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Ergonomic Assessment of Workstation among Computer Users of Karachi

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ABSTRACT
Objective: *To assess the ergonomics of workstation among computer users of Karachi.*
Methodology: *It was a cross sectional study. Random selection of computer users from different organization of Karachi. The data collected from January 2012 to June 2012. We selected computer users from both gender between 17 to 41 years of age by convenient sampling. Those selected, were subjected had a work experience of about one year using computer for at least two hours. A self-administered questionnaire was used to assess the ergonomics of workstation.*
Results: *Results showed that 63% participants do not use proper back rest so the chances of developing lower back pain is also too high. And also, their seat width and depth is not comfortable and ergonomically suit them. Most of the participants responded that they have arm rest in their chairs and they usually support their forearms on the arm rest.*
Conclusions: *The symptoms increases with the increase contact time with the VDT. Most of the computer users are not working in ergonomically designed workstations. So the complaints of musculoskeletal pain among computer users of Karachi are much higher as compared to the other countries. It is recommended that organizations should follow the guidelines provided by the Occupational Safety and Health Administration (OSHA) and be encouraged to purchase adjustable equipment for accommodation of the users.*
Key words: *Work related Musculoskeletal Disorders, Assessment, Ergonomics, computer user, Workstation.*

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I. INTRODUCTION

"Ergonomics (or human factors) is the scientific discipline concerned with the understanding of the interactions among humans and other elements of a system, and the profession that applies theoretical principles, data and methods to design in order to optimize human well being and overall system". And, "practitioners of ergonomics, ergonomists, contribute to the planning, design and evaluation of tasks, jobs, products, organizations, environments and systems in order to make them compatible with the needs, abilities and limitations of people".[1-2]

Since we know what is ergonomic, it is important to know that it is also a system oriented discipline and now day it applies to all the aspects of human life and activities they perform. Since ergonomics work in all aspects, therefore sectors have been made to make it particular for a specific field or the application domains.[3] These application domains evolve constantly and are not exclusive. Every time changes are being made and new old ones are contently being replaced by the new ones. The domains represent specific human attributes and characteristics of human interaction. The domains are as followed:

Physical ergonomics is related to physical activities which are concerned with human anthropometric, biomechanical, anatomical and physiological characteristics. The topics that are relevant include work-related musculoskeletal disorder, health, posture, workplace layout, repetitive movements and materials.[4]

Cognitive ergonomics affect the interactions among the humans and elements of the system. It is concerned with mental processes for example reasoning, perception, motor response and memory. The topics that are included in cognitive ergonomics are decision making, human reliability, mental workload, human computer interaction, skilled performance, work stress and training.[5-7]

Organizational Ergonomics is concerned to optimizing sociotechnical systems, including their processes, organizational structures and policies. The topics that are included in organizational ergonomics are

work design, new work paradigms, communications, design of working times, crew resource management, teamwork, community design, participatory design, virtual organizations, quality management, cooperative work telework and organizational culture.[8-10]

As we know that ergonomics program and sector work in every aspects, therefore they do so by utilizing all the skills of many disciplines: these includes psychology, safety, medical, management, employees or associations and engineering.[11] They work as a team and together they identify the problems and evaluate the reason or cause of the problem and then they decide and plan the mode of steps and actions to be taken in order to solve the problems. Once all these things and questions have been identified and have been evaluated then ergonomics change methods are implemented.[12-14]

Now days, ergonomics have two pioneer and main objectives, regarding safety, work design issues and workplace health. The two objectives are as followed:

1. Enhance productivity and performance.
2. Prevent injury and Fatigue[15]

In order to obtain these objectives, changes are needed to be done to worker job interface. There are 4 basic methods of change implementation or work modification. These are:

1. Change the work process.
2. Change the work environment.
3. Change the work management.
4. Change the tools.[16-18]

For every field there is requirement for the process; change or substituting the work process or environment, management; the way it is managed by administrative control and implementation; how it can be implemented to others. Here, engineering controls processing. They look into how and what changes are made to work and work environment.[19] An example to engineering would be the change to product or materials, size and shape, weight of the equipment to perform work. The second method is management, the administrative control. It is really important to manage it as there can be need for changing the work environment and to change the way it works or for need of changing equipments. The last thing is the implementation of the work, the way work is implemented.[20-21] All these objectives are important in all the aspects and for all kinds of work. Whether it is regarding humans or the machine, as for the machines are used by humans and can be dangerous it not worked upon while ignoring these objectives. It's not just that these objectives are implemented only upon human or machines but entirely upon the field of ergonomics.[22-24]

The task for performing work can be done more effectively due to the interaction between the employee and the machine in a particular workspace and the environment. Here the workspace is described in terms of the size and the layouts of the machine. This will have effect on the posture of the worker and the result would be that how comfortably and efficiently the worker is able to work while utilizing the machine. Here environment is described in terms of its effects from the surrounding, such as temperature, lighting, vibration and etc.[18, 25]

The main goal of the ergonomics is to:

1. Prevent and reduce the risk of injury and fatigue.
2. Prevent musculoskeletal disorders.
3. Improve quality of work environment.
4. Improve productivity and quality of work[26]

Posture and ergonomics are widely related. The way we sit while working or the way we are used to of adopting things in a bad posture is solve through ergonomics. Since ergonomics helps in solving problems when it comes to human and its work in the same way it helps in improving our posture while working. It takes the comfort level into consideration while working or while we are at workstations. Individuals usually twist or strain themselves to reach keyboard or sit in odd contortions, which then results in pain in several body parts, such as neck, back and wrist. Among neck, back and wrist, neck and back are the most common regions that where people complain of having pain, quiet frequently.[27]

By adopting some simple posture awareness, chair consciousness and workstation modifications we can prevent problems. These are as followed:

- To sit comfortably on chair, lower the height of the chair so that back touches the chair.
- Rest the feet firmly on the floor, just in front.
- Keep the monitor screen in a centralized position so that eyes are at the same level to the tool bar.
- Keep the keyboard and mouse at the edge of the desk so that one's need not to stretch.
- Keep the mouse in a position that naturally hand and wrist fall at rest.
- Do wrist, hand, neck and back exercises on daily basis.

It is said that when an average person sits on chair 400 pounds of pressure is applied on the lower back. If the person does not exercise so the back is unable to support the body then the undergoing stain will affect other areas of the body including hand, are and wrist.[28]

The things that I have mentioned earlier are properly implemented then you will not face any problems regarding your posture, while sitting on chair. Elaborating the fore mentioned points, you can take several steps to reduce strain as you work. First consider your desk posture. You need to be sure that whenever you sit on chair your lower back should be in contact with the back of your chair. You should make sure that you maintain your natural back cure. This can be done by keep a roll up towel or lumber roll. Make sure that back of the head should be lifted and the lower back is supported. Your back should be angled a few degree in such a way that it widen the angle between torso and thighs. Your arms should be relaxed with forearms and hands parallel. The wrist and the hand should be naturally in the correct position and relaxed. Your thighs should not be stretched and should be at right angled to your torso and knees at right angle to thighs.[29]

Remember to change your position frequently and not to maintain the same posture for a long time. Last but not the least; make sure that you make use of ergonomics devices such as mouse wrist pads, back supports.[13] The objective of this research was to determine the ergonomically workstation among computer users in different organizations of Karachi. This study provide the proper guide line related to ideal ergonomics of workstation and by this study the computer users would be able to work efficiently.

II. MATERIAL AND METHODS

350 participants were randomly selected in different organization in Karachi. The duration of the study was six months from January 2012 to June 2012.The participants were randomly selected, computer users working in different organizations of Karachi and self-administered questionnaires with consent form were distributed to all participants. Participants were asked to complete the self-administered questionnaire and returned to the researcher or the person who gave it to them after one week of time. The targeted population of this study was both gender office receptionist aged between 17 to 41 years and had a work experience of about one year using computer for at least two hours were included in this study. Computer users aged above 41 years and below 17 years were excluded from this study. Those employees who had a history of severe trauma, such as a fracture, neurological injury involving the spine, shoulders or head, or a recent whiplash injury (i.e. less than two years ago) were also excluded from the study. A self-administered questionnaire was used as a data collection tool as it is useful method of covering a large population in a relatively short time and economically it is a cheap method rather than any other type of methods. This method is useful for straight forward questions and self-administered questionnaires provide more ease to the participants as participants can answer the questionnaire in their free time which may also helpful for them to consider each question carefully. The questionnaire for this study was developed to check ergonomics of workstation among computer users. The first part of the questionnaire contained questions concerned participants' demographic details: age, gender, occupations, working hours per day in front of computer, place of work, duty, and work experience. The second part of the questionnaire was consisting of questions regarding the workstation assessment, sitting posture, computer accessories and working conditions.

An inform consent form was also attached with the self-administered questionnaire and the procedure, rationale and aim of the study was fully explained to the respondents. All the data was entered in computer software Statistical Package for Social Sciences (version 20.0). Descriptive statistics were applied out to summarize the data. Frequency and percentages were calculated for qualitative variables i.e. gender, working hours. Each question was coded according to the number of options and a unique code was used for each option of the closed questions.

III. RESULTS

Age of the participants has been ranged from 17 years to 41 years. 23.7% participants were found in the group whose age ranges from 32 to 36 years. In the group whose age ranges from 27 to 31 years were 23.4%. Those participants whose age ranges from 37 to 41 years were 23.4%. 14.9% was found in the group whose age between 22 to 26 years whereas 14.6% was found in the group whose age lies between 17 to 21 years. Out of 350 male participants were 54.3% while female were 45.7%. Participants had more than 5 years work experience were 41.5%, 27.5% participants had work experience of 3-5 years whereas 31% participants had 1-2 years work experience. 40% participants spent 7-8 hours in front of computer, 33.7% spent more than 9 hours, 13.4% spent 2-4 hours whereas 13% participants spent 5-6 hours in front of computer. 57.8% participants had complained of pain when they started their work, 31% participant's pain increased when they started their work whereas 11.2% participants had no relationship between pain and work. In working condition out of 350 participants, 67.4% participants hadn't place their head and neck to be about upright position where as 31.7% participants had place their head and neck in upright position. 61.1% participant's head, neck and trunk not face forward during working whereas 38.9% participant's head, neck and trunk face forward. 76.9% participant's

trunk to be about perpendicular to floor whereas 22.6% participant's trunk not perpendicular to floor. 74% participant's shoulders and upper arms to be about perpendicular to floor whereas 26% participant's shoulders and upper arms not perpendicular to floor. 70.6% participant's upper arms and elbows not close to body whereas 29.4% participant's upper arms and elbows close to body. 75.7% participant's forearms, wrists and hands straight and parallel to floor whereas 24.3% participant's forearms, wrists and hands not straight and parallel to floor. 78.3% participants did not take micro breaks or recovery pauses while at the VDT workstation whereas 19.2% participants take micro breaks at the VDT workstation.

Out of 350 participants, in seating 63.1% participants had not backrest support for lower back whereas 36.9% participants had backrest support for lower back. 60.6% participants didn't accommodate their seat width and depth whereas 39.4% participants accommodate their seat width and depth. 66.3% participant's seat armrests did not support forearms while accommodate their seat perform VDT tasks and interfere with movement whereas 33.7% participants had supported armrest while accommodate their seat.

Table IV-1: Demographic Data

Demographic Data	Frequency	Percentage
Age of the Respondent (N= 350)		
17 to 21 years	51	14.6
22 to 26 years	52	14.9
27 to 31 years	82	23.4
32 to 36 years	83	23.7
37 to 41 years	82	23.4
Gender of the Respondent (N= 350)		
Male	190	54.3
Female	160	45.7
Working years (N= 200)		
1-2 Years	62	31
3-4 Years	55	27.5
>5 Years	83	41.5
Time spend in front of Computer (N= 216)		
2-4 Hrs	29	13.4
5-6 Hrs	28	13
7-8 Hrs	86	40
>9 Hrs	73	33.7
Relationship Between Your Work And Pain (N= 342)		
No relation	38	11.2
Yes it starts pain	198	57.8
Yes it increases pain	106	31

Table IV-2: Working Conditions (N= 350)

Working Conditions	Variables	Frequency	Percentage
Head and neck to be about upright.	Yes	111	31.7
	No	236	67.4
Head, neck, and trunk to face forward.	Yes	136	38.9
	No	214	61.1
Trunk to be about perpendicular to floor.	Yes	269	76.9
	No	79	22.6
Shoulders and upper arms to be about perpendicular to floor.	Yes	259	74.0
	No	91	26.0
Upper arms and elbows to be close to body	Yes	103	29.4
	No	247	70.6
Forearms, wrists, and hands to be straight and parallel to floor	Yes	265	75.7
	No	84	24.3
VDT tasks to be organized in a way that allows you to vary VDT tasks with other work activities or to take micro-breaks or recovery pauses while at the VDT workstation	Yes	74	19.2
	No	274	78.3

Table IV-3: Seating (N= 350)

Seating	Variables	Frequency	Percentage
Backrest provides support for employee's lower back	Yes	129	36.9
	No	121	63.1
Seat width and depth accommodate specific employee	Yes	138	39.4
	No	212	60.6
Armrests support both forearms while employee accommodate their seat performs VDT tasks and do not interfere with movement.	Yes	127	33.7
	No	232	66.3

Table IV-4: Key Board / Input Device (N= 350)

Key Board / Input Device	Variables	Frequency	Percentage
Keyboard/input device platform(s) is stable and large enough to hold keyboard and input device	Yes	140	40.0
	No	209	59.7
Input device (mouse or trackball) is located right next to keyboard so it can be operated without reaching	Yes	136	38.9
	No	213	60.9

Table IV-5: Monitor (N= 350)

Monitor	Variables	Frequency	Percentage
Top line of screen is at or below eye level so employee is able to read it without bending head or neck forward/backward	Yes	288	82.3
	No	61	17.4
Employee with bifocals/trifocals is able to read screen without bending head or neck backward	Yes	259	74.0
	No	91	26.0
Monitor distance allows employee to read screen without leaning head, neck, or trunk forward / backward	Yes	167	47.7
	No	181	51.7
Monitor position is directly in front of employee so employee does not have to twist head or neck	Yes	151	43.1
	No	199	56.9
No glare (eg, from windows, lights) is present on screen that might cause employee to assume an awkward posture to read screen	Yes	233	66.6
	No	117	33.5
Is it adjusted to a comfortable level of brightness, contrast, font size?	Yes	160	45.7
	No	190	54.2

Table IV-6: Accessories (N= 350)

Accessories	Variables	Frequency	Percentage
Document holder, if provided, is placed at about the same height and distance as monitor screen so there is little head movement when employee looks for document to screen	Yes	143	40.9
	No	206	58.8
Wrist rest, if provided, allows employee to keep forearms, wrist and hands straight and parallel to ground when using keyboard.	Yes	251	71.7
	No	98	28.0
Telephone can be used with head upright (not bent) and shoulders relaxed (not elevated) if employee does VDT task at the same time.	Yes	85	24.3
	No	264	75.5

Table IV-7: Working Environment (N= 350)

Working Environment	Variables	Frequency	Percentage
Workstation and equipment have sufficient adjustability so that the employee is able to be in a safe working posture and to make occasional changes in posture while performing VDT tasks.	Yes	281	80.3
	No	68	19.4
VDT workstation, equipment, and accessories are maintained in serviceable condition and function properly	Yes	286	81.7
	No	60	17.2
Noise levels are conducive to concentration.	Yes	165	47.1
	No	183	52.3
The lighting is adequate for the tasks that I perform.	Yes	180	51.4
	No	169	48.2
I feel comfortable with the room temperature and air flow	Yes	229	65.4
	No	118	33.4
My work does not involve tasks that are physically demanding or cause physical discomfort	Yes	294	84.0
	No	55	15.7

IV. DISCUSSION

This is the first study assessing the ergonomics of workstation among computer users working in different organizations of the Karachi. Most of the participants in this study were middle aged people and their age varies between 27 to 41 years. And 54.3% participants were male and 45.7% were females who participated in this study. Although, a few number of participants showed that they are serving additional jobs but most of the participants in this study were working in front of computer 7 to 8 hours daily to perform different VDT tasks. Most of the population showed a positive relation between their work and pain and they responded that either pain starts or aggravate when they perform their VDT tasks and they usually take NSAIDs for the relieving of pain. Studies comparing postures under conditions of different computer monitor heights found that monitors at or slightly below eye level resulted in head tilt and head/neck postures that were in extension, compared to the "comfortable" postures reported here and in the Grey study.[9] When the participants were asked

about the ergonomics, so the result showed that most of the participants are not working in an ergonomically designed workstation and they showed their whenever they look at the monitor screen so their neck remain in flexed position rather than the neutral position. The results of this study showed that the monitor screen is too far or either too low of the users so he or she has to bent forward or to adapt a forward head and Kyphotic posture and these findings are consistent with those of Braun's study.[21] According to some researchers the further the head lean forward the more will be the chances of upper cervical flexion and lower cervical extension and development of forward head posture. [18-21]

The results showed that although a large number of population keep their arms and forearms perpendicular to the ground but their elbows and shoulders are not closed to the body rather their shoulder remain I abducted position this is usually because of the placement of the mouse or input device too far so the user had to keep his or her shoulder in abducted position.Results also showed that most of the participants do not use proper back rest so the chance of developing lower back pain is also too high. And also, their seat width and depth is not comfortable and ergonomically suit them. Most of the participants responded that they have arm rest in their chairs and they usually support their forearms on the arm rest.A large number of the population responded that their keyboard is not of standardized size so participants were found to be uncomfortable while using the keyboards. Although most of the participants responded that the upper border of the monitor screen is at their eye level so they do not need to have excessive forward movement of the neck while reading from the monitor screen either with or without bifocals or trifocals. But they also showed that the mouse or input device is not placed ergonomically. It is too far from the keyboard rather than very next to the keyboard on the right side, so either they have to lean forward or abduct their shoulder while using the mouse that may cause shoulder pain. Demure *et al.* found that new, directly adjustable furniture significantly increased wrist/hand discomfort over that of workers with dated, non-adjustable furniture, despite the presence of more precise ergonomic measures in the model. They also found that 'poor keyboard position' increased wrist/hand discomfort but 'poor layout' of the workstation, interestingly, decreased wrist/ hand discomfort.[18]

A greater number of participants responded that the position of the monitor screen is not exactly in front of them so they have to perform the twisting movement while looking at the monitor screen.Karlqvist *et al*. found the risk of musculo-skeletal symptoms in the shoulder (scapular), shoulder joint (upper arm), elbow and wrist to be greater when the mouse was 'non- optimally' located.[10] Cook *et al*. found an association between symptoms in the neck and arm abduction specific to mouse use. According to our polychotomous modelling, the three occupations differed from each other substantially. Among the office workers, problems associated with the mouse were emphasized. For the computer users, strain in the wrists and fingers after an ordinary workday proved to be a problem, possibly as a consequence of the worker considering the client and neglecting the need to work ergonomically. Most of the participants do not face any glare effect. But they are not comfortable with the brightness, contrast and font size and with the position of the document holder to perform the VDT tasks. Most of the respondents responded that they use wrist rest and their wrists are supported and parallel to the ground. Most of the participants answered that while operating the telephone, usually they do not keep their neck in neutral position.[12]

The participants also showed that their equipments are maintained and functioning properly and in a serviceable condition. A moderate response was found regarding the noise level and with the lighting in a workstation. A group of participants answered that the noise level and lighting effect their performance while the other group shows that the level of the noise and lighting conditions are acceptable and it does not effects on their performance. But a large number of population responded that the temperature of the room and ventilation is suitable for working and their working tasks are not too much physically stressful or they usually do not creates physical discomfort for them.

V. CONCLUSION

The overall aim of this research was to assess the ergonomics of the workstation among computer users in different organization of Karachi. The main conclusion arises from this study summarizes as the symptoms increases with the increase contact time with the VDT. Most of the computer users are not working in ergonomically designed workstations. So the complaints of musculoskeletal pain among computer users of Karachi are much higher as compared to the other countries. It is recommended that organizations should follow the guidelines provided by the Occupational Safety and Health Administration (OSHA) and be encouraged to purchase adjustable equipments for accommodation of the users. The equipments should be user friendly. The furniture in the workstation should be designed to facilitate task performance, minimize tiredness and injury by fitting equipment to the body size, strength and range of motion of the user. As ergonomically designed furniture can decrease complaints of pain and occurrence of injuries, increase productivity, improve morale, and decrease work-related musculoskeletal disorders.

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