Research Paper: Comparison of Perceived Musculoskeletal Discomfort Among Six Common Postures for Laptop Use in Female Students

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ABSTRACT

Purpose: The present study aimed to compare Musculoskeletal Discomforts (MSDs) among six different common postures while working with laptop in female students of University of Tehran, Tehran City, Iran.

Methods: This was a crossover trial study. Eighteen female students voluntarily and purposefully participated in all stages of the study. The study participants were randomly assigned into groups to work for 10 minutes on different postures for laptop use during six continuous nights. MSDs was measured each night after 10 minutes of laptop use. For this purpose, Van der Grinten and Smith (1992) method was applied. The obtained data were analyzed by repeated measures one-way ANOVA at a significance level of $P \leq 0.05$, in SPSS.

Results: The obtained results suggested a significant difference among six working postures in MSDs ($P=0.005$). The results of Bonferroni post hoc analysis revealed that the highest level of MSDs was observed in a cross-legged sitting position on the floor. While, the lowest level of MSDs was found in the sitting on a chair posture. In addition, the study participants who used a desk in order to increase the height of the laptop, reported less levels of MSDs than laptop use in the cross-legged position on the floor ($P=0.039$) or sitting on the bed ($P=0.011$).

Conclusion: According to this study, in order to minimize MSDs during working with laptop, it is recommended to use desk and chairs instead of sitting cross-legged on the floor or bed.

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Highlights

- All six working postures of working with laptop create musculoskeletal discomforts for users.
- Sitting on a chair has the lowest level of musculoskeletal discomfort.
- Cross-legged sitting position on the floor creates the highest level of musculoskeletal discomfort.

Plain Language Summary

In recent years, people, and especially students use laptops more than desktop computers. The present study aimed to compare Musculoskeletal Discomforts (MSDs) in six different common postures female university students use while working with laptops. MSDs were assessed after six continuous nights of working on the laptop (each night for 10 min). The obtained results showed significant differences among six working postures with regard to MSDs. The highest level of MSDs was observed in a cross-legged sitting position on the floor; while, the lowest level of MSDs was found in the sitting on a chair posture. In addition, participants who used a desk in order to increase the height of the laptop, reported lower level of MSDs than when they used laptop at the cross-legged position on the floor or sitting on the bed.

1. Introduction

Musculoskeletal Disorders (MSDs) are considered among the major problems in industrialized countries [1]. According to the Bureau of Labor Statistics of the United States of America (2014), MSDs accounts for 32% of all injuries and diseases [2]. MSDs are the main cause of work absence in 40% of cases [3]. According to the United Kingdom Labor Force Survey (2015), 9.5 million working days are lost due to musculoskeletal disorders, which is equivalent to 17 days per person [2]. These disorders have serious effects on the economy, reduced productivity, and early disabilities [4-6].

MSDs are the most expensive forms of labor disability [7] and impact many people [8]. MSDs occurs following damages to the muscle, bone, nerve, tendon, tendon sheath, or synovial tendon sheath lubrication [9]. MSDs is associated with tension, fatigue, soreness, heat or tremor in the affected area [10]. Short-term discomforts can predict musculoskeletal pain in the future [10-15]. Prior research reported that discomfort in the neck and shoulder regions are significantly associated with the prevalence of tendonitis in the upper limbs within a period of 4 to 5 years. Cumulative stress in the waist has also been reported to be associated with the future development of low back pain [10].

Women are more susceptible to MSDs due to lower muscle strength, higher flexibility, and less pain threshold [16]. Computer users are significantly susceptible to MSDs, too [2]. Many recent studies have evaluated the effects of computer use on people's health [8]. These studies argue that the prevalence of MSDs is increasing in computer users [17] and it is even higher than some other occupations, like manual labor [18].

In recent years, laptops have been used more than desktop computers among people, and especially students. A study on 30616 students revealed that the number of laptop users has been increased from 66% in 2006 to 88% in 2009, while during this period, the number of desktop users have been decreased from 71% to 44% [19]. According to D'Silva (2016), 46.8% of US students used laptop in 2004, which reached 90% over the 10 years [20]. Laptop is among the electronic devices which can be used in any circumstances due to its portability; thus users can have a variety of postures while working with it [21]. In addition, the special design of laptops has led to increase in the frequency of bending the neck, applied torque, tissue stress, and physical discomfort [22].

Various studies demonstrated that the odds of developing MSDs is higher in working with laptop than using desktop computers [19, 23]. In addition, the comparison of MSDs among men and women has revealed that during work with laptops, women report more discomfort than men [24]. Researchers have also reported the lower level of pain threshold [25], more working hours with laptop [24, 26], and smaller skeletal systems in women, than men [24].

On average, each student spends 21.3 hours per week and 8.8% of students spend more than 40 hours per week on the internet [19]. Among which, women spend more time working with laptops per week [26] and spend more hours in sitting position for studying and working with laptops. Therefore, it can be expected that many of them suffer from MSDs due to inappropriate postures.

Smith et al. (2009) estimated that 2.52 million students suffer from upper limbs MSDs before being hired [19]. In addition, given the importance of preventing musculoskeletal disorders, also the expanded use of laptops among students, identification of postures with the least musculoskeletal injuries will greatly help to prevent such disorders, especially for the students, as the next generation of labor force. Therefore, the current study aimed to compare the MSDs in six frequent postures of using laptops for 10 minutes among female students of University of Tehran, Tehran, Iran.

2. Materials and Methods

This was a crossover trial study. The participants were randomly assigned into the groups of different postures for laptop use within a period of six continuous nights.

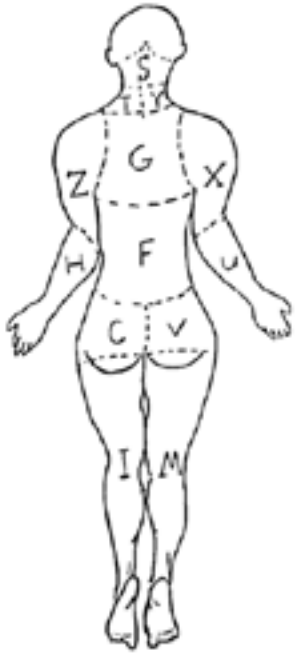
Participants

The study population consisted of the female students of University of Tehran. Available population was all female students who lived in dormitories of University of Tehran. Of them, 30 female students voluntarily and purposefully participated in this study. They met the inclusion criteria and attended the evaluation session. Students who had at least 1-year experience of working with laptop, lacked any acute and chronic pain during the study [21, 27, 28], and were right handed attended the study [21, 29].

At first, the aim and procedure of the research were described to the study participants and a written consent was obtained from them for participation in the study. During the research process, 12 participants were excluded from the study due to working with laptops an hour before the time of assignment to the desired posture, or they were reluctant to continue attending the study. Eventually, 18 students participated in all stages of the study. The study participants were not allowed to use laptop accessories like cool pad and mouse during the testing process.

Data collection

The musculoskeletal discomfort was defined as any burning sensation, fatigue, stiffness, heat, or vibration in the affected area. Musculoskeletal discomfort was measured by Localized Musculoskeletal Discomfort (LMD). LMD is usually used for evaluating the severity and number of affected areas of musculoskeletal discomfort in most relevant studies [6, 19, 21, 30]. The LMD method was introduced by Van der Grinten and Smitt in



10= Extreme discomfort (almost maximum)

9=

8=

7= Very high decomfort

6=

5= High decomfort

4= Somewhat high decomfort

3= Moderate decomfort

2= Little decomfort

1= Very little decomfort

1/2= Extremelly little decomfort

0= No decomfort

Figure 1. Body regions of discomfort

1992 [10]. The basis of this approach is the Berg Rating of Perceived Exertion (RPE) scale.

Participants should report any type of discomfort by selecting a number from 0 to 10 which represents the level of perceived musculoskeletal discomfort. Zero indicates lack of perceived discomfort, and 10 represents the highest level of discomfort. Participants were asked to identify the severity of discomfort in 13 areas of the body (Figure 1). The sum of 13 scales were considered as the total score for the musculoskeletal discomfort in the entire body.

Intervention

The researcher selected six frequent postures of working with laptops after interviewing 300 female students residing in the dormitory of University of Tehran and asking about their common postures while working with laptop (Figure 2). Then, six tasks similar to working with laptop including a combination of clicking, dragging, reading and typing were designed by the researcher. The participants were randomly assigned into the groups of common postures of laptop use for six consecutive nights; 10 minutes per night [28]. More than that time, users may adjust their postures because of the limited condition. Also, in similar research studies, users reported discomfort after 10 minutes of working with computers or laptops [28, 31].

A map of human body was provided to each participant immediately after completing work with laptops, (Figure 1). Participants must first determine the letter representing the segment in which they felt discomfort from the 13 regions of human body map. Then, rate their level of musculoskeletal discomfort from 0-10. The designed

P1: (Posture) person sat on the floor. The knee was extended and laptop on the femur.

P2: person sat on the floor. The knee was extended and laptop on the pillow.

P3: person sat cross-legged on the floor and laptop on the floor.

P4: person sat cross-legged on the bed laptop on the chair.

P5: person sat on the chair. One knee flexed and laptop on the table.

P6: person sat on the chair and laptop on the table.

Figure 2. Six different common postures of students when using laptop

computer task consisted of a collection of tasks including typing, dragging, dropping, and drawing shapes which were identical for everyone.

Statistical analysis

Descriptive statistics were used to describe the participants. Shapiro-Wilk test of normality was used to examine the normal distribution of data. To determine differences among different postures, repeated measures Analysis of Variance (ANOVA) and Bonferroni post hoc test were used. All statistical methods were performed using SPSS at the significance level of $P \leq 0.05$.

3. Results

The demographic characteristics of the study participants are presented in Table 1. The obtained results suggested that the highest musculoskeletal discomfort was observed in the crossed leg posture on the floor. Also, the lowest discomfort was observed in the use of table while working with laptops. There was a significant difference between musculoskeletal disorder in six postures (P=0.005). Also, the results of Bonferroni post hoc test revealed a significant difference between P5 and P3 (P=0.039), as well as between P5 and P4 (P=0.011) postures (Table 2).

Table 1. Descriptive characteristics of the participants (Mean±SD)

Variable	N=18
Age, y	26.90±3.03
Sanding height, cm	164.16±4.79
Body mass, kg	55.26±7.21
Body mass index, kg/m^2	20.48±2.36

PHYSICAL TREATMENTS

Table 2. Results of inferential statistic

Postures	Mean±SD	95% CI		P of ANOVA	Post Hoc ANOVA P
		Lower Bound	Upper Bound		
P_1	15.05±10.82	9.68	20.43	P_1 vs. P_2	1
				P_1 vs. P_3	1
				P_1 vs. P_4	1
P_2	12.72±10.41	7.55	17.90	P_1 vs. P_5	0.105
				P_1 vs. P_6	0.107
P_3	18.78±15.53	11.05	26.50	P_2 vs. P_3	1
				P_2 vs. P_4	1
				P_2 vs. P_5	1
P_4	15.11±8.11	11.08	19.14	P_2 vs. P_6	1
				P_3 vs. P_4	1
				P_3 vs. P_5	0.039†
P_5	9.33±7.24	5.73	12.94	P_3 vs. P_6	0.076
				P_4 vs. P_5	0.011†
P_6	9.77±9.61	5	14.55	P_5 vs. P_6	1

0.005*

PHYSICAL TREATMENTS

* Significantly different between the postures; † Significantly different compared with P_5 group ($P \leq 0.05$).

4. Discussion

The present study aimed to compare musculoskeletal discomfort among six common postures for laptop use after 10 minutes of using laptops in female students of University of Tehran. Results indicated that the differences in the perceived musculoskeletal discomfort between the positions that participants who used a table and a chair (P5) was significantly less than sitting in a cross legged position on the floor or bed (P3 and P4).

The obtained results of this study are consistent with the results obtained by Gold et al. Asundi et al. Moffet et al. and Fogleman et al. [21, 32-34]. The aforementioned investigations indicate that the perceived musculoskeletal discomfort has increased with decreased laptop height below the line of sight. Gold et al. (2012) evaluated kinematics and discomfort in 3 postures while working with laptop. They concluded that discomfort and non-neutral shoulders, elbows, wrists, and neck in the prone posture were more frequently reported than the posture of sitting on the couch in different states [21].

Fogleman et al. investigated the association between the screen height and keyboard dimensions on perceived discomfort in six areas of the body. They found that the lower height of the screen (below the line of sight) and the keyboard (below-elbow) was associated with increased perceived discomfort in the head/eye and shoulders/lower back, respectively [32].

Two important features of the laptops include the desktop screen connected to the keyboard and the effect of angle between the keyboard and screen on the screen light. This matter limits adjusting the position of keyboard, and screen that are the main determinants of the posture [27]. In the present study, by decreasing the laptop height (in the crossed-legs position) the study participants could increase the angle between the keyboard and screen, in order to increase the dominance over the laptop screen.

According to Villanuevaimbg et al. it requires the adoption of a forward head posture leading to increased stress on the extensor muscles of the neck [35]. In addition, in the postures that the height of the laptop is low, the keyboard is also lower in height than the elbow level. Thus, according to Simoneau et al. it leads to an increase in the extension of user's wrist [36]. Mene'ndez et al. stated that over 50% of the reported pain by students is due to working with computer [19]. Moreover, according to Chang et al. the use of more than 3 hours of computer per day doubles the odds of developing MSDs [19]. As a result, any effective factor in preventing MSDs is important for health.

Some of the limitations of this study were the small sample size and the limited time of conducting the intervention. Therefore, longitudinal studies with larger sample sizes are required to attain more precise conclusions.

The present study compared six common postures of working with laptops after 10 minutes of using laptops among female students of University of Tehran. The obtained results recommend laptop use in a sitting position on the chair if possible. This will reduce the musculoskeletal discomfort during working with laptops. We also suggest placing and using the laptop on a table, instead of sitting on the floor or bed.

Ethical Considerations

Compliance with ethical guidelines

The study was approved by the Ethics Committee of the Sport Sciences Research Institute of Iran (IR.SSRI.REC.1397.227) and was in accordance with the Declaration of Helsinki.

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Authors contributions

Conceptualization and Methodology: Nahid Allafan, Reza Rajabi, Mahdi Bayati; Investigation: Nahid Allafan; Writing-Original Draft: Nahid Allafan, Mahdi Bayati, Shahnaz Shahrbanian; Writing-Review & Editing: All authors; Funding Acquisition: Mahdi Bayati; Resources: All authors; Supervision: Reza Rajabi, Shahnaz Shahrbanian.

Conflict of interest

The authors declared no conflict of interest.

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