RELATIONSHIP BETWEEN ERGONOMIC FACTORS AND HEALTH HAZARDS IN SOFTWARE INDUSTRIES (A STUDY CONDUCTED AT CHENNAI, INDIA)

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ABSTRACT

In modern era software industry is a boon for job seekers. But as a coin is having two sides one side the industry is encouraging on the other side people are encountering with health hazards. In order to prevent the health hazards we were interested to find the causes for the same. A total of 300 samples having at least five years experience were taken by convenience sampling method. The data was collected by a structured questionnaire. The findings are discussed in this paper. We have also suggested some remedial measures to prevent health hazards due to ergonomic factors.

Key Words: Ergonomic, Osteoarthritis, Carpal tunnel syndrome, Musculoskeletal problem

INTRODUCTION

Computer, a hallmark of technological advancement has ushered in a new genre of occupational health problem, i.e. of computer related health problems1. India is one of the countries where the IT Industry is developing. A lot of job opportunities are available in this field and young generations are attracted by this field both for enjoyment and earnings. India being the forerunner in the cyber world the occupational health personnel is slowly awakening to this group of modern occupational diseases, which are slowly taking its roots among the information technology (IT) professionals. These problems if ignored can prove debilitating and can cause crippling injuries forcing one to change one’s profession.

There is an urgent need to understand the dynamics of these problems and prevent it from assuming epidemic proportions working with a video display terminal (VDT) and a keyboard can be productive, rewarding and a lot of fun. Unfortunately, prolonged postures, coupled with high levels of concentration and the occasional frustration of things going less than perfectly, can lead to physical problems2. Stress can also lead to psychological problems such as depression and so on. Basic understanding in the way you “interface” with your computer can help prevent common health-related VDT and keyboard problems. A little knowledge of the principles of ergonomics, how people interact safely and efficiently with machines and their work environment, can save a lot of discomfort and maximize both productivity and enjoyment7. These factors can be divided into two types one is Working environmental factors and other is human factors.

The main ailments encountered by
ergonomic factors are:
- Visual discomfort
- Musculoskeletal problems
- Stress
- Osteoarthritis
- Carpal tunnel syndrome

The first three problems are common and we will explain in detail what is Osteoarthritis and carpal tunnel syndrome.

**Osteoarthritis**

Of all the forms of arthritis, Osteoarthritis (O.A.) is, by far, the most common.

This makes sense when we realize the nature of the disorder. O.A. is actually nothing neither more nor less than “wear and tear” of the joint surfaces. We are all familiar with that smooth, shiny cap of cartilage on the ends of chicken bones. That is a fine example of a healthy joint surface. If this bearing surface becomes roughened, cracked, dehydrated, abrasive, not so slick; when friction and wear occur with movement; that situation is O.A. This is what gives the stiffness and rigidity to the joints that limits the flexibility and decreases the ranges of motion. You then can feel the crepitus (a sound like hairs rubbed together between your fingers) caused by the roughness of the joint surfaces. And it aches!

The fact is our joints are so perfect at birth and so good at self maintenance that they could last a century or more. And they do in many people. Nobody has O.A. in all their joints, even though all your joints are the same age, so it can not be caused purely by aging. The problem is merely cumulative stress and mechanical trauma. As we get older we accumulate more and more abuse to our joints. Falls, auto accidents, sprains and the like are obvious culprits. Indeed, severe or repeated trauma will virtually guarantee O.A. of a joint.

More insidious factors such as poor posture, chronic over work, tedious, repetitious chores and prolonged postures are also hard on our joints. Some diseases processes, such as diabetes, slow down the repair processes and thus speed up joint erosion. As we age our cartilages tend to dry up and become brittle. This is especially true for those of us who do not have adequate water intake. Being overweight puts a lot more compression on the weight-bearing joints in the spine, hips and knees and feet. Finally, emotional factors such as worry, grief, anger, fear and impatience can cause our muscles, especially in the neck, to tighten to the point of jamming the joints together, creating greater friction and wear.

**Carpal Tunnel Syndrome**

Carpal tunnel syndrome (CTS) is a compression of the median nerve in the wrist. Symptoms include pain and numbness in the hand (especially at night), clumsiness, paresthesia (pins and needles), and trophic changes (such as muscle wasting). In true CTS, these are felt where the median nerve goes: the palm side of the index and middle fingers and part of the thumb and ring finger. Conservative treatment without surgical intervention will usually give relief, especially if done early after onset.

Similar symptoms can also be due to nerve compression in the neck, shoulder or arm.

<table>
<thead>
<tr>
<th>Working environmental factors</th>
<th>Human factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Visibility</td>
<td></td>
</tr>
<tr>
<td>2. Chairs</td>
<td></td>
</tr>
<tr>
<td>3. Keyboards</td>
<td></td>
</tr>
<tr>
<td>4. Mouse</td>
<td></td>
</tr>
<tr>
<td>5. Desks</td>
<td></td>
</tr>
<tr>
<td>6. VDT Keep your distance</td>
<td></td>
</tr>
<tr>
<td>7. VDT Keep fixed</td>
<td></td>
</tr>
<tr>
<td>1. Posture</td>
<td></td>
</tr>
<tr>
<td>2. Eyes</td>
<td></td>
</tr>
<tr>
<td>3. Warm ups</td>
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</tbody>
</table>
from such things as tight neck or shoulder muscles (i.e.: thoracic outlet syndrome or pectoral muscle contracture) or poor neck mechanics to name a few.

**AIMS AND OBJECTIVES**

The following are the aims of this study:

1. To analyze the ergonomic variables causing health hazards.
2. To find the proportion of people encountered visual discomfort.
3. Cause and effects of the musculoskeletal problems
4. Stress analysis
5. Relationship between various factors.

**MATERIAL AND METHODS**

A study was carried out among 300 Information Technology (IT) professionals in Chennai having minimum of five years experience to study the computer related health problems and role of ergonomic factors.

The study subjects were administered a pre designed structured questionnaire covering details like age, working hours, working environment, experiencing of any problem while working on computers and the type and kind of problems perceived.

The working environment of each individual was assessed separately with respect to position of monitor, distance of monitor from the user, use of anti glare screen, type of chair, use of foot rests, position of elbow and legs, position of body, number of breaks, and manner of holding the mouse.

The use of furniture specifically designed for computer use was taken as appropriate. In the present study sitting straight and leg at an angle with feet well supported, elbows and arms supported in neutral position while working, was taken as appropriate while any other position were considered as inappropriate.

The position of monitor in level with the horizontal gaze of the subject was taken as appropriate. The light grip used for holding the mouse was considered as correct manner of holding the mouse.

The visual discomfort due to display of terminal was also considered.

Convenience sampling technique was used to select the samples. The criteria to include the samples were the subjects should have at least five years of experience in the field. The samples were chosen from different IT companies in Chennai.

Statistical appraisal was done by using chi-square test and Correlation Normal test

**RESULTS AND DISCUSSION**

In the present study the data was collected from 300 samples out of which male 59% and female 41%. The age of the subjects varied from 28 to 48 years with mean age of 32.58 years. The computer related morbidity was found in 92% of the study subject. The visual problem was seen in 64% and the musculoskeletal in 64.5% while 62% felt stressful symptoms.

The average working hours was 9 0.35 hours respectively. The correlation between the number of people encountering visual discomfort and working stretch with monitor without breaks was very high (r = 0.7) (Table 4) which coincides with the previous findings.

Musculoskeletal problems were very high along the subjects who were not using proper ergonomic. The females reported more musculoskeletal problems (80%) when compared to male (Table 2, Graph 1). A little knowledge and awareness among the IT professionals about ergonomic factors will reduce these problems.

The study has brought forth a very high prevalence of computer related morbidity in software professionals. There was not much visual discomfort due to display quality. This is a high time to create awareness among the people regarding the uprooting health hazards as the study reveals 92% are affected by health hazards.

Stress and visual discomfort were the
other problems encountered by the respondents. Stress can be avoided by giving proper counseling and yoga etc. Visual discomfort can be avoided by giving proper working environment Table 3.

There is an immediate need for the concerned agencies to collaborate and enforce suitable preventive measures like proper counseling and educating about ergonomic factors so on\(^\text{10}\). This can lead the field as an enjoyable field to work. Constant monitoring and periodic appraisal of health problems are also required.

The authors are planning to apply a fuzzy logic technique to fit a model regarding the health hazards. Normal test

Table 1: Magnitude of Computer related problems by sex

<table>
<thead>
<tr>
<th>SEX</th>
<th>n</th>
<th>Visual discomfort</th>
<th>Musculoskeletal</th>
<th>Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yes %</td>
<td>Yes %</td>
<td>Yes %</td>
</tr>
<tr>
<td>MALE</td>
<td>177</td>
<td>121 69</td>
<td>86 49</td>
<td>78 44</td>
</tr>
<tr>
<td>FEMALE</td>
<td>123</td>
<td>71 58</td>
<td>98 80</td>
<td>48 39</td>
</tr>
<tr>
<td>TOTAL</td>
<td>300</td>
<td>192 64</td>
<td>184 64.5</td>
<td>126 42</td>
</tr>
</tbody>
</table>

Chisquare value df-1 Visual discomfort 3.56 P > .05 Statistically not significant
Musculoskeletal 29.57 P < .001 Statistically significant.
Stress .7577 P > .05 Statistically not significant

Table 2: Relation of musculoskeletal problems with ergonomic variables

<table>
<thead>
<tr>
<th>Ergonomic variables</th>
<th>Inappropriate n</th>
<th>Musculoskeletal problems</th>
<th>Absent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Present</td>
<td></td>
</tr>
<tr>
<td>Furniture</td>
<td>219</td>
<td>171</td>
<td>48</td>
</tr>
<tr>
<td>Position of body</td>
<td>126</td>
<td>91</td>
<td>35</td>
</tr>
<tr>
<td>Position of legs</td>
<td>82</td>
<td>54</td>
<td>28</td>
</tr>
<tr>
<td>Position of elbows</td>
<td>75</td>
<td>59</td>
<td>16</td>
</tr>
<tr>
<td>Position of monitor</td>
<td>232</td>
<td>191</td>
<td>41</td>
</tr>
<tr>
<td>Manner of holding the mouse</td>
<td>256</td>
<td>192</td>
<td>64</td>
</tr>
</tbody>
</table>

Chisquare value (1 df) Musculoskeletal 19.54 P < .001 Statistically significant

Table 3: Relation of visual problem with viewing distance from monitor

<table>
<thead>
<tr>
<th>Viewing distance</th>
<th>No. of persons</th>
<th>Visual problems</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Present</td>
</tr>
<tr>
<td>&lt;45cms</td>
<td>216</td>
<td>131</td>
</tr>
<tr>
<td>45-60cms</td>
<td>41</td>
<td>34</td>
</tr>
<tr>
<td>&gt;60cms</td>
<td>43</td>
<td>27</td>
</tr>
<tr>
<td>Total</td>
<td>300</td>
<td>192</td>
</tr>
</tbody>
</table>
The proportion of Male & Female affected by Visual discomfort and musculoskeletal problems are statistically significant (P<.05, P<.001) but for stress The proportion affected in male and female are statistically not significant (P>.05).

**Suggestions**

**Visibility**

You must be able to see what you are doing easily to avoid eye strain and neck pain. Have adequate amounts of light. Florescent lights are not very good, the so called “natural spectra” florescent lights are not quite as bad, incandescent lighting is better and indirect natural (sun) light is best. Reduce glare as much as possible, not only on your screen but also on the rest of your work areas including the keyboard. Hoods, drapes, glare screens and changing the lights can do wonders. Use the control knobs on the monitor, they can help you. Don’t be afraid to fiddle around with the tilt and height positions of the monitor. Rearrange things until you can see well and it feels comfortable for you.

**Chairs**

As with visibility factors, experiment with chair height and/or tilt. Try different chairs. Keep
trying until you get it the way your body likes.

**Keyboards**

Be sure to get the height right to prevent too much bend at the wrist and allow the forearm to have some support. The arms should hang loose to prevent the shoulder muscles from cramping. Many keyboards can tilt; unfortunately, most of them tilt the wrong way. If anything the keyboard should tilt to help the wrist stay straight, which is to say raising the space bar end and lowering the “top” (the F1, F2 etc.) end? Tilting the keyboard the other way, (space bar lower and “top” row higher) can predispose you to carpel tunnel syndrome.

**Mouse**

The continual clicking and small, precise motions involved in mouse use are a repetitive action that can be a health hazard. A few basic rules can help make handling this convenient input devise safer and more comfortable:

1. Hold the mouse loosely. “White knuckling” the mouse creates too much tension. Use a light touch when you click
2. Use your whole arm and shoulder to move the mouse, not just your wrist. Don’t rest your forearm on the desk while you move the mouse.
3. Do not lift your “pinkie”; use all of your fingers to lightly hold the mouse.
4. Keep your wrist relaxed and neutral, not bent. The click button should be about the same height as your keyboard.
5. Avoid prolonged postures. Rotate your shoulders; gently shake your hands and fingers four or five times per hour.
6. Left hander should use a “left handed” mouse, or configure the mouse to work best with their different (mirror image) hand shape.

**Desks**

Make enough space so that you have room to work, especially if you’re pushing your mouse around. Use a paper holder to keep letters or books semi-vertical and at eye level.

Your work space should be set up so that you need not twist your neck. Documents should be positioned at the same height and next to the VDT, especially if a lot of time is to be spent at these tasks. Make your work space user friendly.

**VDT- Keep your distance**

Electromagnetic radiations follows the inverse square rule, which is to say the further away you are from the source, the weaker they get and they do so quickly. We can protect ourselves with space. It is recommended to stay at least 75 centimeters (30 inches) from the terminal and at least one meter (40 inches) from other terminals.

**VDT- Keep it fixed**

X-ray and other radiation production increases dramatically when the VDT is damaged, improperly maintained, or just plain worn out. PCBs are sometimes released by very old VDT models (i.e. built before 1970).

**Human set up**

**Posture**

No one posture is perfect. You do not have to be “military” but getting comfortable is essential. Footrests help, (or a book or lunch pail or anything handy to rest your feet up a bit), as do cushions if your chair is not providing adequate support. The most important rule is to avoid prolonged positions. Shake your hands and shoulders now and then. Keep loose.

**Eyes**

After good lighting and avoiding glare, the most important eye consideration is to look away from the screen occasionally. It really helps. Also, don’t forget to blink. Blinking moistens the eyes to prevent burning from dryness.

**Warm up**

Just as an athlete prepares for the game by stretching and loosening the joints and muscles to prevent injury and enhance performance, you too should prepare for a marathon session surfing the Net. Do some shoulder rolls, neck stretches, wrist wiggles and
Leg stretches before you even log in? Prevention is better than repair.

**Breaks**

If you hold any part of you in one position for longer than an hour, you set your self up for stiff joints, achy muscles, and tendon fatigue and ligament weakness; not to mention decreased efficiency and diminished concentration. If you are focused on what you are doing, you can loose track of time unless you purposely schedule breaks. Have the computer clock on screen, or steal the oven timer out of your kitchen, or set the alarm on your watch, or somehow let yourself know about the passage of time. Then, at least once an hour, (every half hour would be better), get right up off your seat and walk around, stretch, yawn, wiggle, breath, get the blood flowing and stimulate the joints. It is worth the time and trouble as you will feel better, work sharper and get more done. Take advantage of un-scheduled “downtime”. Instead of staring at the little hour-glass and wishing it would go faster, do something beneficial for your body.

If you already have mechanical body problems, such as neck arthritis or carpel tunnel syndrome, it is necessary to take breaks more frequently; on the order of three or four mini-breaks per hour. Preventing a flair-up is far superior to irritating these disorders.

**Prevention of O.A.**

All this O.A. is, fortunately, preventable to a large extent. Even if we are unlucky enough to have a major trauma such as an auto accident, we can still enhance the repair mechanisms in our joints and minimize the wear that aggravates the damage by following a few simple rules:

- **Adequate Rest**: Eight hours is not a magic number. Get enough sleep at night, or combined with a nap so that you feel well rested.
- **Good Work Habits**: Taking occasional breaks to allow your body to recover is especially important when doing unaccustomed activities. Proper lifting techniques, such as using your knees to lift instead of bending your back, can save a lot of wear and tear. Don’t rush! Haste creates micro trauma to the joints, (micro trauma being little bangs and bruises, small un felt injuries that add up over time).
- **Avoid Prolonged Postures**: Moving parts want to move. Whether resting or working, holding a joint in any one position for very long leads to the formation of adhesions (sticky spots) which can damage that joints surface.
- **Proper Weight**: Avoiding the extra pounds not only helps your joints stay young, but also is very good for the rest of your body especially your heart and weight bearing parts.
- **Reasonable Nutrition**: Not necessarily becoming a health food nut, but eating a balanced diet. This should include some fresh vegetables and some fresh fruit every day. Also some foods that are high in protein. And don’t forget water; five or six glasses a day will help a lot to prevent cartilage dehydration; as will avoid excessive amounts of alcohol, caffeine, salt and sugar.
- **Keep In Shape**: Regular, mild exercise, such as a daily walk, can keep things moving nice and smoothly.

**Prevention of carpal tunnel syndrome**

**Keyboards**

Be sure to get the height right to prevent too much bend at the wrist and allow the forearm to have some support. The arms should hang loose to prevent the shoulder muscles from cramping.

Many keyboards can tilt; unfortunately, most of them tilt the wrong way. If any thing the keyboard should tilt to help the wrist stay straight, which is to say raising the space bar end and lowering the “top” (the F1, F2 etc.) end? Tilting the key board the other way, (space bar lower and “top” row higher) can set you
up for carpel tunnel syndrome.
Your health may be affected by radiation
given off by your computer. Computers do
generate very low levels of infrared light, visible
light, ultraviolet light, X-rays and
electromagnetic fields. Recent studies have
raised some concerns about ELF and VLF
waves, PCBs, ultrasound, electrostatic fields
and other emissions as well.
Extremely low frequency (ELF) electro-
magnetic waves are produced by high
voltage power lines, transformers; virtually
everywhere electricity flows, including a VDT
screen. Very low frequency (VLF)
electromagnetic waves are also emitted by
computers.
Much of the current, (no pun intended),
data regarding how much radiation is safe, and
how safe is safe, is inconclusive or even
contradictory.
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