 and found a strong positive relationship between pain duration and forearm, elbow, neck and shoulder pain [21]. In another study examining this relationship between chronic pain and pain severity, sensitization following persistent pain in the peripheral and central nervous system is explained by mechanism involved in allodynia and hyperalgesia [22]. We believe that the chronicity of pain in office workers increases the severity of pain perceived by individuals in accordance with this theory.

### 4.4. Work related pain

In a study conducted by James et al., 70% of those experiencing neck, shoulder and upper back pain, and 60% of those experiencing LBP, were found to think that their pain was related to their work [14]. In our study, we found that the participants who stated that their pain occurred after starting their current work experienced more severe pain in all regions compared to the others. These results suggest that individuals' increased computer use, or negative attitudes related to work cause individuals to perceive musculoskeletal pain more severe than they actually do. We have determined the relationship between the time of computer use and the pain of office workers occurs after starting current work, but we think that there is a need for more comprehensive studies that examine the psychological, sociological and ergonomic factors that can create this pain.

### 4.5. Effect of improper posture

James et al stated that in office workers, upper back problems were more common in those who sat forward sloping in kyphotic posture and those who sat upright without back support than in those who sat ergonomically [14]. In our study, we found that more neck and upper back pain was seen in those who worked with unsuitable monitor positions and those who sat in inappropriate posture. The similarity between the literature and our results has made us think that musculoskeletal pain can be improved by regulating posture. This is an important result, so the ergonomic interventions can be optimized for office environments to prevent musculoskeletal pain.

The results of this study are important because we reached most of the individuals in the universe of our study and we examined the musculoskeletal pain caused by computer use from different angles. The methods used in our study are self-report methods. The limitation of our study is that the methods used in the evaluation of posture are not evaluated with a more objective method such as video-based 3D observation.

## 5. Conclusions

As a result, the data obtained from our study showed that office workers experienced more frequent pain in the upper back, neck and lower back regions. We observed that the pains in these regions, especially LBP, caused disability over time. We found that the aforementioned pain was exacerbated with increasing daily computer use. Also, we found that the pain of individuals in our study were experienced pain severely as they became chronic. We think that this situation is caused by the sensitization of the individual's central nervous system against chronic pain. In addition, we found that inappropriate monitor and sitting position were associated with more frequent neck and upper back pain. This study suggests the regulation of working time and working posture to reduce musculoskeletal pain in office workers.

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Table 1. Demographics of participants.

| Variable | Mean ± SD |
|---|---|
| Age (years) | 37.35±8.43 |
| Height (cm) | 168.65±7.80 |
| Weight (kg) | 72.87±14.59 |
| BMI | 25.51±4.29 |
| Work related factors | |
| Working time (hours/day) | 7.91±0.98 |
| Computer usage time (hours/day) | 6.69±1.83 |
| Computer usage time (hours/week) | 30.82±7.30 |
| Total time worked in current job (years) | 10.08±6.27 |

Table 2. Most frequent pain region according to body diagram.

| Variable | Present n (%) | Pain intensity (cm) Mean ± SD |
|---|---|---|
| Neck | 236 (66) | 4.93±1.99 |
| Shoulder | 206 (56.9) | 4.22±2.15 |
| Upper Back | 252 (69.6) | 4.93±1.99 |
| Lower Back | 232 (64.1) | 4.91±2.30 |

Table 3. Difference between pain severity of body regions according to the situation of pain started before and after current job

| Region | Did the pain begin after you started your current job? Yes Mean ± SD | No Mean ± SD | *p** |
|---|---|---|---|
| Neck/Upper Back Pain (VAS) | 4.60±2.41 | 3.00±2.72 | < 0.001 |
| Right Shoulder/Arm Pain (VAS) | 3.53±2.64 | 1.88±2.57 | < 0.001 |
| Left Shoulder/Arm Pain (VAS) | 2.72±2.55 | 1.58±2.45 | < 0.001 |
| Lower Back Pain (VAS) | 4.08±2.90 | 2.75±2.85 | < 0.001 |

*Mann-Whitney U Test, VAS: Visual Analog Scale

Table 4. The frequency of disturbance in activities of daily living because of painful body regions in the last one year

| Region | Have your painful regions restricted your daily life in the past year? | |
|---|---|---|
| | Yes<br>n (%) | No<br>n (%) |
| Neck | 83<br>(22.9) | 279<br>(77.1) |
| Shoulder | 68<br>(18.8) | 294<br>(81.2) |
| Upper Back | 102<br>(28.2) | 260<br>(71.8) |
| Lower Back | 119<br>(32.9) | 243<br>(67.1) |

Table 5. Comparison of pain intensity of body regions according to acute-chronic status of pain

| Region | Acute-Chronic status of pain | | |
|---|---|---|---|
| | Acute<br>Mean ± SD | Chronic<br>Mean ± SD | *p** |
| Neck/Upper Back Pain (VAS) | 3.39±2.49 | 5.63±2.40 | < 0.001 |
| Right Shoulder/Arm Pain (VAS) | 2.31±2.43 | 4.52±2.92 | < 0.001 |
| Left Shoulder/Arm Pain (VAS) | 1.75±2.22 | 3.75±2.92 | < 0.001 |
| Lower Back Pain (VAS) | 3.02±2.73 | 5.09±3.01 | < 0.001 |

*Mann-Whitney U Test, VAS: Visual Analog Scale

Table 6. Distribution of pain frequencies according to neck, upper and lower back posture

| Posture | | Neck Pain | | Upper Back | | Lower Back | |
|---|---|---|---|---|---|---|---|
| | | Yes | No | Yes | No | Yes | No |
| Cervical Region | Proper Posture | 116 (48.5%) | 83 (67.5%) | 122 (48.4%) | 77 (70.0%) | 121 (52.2%) | 78 (60.0%) |
| | Improper Posture | 123 (51.5%) | 40 (32.5%) | 130 (54.6%) | 33 (30.0%) | 111 (47.8%) | 52 (40.0%) |
| *p** | | 0.001 | | < 0.001 | | 0.150 | |
| Thoracolumbal Region | Proper Posture | 117 (49.0%) | 78 (63.4%) | 122 (48.4%) | 73 (66.4%) | 118 (50.9%) | 77 (59.2%) |
| | Improper Posture | 122 (51.0%) | 45 (36.6%) | 130 (51.6%) | 37 (33.6%) | 114 (49.1%) | 53 (40.8%) |
| *p** | | 0.009 | | 0.002 | | 0.125 | |

*Chi-square test.

Table 7. Corelation between daily computer use and pain intensity of body regions

| Variable | Neck/ Upper Back Pain (VAS) | Right Shoulder/ Arm Pain (VAS) | Left Shoulder/ Arm Pain (VAS) | Right Elbow/ Forearm Pain (VAS) | Left Elbow/ Forearm Pain (VAS) | Right Wrist/ Hand Pain (VAS) | Left Wrist/ Hand Pain (VAS) | Lower Back Pain (VAS) |
|---|---|---|---|---|---|---|---|---|
| Daily computer usage time (hour) | 0.177* | 0.183* | 0.097 | 0.183* | 0.169* | 0.173* | 0.181* | 0.188* |

**p <0.01* ; Spearman's Correlation Test, VAS: Visual Analog Scale