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Original

The Effect of Education on Improving the Working Conditions of Computer Users

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Abstract

Introduction: A large part of the compensation payments is allocated to the musculoskeletal disorders of the injured employees. The economic losses imposed by these disorders affect not only the individuals, but also the organizations and communities. The aim of this study was to investigate the effect of educational intervention on improving the working conditions of the computer-using employees working in Yazd University of Medical Sciences. **Method:** This semi-experimental study was conducted among the employees of Yazd University of Medical Sciences. In this regard, 100 computer users were randomly selected and the study was conducted in three stages of investigating the current situation, implementing the educational intervention, and re-investigating the situation. We collected the information one month before and one month after the educational course. For this purpose, we used the Occupational Safety and Health Administration (OSHA) checklist 1910/0900 (31 questions).We analyzed the data using SPSS version 19 and run Chi-square and descriptive statistics to determine the frequency. The significance level was also considered at 0.05. **Results:** We found that the postures of the participants were unfavorable before the intervention and they were unconscious about it. However, after the intervention, we observed a significant change in their postures (P <0.05). Moreover, we investigated the effect of intervention on desk and workstation medical condition and found no significant difference between the results before and after the intervention (P> 0.05). In other words, we cannot change the inappropriately designed desk or workstation by the training intervention. **Conclusion:** Interventions based on the ergonomic training had a positive effect on the improvement of participants' posture at work. This improvement one month after the intervention can confirm the sustainable effectiveness of such programs. In addition, educational intervention did not have any effect on the workstations; the training program could not change the workstations that were undesirable in terms of ergonomics.

Keywords: Office staff; Education; Ergonomic status; Workstation

Introduction

Occupational musculoskeletal disorders, injuries, or musculoskeletal disorders of tissues are associated with risk factors in the workplace and have various names such as cumulative traumatic impairment and repetitive stretch injuries.[1] According to a survey conducted by the World Health Organization and the provided documentation by the organization in 2013, about 48 percent of all work-related illnesses are the musculoskeletal injuries. Musculoskeletal disorders are in the second rank in

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classification of health problems. These disorders impose over $ 1.2 billion as direct costs and $ 90 million as indirect costs over the governments.[2] Musculoskeletal disorders are common problems for computer users.[3] Excessive use of the computer is associated with an increased risk of pain, itching, and numbness of the neck, shoulders, elbows, wrists, and hands.[4] The review of scientific literature confirmed the relationship between computer use and musculoskeletal disorders.[5] In recent years, application of computers is necessary in almost every job and we can find fewer occupations completed without the computers.[6] Scientific reports and published articles indicate that the risk of musculoskeletal disorders among computer users is high in comparison with other occupations.[7] It is reported that 27 percent of computer users have distress in their neck and shoulders.[8] Some researchers emphasized that the prevalence of musculoskeletal disorders was higher among the computer users than the other staffs.[9] It was also reported that computer users were prone to progression of skeletal-muscular symptoms with a prevalence of 50 percent.[10]

At present, control and reduction of musculoskeletal disorders among the workforce is one of the most important problems of the ergonomic specialists around the world. In this regard, many countries set regulation to prevent from the work-related musculoskeletal disorders (WMSDs) as one of their national priorities.[11,12] A few longitudinal field studies were conducted about the effects of ergonomic interventions on the health and performance of individuals.[13] However, studies over the control strategies in the work environment showed that the staffs' efficiency would increase by conducting training courses and proper adjustments of the equipment. Staffs should be trained about proper use of well-known solutions using an intelligible language. Ergonomic training also should provide the safety and health issues.[14-16]

According to the above-mentioned ideas, continuous work with computers and sedentary conditions are the risk factors for the musculoskeletal disorders. With regard to the prevalence of these disorders, many financial and human damages can be decreased using educational courses. Therefore, the present research was carried out among the office staffs of the central building of Shahid Sadoughi University of Medical Sciences in Yazd. These staffs sit long hours at the computer desk daily while doing their job.

Methods

In this interventional semi-experimental study, 100 office staffs participated in with at least one year work experience and eight-hour shift work using the convenience sampling. We excluded the individuals who had musculoskeletal disorders caused by accidents, such as driving, etc.The study was conducted in three phases of initial evaluation, intervention, and evaluation of the intervention effectiveness.

Phase I - Initial evaluation of the work environment

Data collection was carried out using the OSHA Ergonomic Evaluation Checklist.[17] The office staffs of the central building of Yazd Shahid Sadoughi University of Medical Sciences completed the checklist (Standard No. 1910/0900) designed by the US Department of Labor's Occupational Safety and Health Department. This checklist includes 31 questions related to the standard status of working conditions, seating, using keyboard, data entry devices, monitor, work environment, and computer accessories. The questions in this checklist should be answered using the provided options: yes, no, and not relevant. The answer “yes” (in order to provide a point of interest to that question) was given one score. The negative answers received zero score and if the question was marked as not relevant (non-applicable conditions) it was ignored. In this checklist, the positive answer to all questions related to the working conditions section or a maximum of two negative responses to other questions was considered as absence

of any problem regarding the the work environment characteristics in terms of ergonomic principles. Each user evaluated the working condition and completed the checklist. Nine faculty members of Islamic Azad University of Khorasgan evaluated the scientific validity of this checklist. Its reliability was also confirmed by the Cronbach alpha coefficient (0.86).[18]

Phase II - Training intervention

The training intervention was simple, low cost (as the most important factor) and conductible:

A faculty member in the field of ergonomic training provided the theoretical and practical contents of the workshops using PowerPoint slides in two sessions of 1.5 hours. The course topics included how to sit properly, adjust the height of the chair and the table, use the soft pad for the lower back if necessary, put legs on the ground, and the appropriate angle of the knees, the distance between the table and the chair, the proper position of the keyboard and monitor, as well as stretching exercises for preventing the musculoskeletal disorders.The ergonomic training courses included 90 minutes of education on improving the posture of computer users, minimizing the pressure on the forearm, back, and neck by adjusting the body angles and postures, and practical training. The practical trainings included some applicable strategies on adjusting the body angels and posture, improving the workstation conditions by changing the height of the chair and desk, adjusting the backrest tilt of the chair, tilt of the keyboard, and height of the screen, body inclination and orientation, as well as the forearm and foot supports. These changes were according to the commonly used texts about the work environment ergonomics.[19-24]

Phase III - Evaluating the effectiveness of the intervention

One month after the intervention, a work environment ergonomic checklist was used again and the level of effectiveness of the ergonomic intervention was identified. Then, we compared the post- and pre-intervention data.We used descriptive statistics to determine the frequency and run the Chi-square to compare the scores of participants. We also compared the groups regarding the pre- and post-intervention scores. All values of P were two-sided and the P value of less than 0.05 was statistically significant.

Results

The effect of intervention on the participants' working condition:

Statistically significant results showed improvement of workstation status after the intervention (P <0.05). The frequency of correct answers rose regarding the questions 1, 3, 4, 5, 6, and 7. This indicates improvement of the individual situation in the workstation.In contrast, the frequency of correct answers to questions 2, 8, and 9 almost remained unchanged (P> 0.05), which indicates no significant difference between the pre- and post- intervention results Table 1.

The effect of intervention on the seating status:

The number of correct answers to questions 10 and 14 increased after the intervention, which indicates that the intervention had a significant effect on the correct sitting position of body (P <0.05). The frequency of correct answers to questions 11, 12, and 13 remained unchanged after the intervention that shows the intervention did not effect on the body position (P> 0.05) Table 2.

Table 1. Comparison of working condition results in performing computer tasks before and after the intervention

P	X^2	One month after intervention		Before the intervention		Questions
		Percentages	Number	Percentages	Number	
1. Your head and neck should be straight and in a line with the body (avoid bending forward or backward).						
0.0	92.81	81	81	13	13	
2.Head, neck, and body should be in a straight line (not rotated)						
0.23	2	93	93	87	87	
3. The body should be perpendicular to the ground (one may rely slightly on the back of the chair).						
0.00	89.86	85	85	18	18	
4. The shoulders and upper arms should be in a single line with the body, generally perpendicular to the ground (they should not be raised or extended to the front).						
0.00	138.90	87	87	4	4	
5. The upper part of the arms and elbows should be close to the body (they should not be stretched out).						
0.00	155.44	91	91	3	3	
6. Forearms, wrists, and hands should be straight and in one line (forearms should have an angle of about 90 degrees with the arm).						
0.00	172.99	97	97	4	4	
7. The hands and wrists should be straight (not bending upwards, downwards, or towards the little finger).						
0.00	165.76	94	94	3	3	
8. The thighs should be parallel to the ground and the forelegs should be perpendicular to the ground (the thighs may be placed slightly above the knees).						
1	0.00	97	93	97	93	
9 .The feet soles should be on the ground or on a footrest.						
0.62	1.02	99	99	97	97	

Table 2. Evaluation of the seat before and after the intervention

P	X^2	One month after intervention		Before the intervention		Questions
		Percentages	Number	Percentages	Number	
10. The backrest should support the back.						
0.00	135.83	96	96	14	14	
11. The width and depth of seat should be suitable for the user (the seating space should not be very large or very small).						
1	0.00	94	94	94	94	
12. The seat front should not press against the back of the knees and legs (the sitting space width and length should not be large).						
1	0.00	93	93	93	93	
13. The seat should have a cushion with round edges and should be in a cascade mode (without sharp edges).						
1	0.00	99	99	99	99	
14. If the seat has arms, they should support both forearms during working and should not interfere with the movement.						
0.00	44.52	92	92	49	49	

Table 3. Evaluation of keyboard and other data entry devices before and after the intervention

P	X^2	One month after intervention		Before the intervention		Questions
		Percentages	Number	Percentages	Number	
15. The placement site of the data entry devices is fixed and is large enough to put the keyboard or other data entry devices on it.						
0.72	0.52	97	97	95	95	
16. The data entry devices such as mouse are located close to the keyboard and there is no need to lift the hands.						
0.18	6.36	88	88	74	74	
17. Application of the data entry devices is convenient and their size and shape are proportional to the user's hand size(not too large or very small)						
0.00	132.87	96	96	85	85	
18. The hands and wrists should not lean with sharp edges.						
1	0.00	1	1	1	1	

The effect of intervention on the status of keyboard and other data entry devices:

The number of correct answers to question 17 increased after the intervention. A significant difference was observed between the scores before the intervention and one month after the intervention (P <0.05). The frequency of correct answers to questions 15, 16, and 18 remained almost constant, which indicates no significant difference between before and after the intervention (P> 0.05) Table 3.

Table 4. Evaluation of the monitor before and after the intervention

P	X^2	One month after intervention		Before the intervention		Questions
		Percentages	Number	Percentages	Number	
19. The monitor screen should be in the same level with or lower than the eye. In order to look at the screen, you should not bend down or backward.						
0.00	34.68	97	97	64	64	
20. The monitor distance should allow you to see it without bending the head, neck, or body backward or forward.						
0.00	0.00	78	78	78	78	
21. The monitor should be right in front of you, so that you can see it without turning your head and neck.						
0.00	72.32	99	99	45	45	
22. There should be no stunning reflection (for example, due to the light from windows, lamps, etc.) on the screen that forces you to change your body position inappropriately to see the information.						
0.00	10.52	100	100	90	90	

Intervention Effect on monitor status:

The frequency of correct answers to questions 19, 20, 21, and 22 increased after the intervention, which indicates that the training course affected the adjustment of the distance and angle of the monitor (P <0.05) Table 4.

The Effect of intervention on the table and workstation status:

In this case, the frequency of correct answers to questions 24 and 25 remained constant, which indicated that the intervention did not have any effect (P> 0.05). In other words, design problems could not be changed by the training intervention Table 5.It should be noted that answers to questions 23, 26, and 27 were incomplete and these questions were not analyzed statistically.

The effect of intervention on accessories:

Increase in the number of correct answers to questions 29 and 30 indicates that the intervention improved the body condition while using the accessories (P <0.05). The frequency of correct answers to question 28 remained constant after the training course, which indicated that the situation remained the same and no difference was observed before and after the intervention Table 6.

Table 5. Evaluation of the desk and workstation before and after the intervention

P	X^2	One month after the intervention		Before the intervention		Questions
		Percentages	Number	Percentages	Number	
24. There is enough space between the upper thighs and the computer desk / keyboard (the thighs are not under pressure).						
1	0.00	97	97	97	97	
25 The foreleg and feet have enough space under the work surface, so you can get close enough to the keyboard or data entering devices.						
1	0.00	72	72	72	72	

Table 6. Evaluation of the accessories before and after the intervention

P	X^2	One month after intervention		Before the intervention		Questions
		Percentages	Number	Percentages	Number	
28. The resting place of the wrist or palm should have a cushion with no sharp or angled edges to press the hand.						
1	0.00	62	62	62	62	
29. Resting place of the wrist or palm should be in the same level with the keypad or other data entry devices						
0.00	66.93	62	62	7	7	
30. If your head is straight (not bent) and the shoulders are comfortable (not up), you should be able to use the phone and the computer at the same time comfortably.						
0.00	120.61	95	95	18	18	

Table 7. Evaluation of the general status of the workstation before and after the intervention

P	X^2	One month after intervention		Before the intervention		Questions
		Percentages	Number	Percentages	Number	
31 The workstation and devices are configurable so that you can work in a safe working condition and make occasional changes while working.						
1	0.00	34	34	34	34	
32. The computer, workstation, and accessories are kept in a good condition and work properly.						
0.00	118.68	87	87	10	10	
33. The computer device, its accessories, and workstation let you to change your body position and have small breaks or stops to rebuild your strength.						
0.12	4.08	100	100	96	96	

Changing the general status of the workstation before and after the intervention:

The number of correct answers to question 32 increased after the intervention, which indicates that the intervention was effective on this issue. The frequency of correct answers to questions 31 and 33 remained almost unchanged, which indicates no significant difference between before and after the intervention ($P > 0.05$) Table 7.

Discussion

In many countries, interventional studies were conducted to prevent and control the musculoskeletal disorders.[25-27] In order to reduce the workload, we need to look for a simple and effective intervention. Previous research indicated that sitting or standing for a long time prmaintaining a repetitive posture are the risk factors of the musculoskeletal disorders. In this study, interventional trainings such as the ergonomic exercises were conducted based on the mentioned risk factors. Before the intervention, the participants' postures were unfavorable at work, although the staffs did not notice it. However, after the intervention, the postures of most people improved at workstations. Increase of the correct answers to most questions after the intervention indicates that the training course had positive sustainable effects on the participants' ergonomic conditions. However, the educational interventions did not have an impact on the improvement of workstation status.

The computer users were trained regarding the favorable posture of the body; the correct working position behind the desk, the optimum angle between the monitor and the sight, the appropriate distance between the monitor and the operator, and the adjustment of the workstations appropriate to the user. Conduction of training courses on these principles helps the staffs to pay special attention to preserve their appropriate postures and consequently prevent from musculoskeletal disorders. Educational courses also enabled the staffs to adjust their work schedule to have a break time for performing stretching exercises, which can reduce the stress level of the working forces. Da costa et al. conducted a study on stretching and aimed to investigate the reduction of musculoskeletal disorders. They reported some useful effects of stretching exercises on preventing the musculoskeletal disorders.[28] Robertson et al.[29] demonstrated that the participants trained in ergonomic programs had the least musculoskeletal disorders and visual discomfort. They also had better performance than the control group.[30] Yu et al. found a significant reduction in musculoskeletal disorders of the lower extremities, wrists, and fingers in workers after the ergonomic training.[31] Mahmud et al. reviewed the effects of office ergonomic trainings on reducing the complaints of musculoskeletal disorders and improving the workstation exercises in using keyboards, monitors, and chairs. The findings indicated that the educational intervention program was effective in reducing the risk of musculoskeletal disorders and improved the workload at the

workstation significantly.[32] Sundstrup et al. investigated the effect of two types of training interventions on the reduction of chronic disability and pain in the upper extremity of people with repetitive work. The results showed that ergonomic trainings were effective in reducing these disorders.[33] Amick et al. conducted a study on the effect of the ergonomic exercises in reducing the symptoms of growing musculoskeletal disorders among staffs. They found that trainings reduced the progressing symptoms at the end of the working day.[34] Ketola et al. also examined the impact of ergonomic intervention on changing the workstation conditions and reducing the musculoskeletal disorders of the staffs working with digital devices. They concluded that the ergonomic trainings reduced the inconvenience resulted from working with digital media and improved the physical condition of the staffs working with these devices.[35] Nasiri conducted a research on the risk evaluation of the musculoskeletal disorders in administrative offices and reported that implementation of the educational interventions was effective on the reduction of this risk factor. Nasiri also stated that this program had a significant effect on the increase of the individuals' awareness about the correct way of working with equipment at the workstation. The findings of the mentioned study showed that the risk factors increased the rate of abnormalities, whereas the training courses improved the correct use of workstation equipment.[36] Furthermore, Habibi et al. conducted a study on the effect of ergonomic interventions, including training courses, exercising, and software using, on the physical condition and musculoskeletal disorders of computer users. The study showed that the ergonomic interventions reduced the participants' disorders and improved their body status.[37]

Conclusion

This study provided evidences regarding the effectiveness of the training ergonomic intervention program. Staffs should be aware of the appropriate body posture at the workstation to reduce the risk of musculoskeletal disorders. Interventions including ergonomic training had a positive impact on the body posture and increased the staffs' knowledge on how to work efficiently and safely with the equipment. It should also be noted that this change of behavior may return to its original state because staffs are not familiar with the new conditions that may arise.

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