Industrial Engineering Letters
ISSN 2224-6096 (Paper) ISSN 2225-0581 (online)
Vol.4, No.10, 2014

Musculoskeletal Discomforts in Body Posture of Computer Users: A Quantitative Analysis

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Abstract
In recent times, computer has become a common tool that is being used by almost every individual from various field of human endeavor. This is due to the fact that computer offer a lot of different services and facilities to help the users to perform and complete the task s more efficient and effective. A variety of sectors including banks, government offices, private entities, autonomous institutions etc. Have computerized their data systems for smooth and faster flow of information. Injuries due to the usage of computer system have been recognized worldwide and several actions that involved repetitive or forceful movements and the maintenance of constrained or awkward postures have also been associated with musculoskeletal visor der. Work- related musculoskeletal disorders have been found to be associated with numerous occupational risk fact ores including physical work load factors such as force, posture, movement and vibration , psychosocial stressors and individual factors. This study illustrates the idea of understanding how demographic structure (gender, age, height, and weight) physical and psychosocial job characteristics, computer usage , office ergonomics, symptoms of Work- related musculoskeletal disorders , perceived musculoskeletal discomfort types and their frequencies may affect formation of musculoskeletal disorders in the computer users. This study was conducted on a survey of questionnaires among computer users and applied a rigorous research methodology to treat the survey data. From an extensive re view of the literature in the field of computer users and their musculoskeletal disorder & body posture, 16 musculoskeletal disorders and 6 major outcomes were identified. A questionnaire survey instrument was developed, reliability of the questionnaire were tested using data from 3000 participants. The data was analysed using Reliability analysis, Pearson's correlation. It was concluded finally that the instrument presented in this paper was reliable and valid. Researchers will be able to use this for body posture analysis and gait analysis.

1 Introduction

Work- related musculoskeletal disorders have been found to be associated with numerous occupational `risk factors', including physical work load factors such as force, posture, movement and vibration, psychosocial stressors and individual factors (Bernard et al ., 1994; li and Buckle, 1999). ''Musculoskeletal disorders'' include a wide range of inflammatory and degenerative conditions affecting the muscles, tendons, ligaments, joints, peripheral nerves, and supporting blood vessels. Body regions most commonly involved are the low back, neck, shoulder, forearm, and hand, although recently the lower extremity has received more attention (Punnett and Wegman, 2004). Work- related musculoskeletal disorders (WMSDs) are responsible for morbidity in many working populations and are known as an important occupational problem with increasing compensation and health costs, reduced productivity, and lower quality of life (Motamedzade et al., 2011). Computer use at work has been implicated in the development of musculoskeletal disorders. In adults, using a computer at work is thought to be associated with musculoskeletal symptoms and clinical disorders in the upper extremities, neck and upper back (Gillespie 2006, National Research Council and Institute of Medicine, 2001).

The National Institute for Occupational Safety and Health (NIOSH, 1997) in the USA defines Musculoskeletal Disorder (MSD) as a disorder that affects a part of the body's musculoskeletal system, which includes bones, nerves, tendons, ligaments, joints, cartilage, blood vessels and spinal discs. These are the injuries that result from repeated motions, vibrations and forces placed on human bodies while performing various job actions. The individual factors that can contribute to musculoskeletal symptoms include heredity, physical condition, previous injury, pregnancy, poor diet, and lifestyle. In current era of information technology, computers are widely used by students. Developing a causal relationship between risk factor and disorder development associated with computer use has been difficult. Two of the most common potential risk factors investigated in the literature

thus far, have been posture and workstation design. Oates et al investigated computer use by elementary schoolchildren using the Rapid Upper Limb Assessment (RULA) and found that many children were placed in an "at risk of injury" posture. Laeser et al also used RULA in their investigation of the effects of computer workstation design on posture and concluded that children's' posture improved significantly at an adjusted workstation.

2 Risk Factor for WMSD'S

- **Repetition**

Performing the same or similar motions repeatedly can result in trauma to the joints and surrounding tissues. Without time for rest and recovery, repetition can lead to injury. For our review of the neck or neck/shoulder region, we chose those epidemiologic studies that examined repetition or repetitive work activities and MSDs. Studies generally address repetition as cyclical work activities that involved either: repetitive neck movements (e.g., the frequency of different head positions during a cycle), or repeated arm or shoulder motions that generate loads to the neck/shoulder area (e.g., trapezius muscle).

- **Static Loading or Sustained Exertions**

Where the muscles hold the body in a single position for a long time off period . This lack of movement reduces circulation and causes muscle tension, which can contribute to or aggravate an injury. Sustained exertions are a type of static loading where force is applied continuously for long periods of time factors (Bernard, 1997 and Washington State Department of Labor and Industries, 2002).

- **Awkward Posture**

Posture is the position of the body while performing work activities. Awkward posture is associated with an increased risk for injury. It is generally considered that the more a joint deviates from the neutral (natural) position, the greater the risk of injury (Washington State Department of Labor and Industries, 2002).

- **Mechanical Contact Stress**

No study of neck MSDs met the four criteria to address strength of association between vibration and neck MSDs. Machine operators exposed to static work and whole- body vibration were compared to carpenters exposed to dynamic physical work and presumably no vibration to see whether occupational status was related to neck MSDs (Bernard, 1997).

- **Additional Risk Factors**

While the risk factors described previously are typically found in the office environment, there are other risk factors that are more common in industrial jobs or work at home which your employees should be aware of. These include:

• Hand- arm vibration, such as when holding a power to ol
• Whole body vibration, such as when driving a car over rough roads
• Exposure to extreme temperatures, especially to cold
• wearing loose fitting gloves when working with tools

These risk factors all reduce sensation in the hands and fingers, and therefore lead to the use of too much force when gripping objects. In addition, vibration, whether to the hands or the whole body, can lead to changes in circulation and the breakdown of tissues (Washington State Department of Labor and Industries, 2002).

- **Force**

For our review, we included studies that examined force or forceful work or heavy loads to the neck and neck/shoulder, or described exposure as strenuous work involving the upper extremity that generates loads to the trapezius muscles. Most of the studies that examined force or forceful work as a risk factor for neck/shoulder had several concurrent or interacting physical work load factors. Force has generally been defined as: either externally as a load or internally as a force on a body structure, or a force magnitude expressed in Newton's or pounds or as a proportion of an individual's strength capacity, usually measured by EMG. Most studies that have dealt with force loading of the neck or stress generated on the neck structures are from biomechanical studies performed in the laboratory. In the epidemiologic studies reviewed, force is usually estimated by either questionnaire, biomechanical models, in terms of weight lifted, electromyography activity, or the variable, "heavy physical workload" (Washington State Department of Labor and Industries, 2002).

- **Factors Outside of Work**

A range of physical conditions may develop or be made worse by working with computers. By 'physical conditions' we mean problems that may affect muscles, connective tissues, tendons, ligaments, joints, bony structures, the blood supply, nerves and the skin. The symptoms associated with these conditions are sometimes given a medical diagnosis such as 'epicondylitis or carpal tunnel syndrome' or a general umbrella label such as 'gradual process injury' (the currently accepted umbrella term for these types of injury). The terms 'occupational overuse syndrome' (OOS) or repetitive strain injury' (RSI) have also been used,

amongst others. Within the literature, there are a number of umbrella terms that have been used to describe these symptoms. Many people experience upper limb, neck or back discomfort and pain, whether or not they work with computers. However, the onset of symptoms and the movements or body postures adopted while working at computers are often related. Symptoms may include: Pain, Fatigue, Muscle discomfort, Stiffness, Burning sensations, Weakness, Numbness, Tingling (DEPARTMENT OF LABOUR, 2010). (WISHA Services Division, 2002) suggested some of other factors are:

- Lack of flexibility
- Recreational activities which involve the risk factors described previously
- Computer use at home
- Predisposing medical condition

3 Research Approach

According to Creswell, the research approach (Qualitative, Quantitative, or Mixed Methods) is decided based on interrelated levels of decisions which when made dictate the approach and d the research design process. These decisions are based on which knowledge claims, strategies of inquiry, and research method is us ed. The following definitions explain research approaches: Creswell (1994) has given a very concise definition of quantitative research as a type of research that is `explaining phenomena by collecting numerical data that are analyzed using mathematically based methods (in particular statistics).

4 Instrument development

A combination of both primary as well as secondary data was used as follows:
Questionnaires were used for primary data collection. The questionnaire was developed and refined, by means of a Pilot Study, and then distributed to all respondents. The Five - point Likert scale, which is the most commonly used tool for this purpose, was utilized to identify a range of responses within the questionnaire. With this 5 - point scale the points can be labeled: - very low, low, medium, high, and very high. The literature review was used as a secondary source of data collection. This covered both general as well as more detailed information concerning different issues.

5 Questionnaire Structure

The questionnaire technique has been employing as data gathering method to obtain data from participants (Appendix A). The prepared questionnaires were distributed into 3000 participants.
The questionnaire is divided into four sections, as follow:
Question 1-8: General information of participant
Question 9-24: Questions on Input factors
Question 25-30: Questions on Output Factors

16 Input Factors

- Headache
- Overall body fatigue
- Burning eyes
- Vision is blurt
- Redness of eyes
- Pain in neck
- Discomfort level of shoulder
- Discomfort level of back
- Discomfort level of upper arm
- Discomfort level of elbow
- Discomfort level of lower arm
- Discomfort level of wrist
- Effect of work load
- Effect of body posture
- Effect of lower back
- Effect on fingers

Six Outcome Factors

- Effect of Carpel tunnel syndrome
- Effect of Back, neck, and shoulder
- Effect of Eye and vision

- Effect of Stress and depression
- Effect of Tension headaches
- Effect on Brain and Memory

6 Sample frame

In this study 3000 participants are taken, these participants are from age group 19 to 25 and these participants are computer users for more than 56 hrs. in a week . All the participants were taken from Lovely professional university, Phagwara, Punjab for quantitative analysis.

7 Data Analysis

After collecting the raw data, the responses has been coded and entered into SPSS 16 for data analysis. Method of data analysis includes.

7.1 Reliability analysis:

Reliability refers to the extent to which an experiment, test, or any measuring procedure provides the same results in repeated trials. It is a statistical measure of how reproducible the survey data are (Litwin, 1995).

Cranach's alpha is a useful statistic for investigating the internal consistency of a questionnaire and is important for the measurement of the internal consistency and deletion of individual components (Cronbach, 1951).

The reliability coefficients of sixteen input factor of computer users and six outcome factors are shown below:

Table 1 The Reliability Coefficient (Alpha) of sixteen input factors and six outcomes factors of computer users

Factors	Number of items	Items deleted	Cronbach's alpha
QUESTIONS	22	None	.960

Table 2 : A commonly accepted rule of thumb for describing internal consistency (George et al., 2003)

Cronbach's alpha	Internal consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

Based on the cronbach's alpha result shown in Table 1, all the values are within the above mention range, for 16 input factors and 6 outcome factors the value of cronbach's alpa is .960.

7.2 Correlation result between 16 input factors and 6 outcome factors:

The result of the correlation between the 16 input factors and 6 outcomes factors are shown in Table 2 Theoretically, correlation is a measure of the relationship between two or more variables. Correlation coefficient can range from - 1.00 to +1.00. The value of - 1.00 represent a perfect negative correlation while value of +1.00 represent a perfect positive correlation. A correlation between two variables means that if the one increases, the other one increases. On the other hand, a negative correlation means if one increases, the other one decreases. A value of 0.00 represents a lack of correlation. Following to this step, the relationship between the 16 input factors and 6 outcome factors was examined using Pearson correlation. The table below shows the results of this test

Table 3 Correlation result between computer users input factors and outcome factors

INPUT QUESTION		OUTPUT QUESTION					
		Q28	Q29	Q30	Q31	Q32	Q33
Q9	r	1.000**	.620**	.427**	.436**	.541**	.443**
	Sig.	.000	.000	.019	.016	.002	.014
Q10	r	.620**	1.000**	.521**	.437**	.460**	.255**
	Sig.	.000	.000	.003	.016	.011	.173
Q11	r	.427**	.521**	1.000**	.615**	.506**	.310**
	Sig.	.019	.003	.000	.000	.004	.095
Q12	r	.436**	.437**	.615**	1.000**	.565**	.479**
	Sig	.016	.016	.000	.000	.001	.007
Q13	r	.541**	.460**	.506**	.565**	1.000**	.711**
	Sig	.002	.011	.004	.001	.000	.000
Q14	r	.433**	.255**	.310**	.479**	.711**	1.000**
	Sig	.014	.173	.075	.007	.000	.000
Q15	r	.604**	.371**	.389**	.374**	.523**	.655**
	Sig	.000	.044	.034	.041	.003	.000
Q16	r	.406**	.437**	.423**	.412**	.688**	.646**
	Sig	.026	.016	.020	.024	.000	.000
Q17	r	1.000**	.620**	.427**	.436**	.541**	.443**
	sig	.000	.000	.019	.016	.002	.002
Q18	r	.620**	1.000**	.521**	.437**	.460**	.255**
	Sig	.000	.000	.003	.016	.011	.173
Q19	r	.427**	.521**	1.000**	.615**	.506**	.310**
	sig	.019	.003	.000	.000	.004	.095
Q20	r	.436**	.437**	.615**	1.000**	.565**	.479**
	sig	.016	.016	.000	.000	.001	.007
Q21	r	.541**	.460**	.506**	.565**	1.000**	.711**
	sig	.002	.011	.004	.001	.000	.000
Q22	r	.443**	.255**	.310**	.479**	.711**	1.000
	sig	.014	.173	.095	.007	.000	.000
Q23	r	.604**	.371**	.379**	.374**	.523**	.655**
	sig	.000	.044	.034	.041	.003	.000
Q24	r	.406**	.437**	.423**	.412**	.688**	.646**
	sig	.026	.016	.020	.024	.000	.000

8 Discussion

From the results of 16 input factors and 6 outcome factors of computer users, it can be concluded that computer users has many musculoskeletal disorders. These musculoskeletal disorders in back, lower back, neck and shoulder. Carpel tunnel syndromes in wrists, elbow s, lower arm, upper arm and the numbness in the fingers. Eye and vision problems like burning eyes, blurred vision, redness in eyes and eye fatigue (asthenopia). Stress and depression in computer users like frequent headaches, short temper, sleeplessness and depression. Tension headaches in computer users pain in head, scalp or neck and backache, Brain and Memory problems among computer users. These musculoskeletal disorders among computer users shows that there are overall body fatigue and tiredness during or after working at the computer which leads wrong body posture of the body. Thus from the correlation analysis it is clear that all the input factors and outcome factors are positively correlate d with each other. In summary, by looking at the correlation of the 16 independent factors with 6 outcome factors, there is evidently significant multi- co - linearity. The correlation coefficients were in the range of 0.000 to 0.173 between 16 input factors and 6 outcome factors. From the Table 4.7 correlation between headache an d output factors is (r=.722) (P<.000) . It shows that the headache is positively correlated with output factors. Correlation between overall body fatigue and output factors (r=.699) (P<.000) and correlation is positive. It shows that overall body fatigue has the cause of different musculoskeletal disorders and body posture of the computer users. Correlation between burning eyes and output factors (r=.746) (P<.000) and correlation is significantly positive. Correlation between distance vision and output factors (r=.788) (P<.000). Correlation between redness of eyes and output factor (r=.840) (P<.000). Correlation between burning eyes, distance vision and redness of eyes with output factors is positive. It shows that the disorders in eyes and vision are related to the musculoskeletal disorders in the computer users. Correlation between pain in neck and output factors (r=.720) (P<.000). Correlation

between shoulder and output factors (r=.637) (P<.000). Correlation between neck and shoulder and output factor is positive. It shows that long use of computer has neck and shoulder problems. Correlation between back and output factors (r=.671) (P<.000) and it is positive. This shows that computer u seers have significantly back problems. Correlation of upper arm and output factor, elbow and output factor, lower arm and output factor & wrist and output factors (r=.722) (P<.000), (r=.699) (P<.000), (r=.764) (P<.000) and (r=.788) (P<.000) respectively. Correlation between them is positive and it shows that computer users have carpel tunnel syndrome and positively related to musculoskeletal disorders in computer users. Correlation between work load and output factors (r= .840) (P<.000) and it is positive. It shows that more work load leads the more disorders in computer users. Correlation between body posture and output factor (r=.720) (P<.000). Correlation between lower back and output factor (r=.637) (P<.000) shows that correlation between lower back and output factor is positive, so lower back has positively correlated with the musculoskeletal disorders.

9 Conclusion

The following section provide, in detail, the result and discussion of experimental analysis , reliability analysis and correlation analysis. Reliability analysis and correlation analysis shows that the input factors are positively correlate with output factors. So this concludes that all the participants are having musculoskeletal disorders .

10 Future scope

- It is recommended that the same study be performed with a larger sample size at a future date on employees of sectors like; call centers, banks, service centers, IT sectors etc. .
- This research can be analyze by using different techniques like electromyography, Pressure and force platforms, video system like motion capture, still cameras etc.
- In this study, the respondents were from age group of 19 to 25. However, to minimize biasness in the responses in future studies, the data needs to be collected from multiple levels of group.

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Appendix A
Questionnaires
Q 1 Name
Q 2 What is your Gender?
Male Female
Q 3 What is your age?
16 to 20
20 to 24
24 to 28
Q 4 How tall are you in cm?
Shorter than or equal to1.50 cm
1.51 to 1.60 cm
1.61 to 1.70 cm
1.71 to 1.80 cm
More than 1.80 cm
Q 5 What is your weight?
Less than 50 kg
51 to 60 kg
61 to 70 kg
71 to 80 kg
More than 80 kg
Q 6 Type of computer you use?
Desktop
Laptop
Pocket PC
Mini computer
Q7 Your Work duration in a day?
Less than 2 hours
2 to 4
4 to 6
6 to 8
More than 8 hours
Q 8 How many years you being using computer?
Less than 1 year
1 to 3
3 to 5
More than 5
Input factors
Please respond to the following questions by tick one of the number
1- Very low 2- low 3- medium 4- high 5 - very high
Q 9 Extent to which headache during or after working at the computer
[1] [2] [3] [4] [5]
Q 10 Extent to which the Overall body fatigue or tiredness during or after working at the computer
[1] [2] [3] [4] [5]
Q 11 Extent to which the burning eyes during or after working at the computer
[1] [2] [3] [4] [5]
Q 12 Extent to which the distance vision is blurt when looking up from the computer
[1] [2] [3] [4] [5]
Q 13 Extent to which Redness of eyes after working at the computer
[1] [2] [3] [4] [5]

Q 14 Extent to which Pain in neck during or after working at computer
[1] [2] [3] [4] [5]
Q 15 Extent to which Discomfort level of Shoulder during or after working at computer
[1] [2] [3] [4] [5]
Q 16 Extent to which Discomfort level of Back during or after working at computer
[1] [2] [3] [4] [5]
Q 17 Extent to which Discomfort level of Upper arm during or after working at computer
[1] [2] [3] [4] [5]
Q 18 Extent to which Discomfort level of Elbow during or after working at computer
[1] [2] [3] [4] [5]
Q 19 Extent to which Discomfort level of Lower arm during or after working at computer
[1] [2] [3] [4] [5]
Q 20 Extent to which Discomfort level of Wrist during or after working at computer
[1] [2] [3] [4] [5]
Q 21 Extent to which Effect of work Load during or after working at computer
[1] [2] [3] [4] [5]
Q 22 Extent to which Effect of body posture during or after working at computer
[1] [2] [3] [4] [5]

Q 23 Extent to which Effect of Lower back during or after working at computer
[1] [2] [3] [4] [5]
Q 24 Extent to which Effect on fingers during or after working at computer
[1] [2] [3] [4] [5]

Outcome factors
Please respond to the following questions by tick one of the number
1- Very low 2- low 3- medium 4- high 5 - very high
Q 25 Extent to which Effect of Tension and headaches during or after working at computer
[1] [2] [3] [4] [5]

Q 26 Extent to which Effect of Back, neck, and shoulder during or after working at computer
[1] [2] [3] [4] [5]

Q 27 Extent to which Effect of Eye and vision during or after working at computer
[1] [2] [3] [4] [5]

Q 28 Extent to which Effect of Stress and depression during or after working at computer
[1] [2] [3] [4] [5]

Q 29 Extent to which Effect on Brain and Memory during or after working at computer
[1] [2] [3] [4] [5]

Q 30 Extent to which Effect of Carpel tunnel syndrome during or after working at computer
[1] [2] [3] [4] [5]

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