

Full length research paper

# Computer users at risk: Health disorders associated with prolonged computer use

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By keeping in view the ISO standards which emphasize the assessment of use of a product, this research aims to assess the prolonged use of computers and their effects on human health. The objective of this study was to investigate the association between extent of computer use (per day) and carpal tunnel syndrome, computer stress syndrome, computer vision syndrome and musculoskeletal problems. The second objective was to investigate the extent of simultaneous occurrence of carpal tunnel syndrome, stress, computer vision syndrome and musculoskeletal disorders among computer users. The sample in this exploratory study consisted of 120 employees and students. Self administered questionnaire was used as an instrument in this field survey study. The findings confirmed that computer related health disorders such as carpal tunnel syndrome, stress, computer vision syndrome and musculoskeletal disorders occur simultaneously among prolonged computer users such as employees and students. The simultaneous occurrence of carpal tunnel syndrome, stress, computer vision syndrome and musculoskeletal disorders is more among employees than students and those who are both employees and students. Employees who use computer daily for more than four hours are more likely subjected to the risks of all these four health disorders. The study concludes that by observing some rules of using computer, minimizing and treating of these disorders are possible.

**Keywords:** Computer, Prolonged use, Carpal Tunnel Syndrome, Computer Vision Syndrome, Health Disorders, Employees, Students.

**Abbreviations:** Electromagnetic Field (EMF), Life Cycle Assessment (LCA), Life Cycle Inventory (LCI).

## INTRODUCTION

Contemporary technology revolution has made our lives with so much convenient that people would hardly imagine life without computer, internet, cable TV, cellular phones, various tools and gadgets. Computers are one of the main tools in businesses, educational institutes, offices, homes and even in cars. On one hand, these technologies including computers have made lives so much easy but on the other hand have created many risks for human health. The negative risks associated with the usage of these technologies are increasing with their growing demand day by day.

Every electronic device including computers and laptops produce a form of Electromagnetic Field (EMF).

This EMF is actually a non ionizing radiation which release energy from these electronic devices that is not enough to ionize the atoms, hence instead of removing electrons it only excites the electrons. This energy brings negative effects to human health. By using computers, laptops or even sitting in computerized workplaces an individual is exposed to the dangerous waves. These radiations may cause rapidly or slowly several health hazards. It means that individuals especially employees spending number of hours for working on computer are directly exposed to the harmful effects of EMF. ISO quality standards emphasize the need of measuring the quality of products throughout its life cycle i.e. from raw materials to disposal. The purpose is to produce safe environment and its components by examining the impacts of products on it. Thus, it is necessary to examine the direct or indirect effects of computers on human health because the world at this time is heavily

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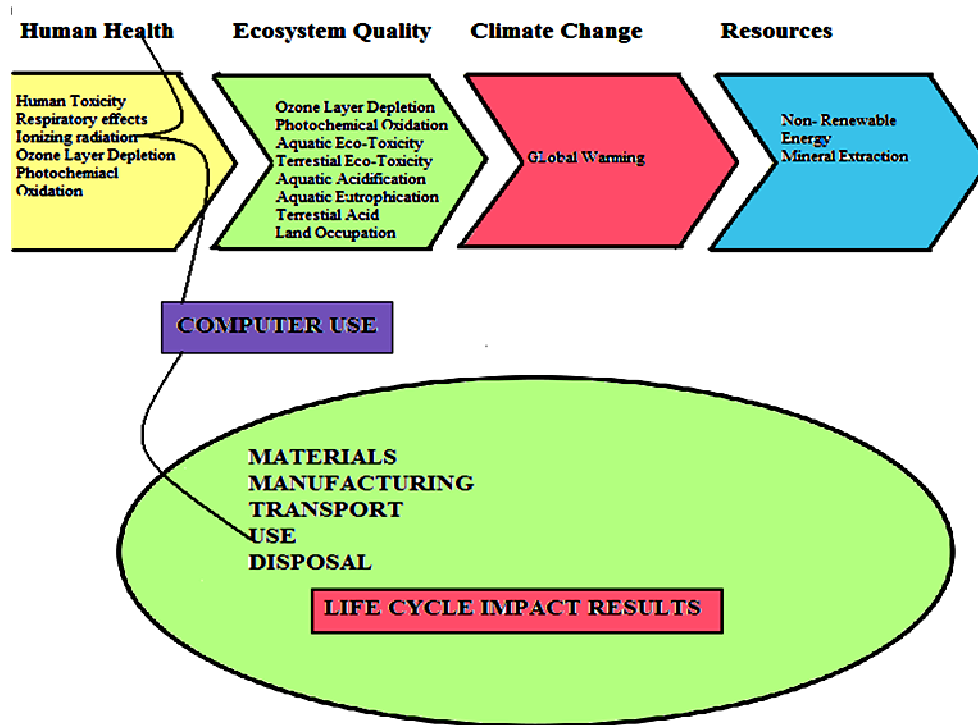


Fig 1: Life Cycle Impact Assessment Approach

dependent upon computers and it is human beings that use computers. Therefore, this study has made an attempt to investigate the reported health disorders among individuals working at computerized workplaces as a result of prolonged computer use. By conducting a field survey, computer users were asked to highlight health disorders they are facing due to extensive use of computers.

The scheme of study is as follows: After introduction, ISO 14040 Life Cycle Assessment, effects of electromagnetic fields and other risk factors on human health are discussed. After it, Research Methodology, results and findings are elaborated. Conclusion and recommendation are discussed in the last section of this paper.

**Literature Review**

**Life Cycle Assessment (LCA)**

According to ISO 14040, Life Cycle Assessment (LCA) refers to the “notion that for a fair, holistic assessment the

raw material production, manufacture, distribution, use and disposal (including all intervening transportation steps) need to be assessed”. It consists of three approaches Life-cycle management, Life-cycle inventory and Life-cycle impact assessment. The areas of protection in life cycle approach are human health, ecosystem quality, climate and resources. Life cycle impact assessment can be said as a holistic approach for environmental impacts. It represents measure of impact of a particular product e.g. computer which can damage one or more areas of production as shown in Figure 1. It not only takes into account the toxic emission from chemicals, but also considers land use, human health, radiations and loss of renewable and nonrenewable resources.

Figure 1 shows the life cycle inventory approach. It consists of life cycle results, midpoints (14 categories such as ionizing radiations, photochemical oxidations, global warming etc) and damage categories (human health, ecosystem quality, climate change and resources). The Life Cycle Impact Assessment (LCIA) methodology suggests a practical execution of a combined midpoint/damage approach, linking all types of

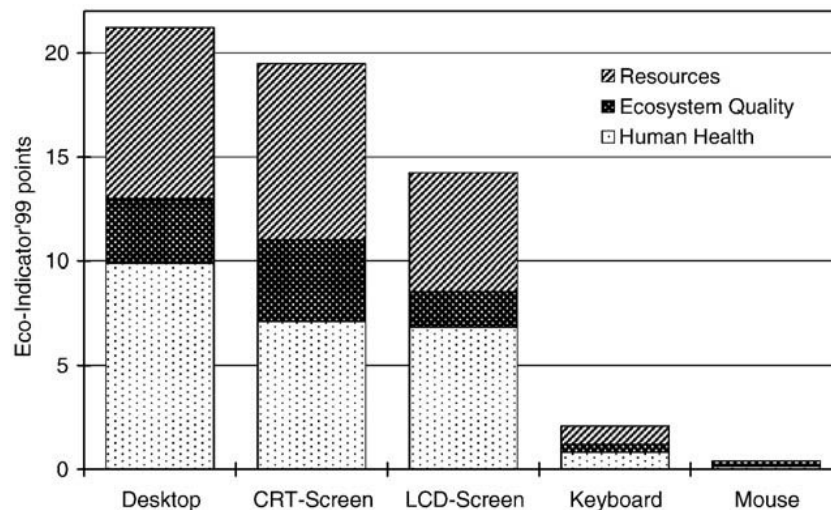


Fig 2: Environmental Impacts Caused by Production of PC System (Duan et al, 2008)

Life Cycle Inventory (LCI) results via 14 midpoint categories to 4 damage categories (Iftekhar Uddin and Jannatul Ferdous, 2010).

In one study Socolof, Overly and Geibig (2005) by using life cycle approach examined the environmental and human health impacts of functionally equivalent 17-inch CRT and 15-inch LCD computer monitors. They found that water eutrophication and aquatic ecotoxicity impacts during life cycle analysis were greater for the LCD while all other impact categories (e.g., resource use, energy, ozone depletion, landfill space use, human health toxicity) were greater for the CRT monitors. In another study Duan et al (2009) also conducted the life cycle assessment (LCA) to investigate the environmental performance of Chinese desktop personal computer system which follows the ISO14040 series. The results of their study also confirmed the environmental effects of computers. Figure 2 provides an overview of these results.

In both of studies, the effect of computer life cycle phases on environment including human health is confirmed. By keeping in view the ISO standards which also emphasize the need of assessment of use of a product, this research aims to assess the prolonged use of computers and their effects on human health.

### Electromagnetic fields and Human health

Electromagnetic fields (EMFs) are invisible lines of force that occur whenever electricity is being conducted. The two types of electromagnetic fields are ionizing and non-ionizing radiation. Ionizing radiation has enough energy to remove electrons from atoms. The loss of an electron with its negative charge causes the atom (or molecule) to become positively charged. Non-ionizing radiation is a

series of energy waves composed of oscillating electric and magnetic fields traveling at the speed of light. Non-ionizing radiation is found in a wide range of occupational settings and can pose a health risk to exposed workers if not properly controlled (Smith, 2010).

Computers are also one of the sources of electromagnetic field. However, because of complexity of the computer circuit the radiation mechanism of every part of a computer is not easy to explain therefore, currently no "electromagnetic radiation model" for whole computer system is available (Hong-xin et al., 2003). One of the reports of NYSUT federation explains that when a ray of oscillating electrons hit the bright surface of a computer screen, it produces a radiant image along with emitting radiations in the environment. These electrons hitting the computer screen also produce pulse electromagnetic radiation (PEMR) which continues for a number of hours even after the turning off the computer and negatively affect living cells.

The hazardous effects of these electromagnetic fields on human health are not explored in a comprehensive manner in research. There are few studies concerning this issues e.g (Barnes, 2006; Mercola, 2010; Kanapeckas et al., 2007). These few studies have focused on the effects of prolonged computer usage on health in form of ion depletion in air, environment due to monitors, radioactive emission from monitors (x-rays/gamma rays, ultraviolet); glare and reflection from monitors; electrical field radiation, electromagnetic field from monitors; static voltage build from monitors; chemical outgases from computer hardware materials and ergonomics (Lee, 1994). Briggs-Kamara1et al., (2009) conducted a research to investigate the impact of computer and photocopier operations in environment of Nigerian University. Their study confirmed that radiation profile of the University shows on the whole health risks.

**Table 1:** Additional Risk Factors

<b>Risk factors</b>	<b>Description</b>
Awkward posture	Includes computer keying with the wrists bent reaching for the mouse
Repetition	Performing the same motion such as keying, using a mouse, or other task every few seconds or on a continuous basis for hours at a time or even the whole work shift
Duration/lack of recovery time	Working long periods at a computer or other job without breaks and changing tasks
Force	The effort it takes to move an object or to remain in a sitting, standing or other position for a long time (prolonged static exertion). Another type of force, known as contact stress comes from pressure against a part of a body, such as resting the wrists against a hard and/or sharp edge
Uncomfortable environment	Poor air quality, improper lighting, glare, noise and other conditions
Organization of work	Includes factors such as staffing levels, scheduling, workload and job pacing, electronic monitoring, performing monotonous tasks, and the amount of control workers have over how they perform their jobs. These are sometimes referred to as psychosocial factors

Source: AFSCME, 2006

Chad-Umoren et al. (2006) in two separate studies evaluated the radiation profile of the indoors and outdoor environment of physics laboratory of the Rivers State College of Education, Port Harcourt, Nigeria. Kanapeckas, et al (2007) in their study measured radiations of electromagnetic fields at 124 workplaces in 42 rooms of Kaunas University of Technology (KUT). They found that radiation level is well below the measured harmful level. Several researches conducted by Center for Radiological Health and Devices, Food and Drug Administration (FDA), Bell Laboratories show that Computer video display terminals "...emit little or no harmful ionizing (e.g., x-rays) or non-ionizing (e.g., infrared) radiation under normal operating conditions."

As there is lack of comprehensive research regarding hazardous effect of computer radiations, therefore, some sources warn about violent impacts over people's health while other sources are in doubt about these effects. The reason behind this is that mostly researchers have analyzed statistical data, for example range of frequencies and level of radiations etc; thus, it is difficult to evaluate the pure impacts on health.

### **Additional Risk Factors for Human Health**

According to Marriam- Webster Dictionary (2010) risk factor is "something that increases risk or susceptibility". It can be said as the probability to occur a particular disease in a person. It can include working conditions as well. The risk factor associated with prolonged use of computer may cause many health problems. The most common risk factors that are source of most of health

problems or injuries in computer users are shown in Table 1 and figure 3.

Many researchers have confirmed that these risk factors have caused several diseases. The effects of computer work have been reviewed by some researchers. Punnett and Bergqvist (1997) reviewed 56 epidemiological studies on effects of computer work and concluded that use of computer and keyboard directly causing hand and wrist disorders and less consistently causing neck and shoulder disorders. Blatter and Bongers (2002) found that about four hour use of computer per day produces musculoskeletal disorders of neck or upper limb in women and six hours or more of computer use causes these symptoms in men. Keir et al., (1999) in their study calculated carpal tunnel pressure among 14 individuals working with 3 different mice. They confirmed that use of mouse is a cause of increasing carpal tunnel pressure.

Some other disorders are also associated with prolonged computer use. Many researchers (e.g Sheedy, 1992; Smith and Stammerjohn, 1981; Costanza, 1994) consider eye- related symptoms as more frequently occurring health disorder among computer users. It is known as Computer Vision Syndrome. Yan, et al., (2008) categorized its symptoms in three: (i) eye-related symptoms (e.g. "dry eyes, watery eyes, irritated eyes, burning eyes"), (ii) vision-related symptoms (e.g. "eyestrain, eye fatigue, headache, blurred vision, double vision"), and (iii) posture-related symptoms (e.g. "sore neck, shoulder pain, sore back"). In another study Wang et al., (1998) found that if computer is used more than 30 hours per week and more than 10 years, depression, obsession and somatic disorders increase. Adair, Ashley

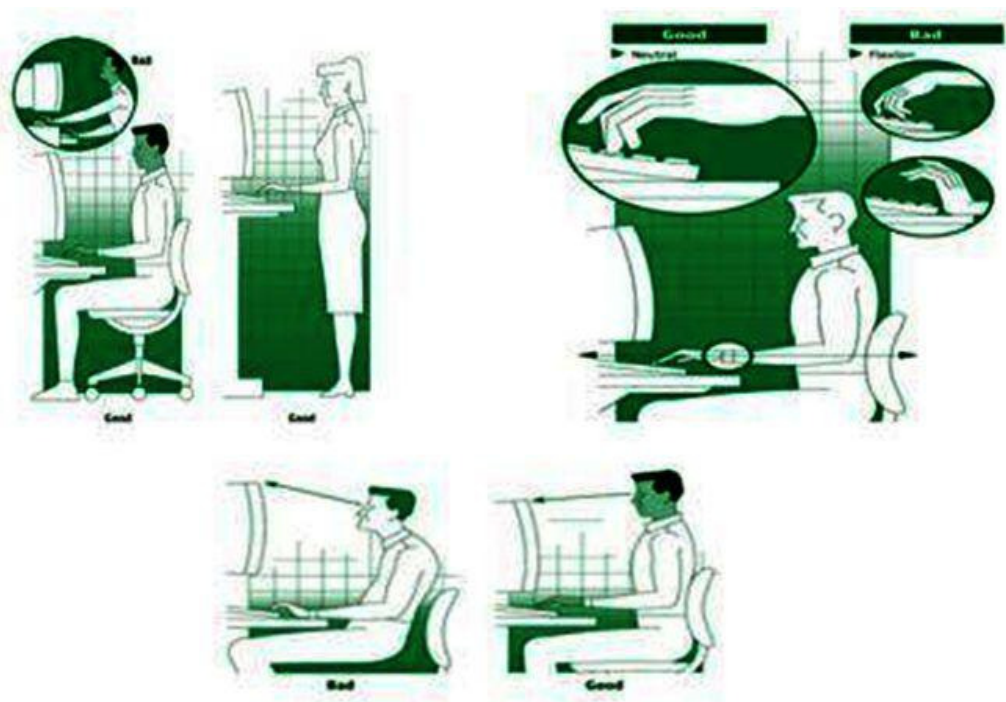


Fig 3: Visual Display of Additional Risk Factors (Source: AFSCME, 2006)

and Chou (1997) complained that studies regarding health effects of electronic devices including computers are characterized by inadequate assessment of field study. No single study fully distinguished the effects of video display terminals use on eyes, musculoskeletal system and job related stress. The review of literature also shows that frequently occurring health problem related with prolonged computer use are carpal tunnel syndrome, back, neck and shoulder problems, computer vision syndrome and stress. The researches conducted in this context have investigated these diseases separately. Still, no research has been reported in which all these frequently occurring diseases are studied together. Therefore, to fill this research gap, the present study by using field survey approach intends to investigate the prevalence of these diseases among prolonged computer users. The main aim of the study is to find a relationship between extent of computer use (per day) and carpal tunnel syndrome, stress, computer vision syndrome and neck and shoulder problems. The research questions addressed in this study are:

To what extent carpal tunnel syndrome, stress, computer vision syndrome and musculoskeletal problems occur simultaneously among prolonged computer users?

Is there any association between extent of computer use (per day) and carpal tunnel syndrome, computer stress syndrome, computer vision syndrome and musculoskeletal problems?

## METHODOLOGY

The study adopted field survey approach as primary data source for investigating the research problem. The nature of study is exploratory. Self administered survey was used because in survey, researchers cannot direct the state of respondents, hence helps to generalize the results (Yalcinkaya, 2007). Secondly survey is able to provide a complete picture of affected computer users and also able to increase awareness about these health issues.

## Sample

In this research individual user of computer was the unit of analysis. Employees from multinational companies and University Research degree students were the target

**Table 2:** Demographic Information of Sample

Category	Frequency	Percentage
<b>Gender</b>		
Male	71	59.2
Female	49	40.8
<b>Occupation</b>		
Employee	64	53.3
Student	22.5	27
Both employee and student	29	24.2
<b>Frequency of computer use</b>		
>2 Hours	0	0
2-4 Hours	27.5	33
<4 Hours	87	72.5
<b>Age</b>		
>25 years	0	0
25-30 years	35.8	43
<30 years	77	64.2

population of this study. Research degree students were selected because it is assumed that they spend most of their time on the computer for conducting research work. Similarly employees from multinational companies were selected because at their workplaces computers are widely used as compared to local or government organizations. Purposive sampling technique was the sampling frame used in this research. This purposive sampling presents the advantages of choosing the sample according to specific characteristics and situations (Ellahi and Manarvi, 2010). Simple random sampling technique was used to choose the sample from the purposive sampling frame. The logic of purposive sampling method was to include those subjects who actually use computers daily. The original sample size for this study was 200 but only 120 out of 200 favorable responses were obtained. Researchers have supported this sample size.

### Instrument

Questionnaire as an instrument of this self administered field survey was used. In the questionnaire demographic information about occupation, gender, age and frequency of computer use was asked. Along with it respondents were asked to indicate all symptoms of diseases which they are experiencing.

### RESULTS

Out of 200, only 120 usable responses were received.

Thus, the response rate was 60%. After collecting the responses data were analyzed using SPSS 17 software. The demographic information of respondents shows that out of 120, majority were males (59.2%) while others (40.8%) were females. Responses in occupation category show that majority 53.3% were employees, 22.5% were students and 24.2% were both employees and students. Among 120 respondents majority 64.2% were above 30 years while remaining 35.8% were below 30 and were between 25- 30 years age. The frequency of computer use shows that 72.5% were those who use computer daily more than 4 hours while 27.5% use computers only for 2-4 hours daily. See table 2

### Health Problems Results

Respondents were asked to indicate all those symptoms which prevail in their case. After analyzing their responses, the categories of diseases were differentiated according to symptoms. The frequency distribution of respondents who indicate the presence of stress, carpal tunnel syndrome, computer vision syndrome and musculoskeletal disorders are shown in Figure 4 below. The data obtained from respondents clearly shows that majority of respondents (45%) are experiencing the entire health problems which are assumed to be associated with prolonged computer use. This is immediately followed by the problem of computer vision syndrome which constitutes almost 25%. It means that computer users who don't have all these health problems, they have computer vision syndrome. Similarly carpal tunnel syndrome and musculoskeletal disorders respondents

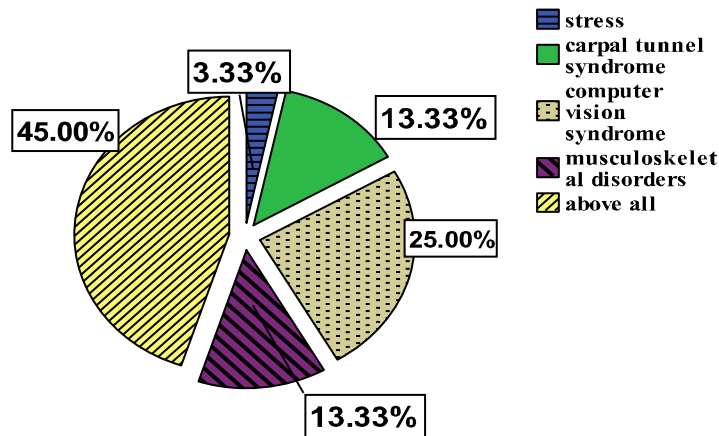


Fig 4: Frequency Distribution of Computer Associated Health Disorders

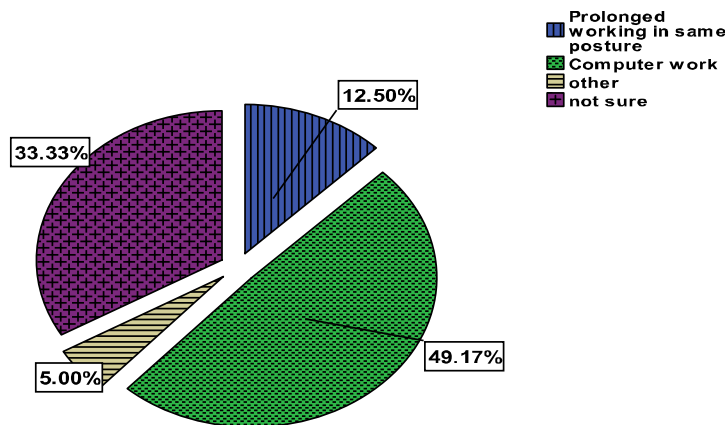


Fig 5: Causes of Computer Associated Health Disorders

are also considerable in size (i.e. 13.33%), while respondents who indicate that they have only computer stress syndrome problem are only 3.33%.

Now, as computer users are experiencing these computer associated health disorders, therefore it was necessary to obtain their opinion about the causes of these disorders. Frequency of their responses in Figure 5 shows that 49.17% computer users think that these problems are due to their use of computer. However there is also considerable size of respondents (33.33%) who are not aware of actual reason of these problems. Remaining 12.5% think that their health disorders are due to prolonged working in same postures, and only 5% think these are due to some other cause.

**Association between frequency of computer use and health disorders**

The association between frequency of computer use and health disorders in a simple way, is depicted in the line graph below. The line graph is chosen because it provides a comprehensive comparison of data variables by providing look and contrast in rise and decline in trends. In a simple way it is a set of numeric data plotted in x-y coordinate system and its visual characteristics clearly display how one variable is affected by the other as it increases or decreases. It also helps to make predictions about data results. The line graph in figure 6 clearly shows that computer users who use computer

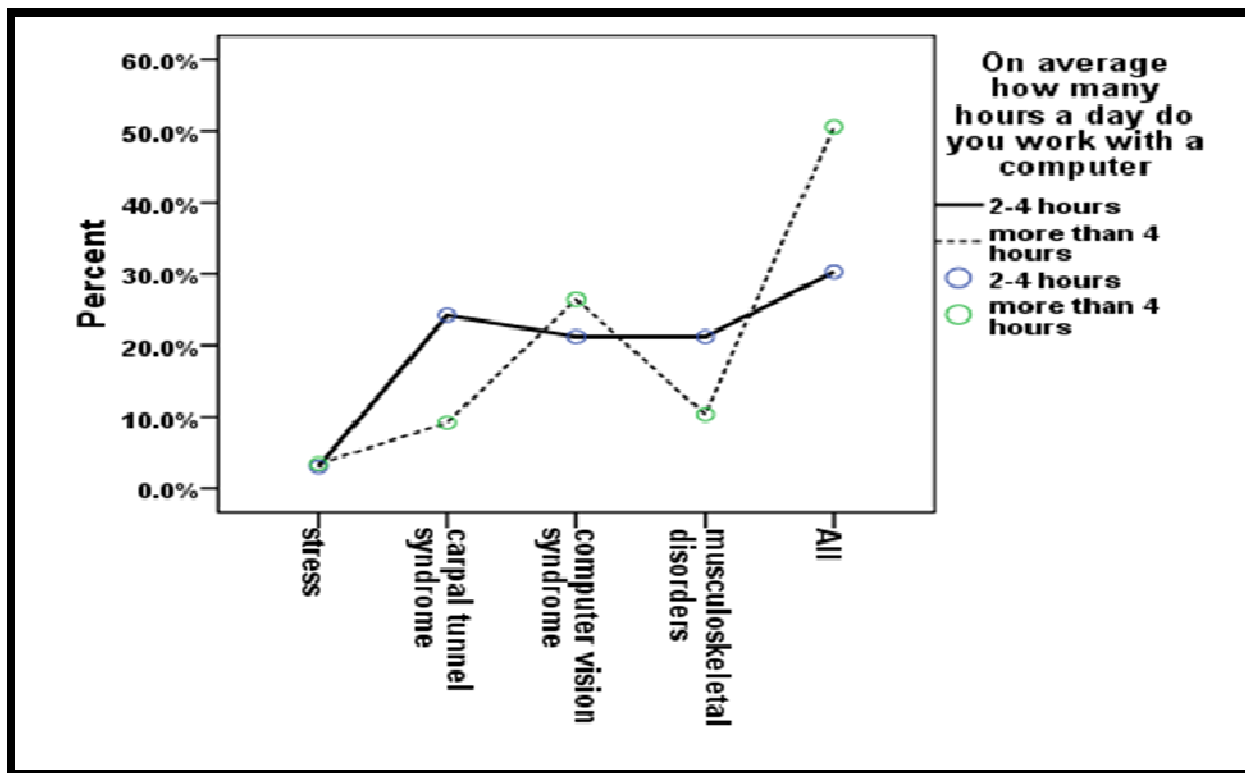


Fig 6: Association between Frequency of Computer Use and Health Disorders

more than four hours daily indicated symptoms of all four categories of computer related health disorders. Individually computer vision syndrome was reported highly among those who use computers more than four hours. Stress did not show a significant relationship with frequency of computer use. Carpal tunnel syndrome and musculoskeletal disorders have shown comparatively less significant relationship with frequency of computer use as compared to computer vision syndrome.

### Demographic Profile and Health Disorders

The analysis of demographic information of respondents and reported health disorders in figure 7 shows that among females the frequency of stress (75%) is highest, followed by computer vision syndrome (53.3%), musculoskeletal disorder (25%) and carpal tunnel syndrome (18.8%). However, among males 81.3 % have carpal tunnel syndrome, 75% have musculoskeletal disorders, 46.7% have computer vision syndrome and only 25% have stress. On collective basis on health

disorders majority males have all diseases (more than 55%) while more than 40% females reported all problems.

On occupational basis 35.2% employees indicated presence of all diseases. On individual basis of disorders 25% employees have shown computer vision syndrome, 18.8% have shown carpal tunnel syndrome and musculoskeletal disorder. Only 10% have shown stress. Among students, majority (31.5%) have shown all problems, 20% reported stress and 12.5% have indicated carpal tunnel syndrome and musculoskeletal disorders respectively. Respondents who were both employees as well as students have confirm that among those 75% have computer vision syndrome, 70% have stress, 68% have carpal tunnel syndrome and musculoskeletal disorders and only 33.3% have all problems. See figure 8.

On age category basis respondents who are in age range of 25-30 years, have high computer vision syndrome (75%). Among remaining 56.3% have shown carpal tunnel syndrome and musculoskeletal disorders respectively, while 26.5% are having stress and only



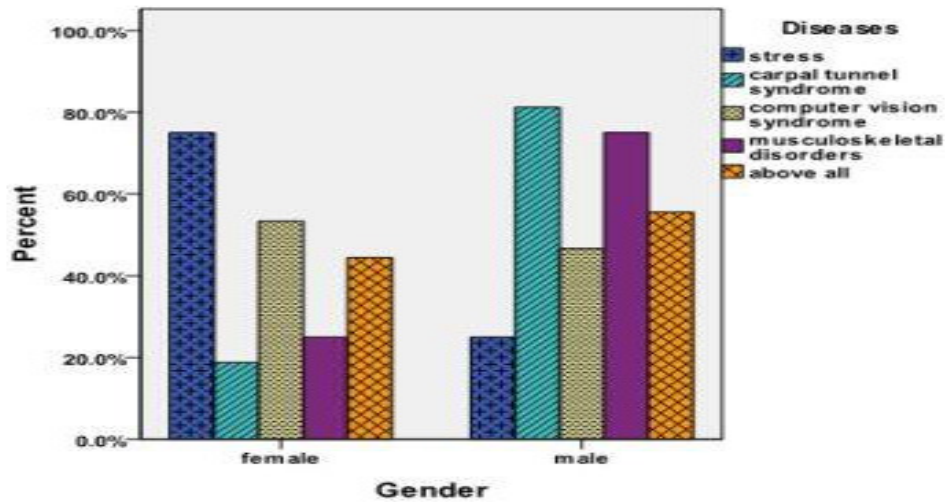


Fig 7: Gender and Health Disorders

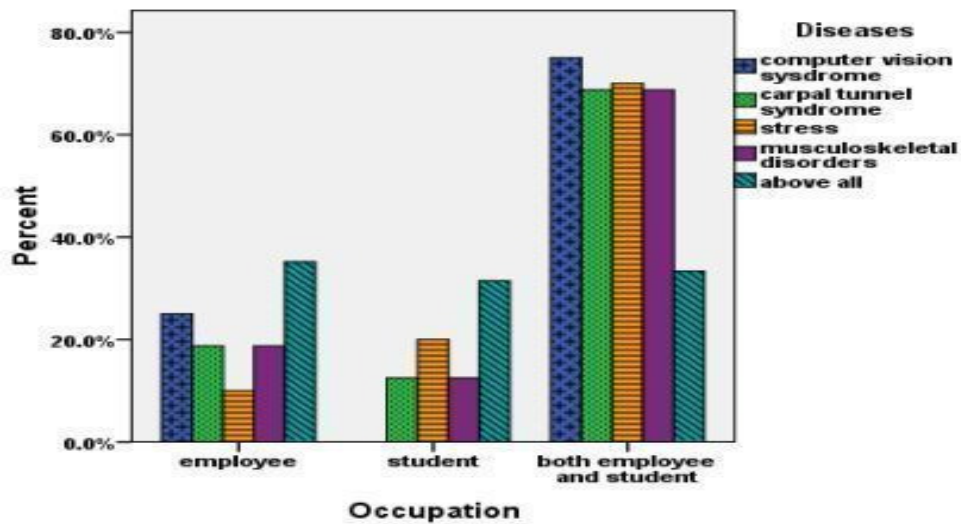


Fig 8: Occupation and Health Disorders

25.9% are facing all health disorders. The other respondents who are of age more than 30 years, majority (74.1%) reported all problems, 73.3% have shown stress, 43.8% have shown carpal tunnel syndrome and musculoskeletal disorders and only 25% have computer vision syndrome. See figure 9.

**DISCUSSION**

Research question one: To what extent carpal tunnel syndrome, stress, computer vision syndrome and neck and shoulder problems occur simultaneously among prolonged computer users?

The study by using the survey approach tried to identify the trends of health disorders related to prolonged computer use. The results confirmed the prevalence of all investigated health disorders among employees and students. The presence of all disorders confirms the effects of electromagnetic field and additional risk factors like awkward posture on human health. A large number of respondents who are not facing all health disorders, are confronted with computer vision syndrome. It means that human eyes are at most risks than any other part of body. The number of respondents having symptoms of carpal tunnel syndrome and musculoskeletal disorders problems was equal. Stress was not reported in high frequency among respondents but it cannot be ignored.

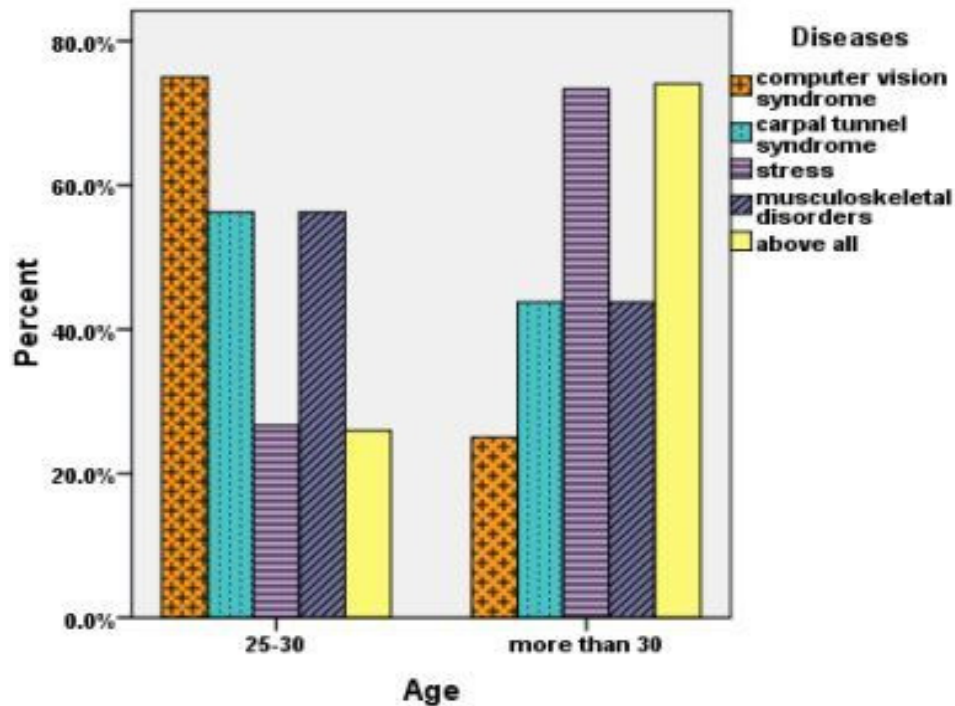


Fig 9: Age and Health Disorders

The prevalence of all disorders among majority of computer users provides answer to first research question. The question was about the simultaneous presence of carpal tunnel syndrome, computer related stress, computer vision syndrome and musculoskeletal disorders among computer users. It provides answer that among prolonged computer users, the simultaneous probability of these entire four computers related health disorders is high. It poses some serious threats for human health which need to be taken seriously.

Research Question two: Is there any association between extent of computer use (per day) and carpal tunnel syndrome, computer stress syndrome, computer vision syndrome and musculoskeletal problems?

The findings confirm that there is an association between frequency of computer use and prevalence of the entire four health disorders i.e. carpal tunnel syndrome, computer related stress, computer vision syndrome and musculoskeletal disorders among computer users. The data reported that users who use computers daily for more than four hours are more likely subjected to the risks of all these four health disorders. However, on an individual basis the findings show that musculoskeletal disorders and carpal tunnel syndrome was not very high among those who use computers more than four hours

daily. An assumption can be made that these two disorders are more related with awkward posture whether they work on computer or not. Computer vision syndrome was found comparatively higher among those who use computer more than four hours daily. This indicates the effects of computer screen in form of electromagnetic radiations and the disorders of carpal tunnel syndrome and musculoskeletal disorders indicates the additional risk factors such as working with bent wrists, a lack of rest for the hands and wrists etc and improper placement of work materials such as computer chair.

It was found in the study that males are experiencing computer related disorders more than females. Individuals who are employee as well as student are more subjected to computer vision syndrome as compared to other disorders. This may be because they spend more time on computers and are directly subjected to ionizing radiation from computers. Individuals who are employees experience almost all problems. Similarly Respondents of age between 25-30 are more subjected to computer vision syndrome and individuals of age more than 30 are more likely to experience all the problems simultaneously.

In order to check the awareness level of users about effects of prolonged computer use, they were asked to

indicate the cause of their health disorder. It was interesting to observe that majority are aware of the effects of computer use, and they regard computer work as a cause of their health disorder. This awareness is particularly useful in the sense that if any safety measures are introduced to computer users in order to minimize or prevent further hazardous effects on health. Thus, finding of study are:

Computer related health disorders such as carpal tunnel syndrome, stress, computer vision syndrome and neck and shoulder problems can occur simultaneously among prolonged computer users.

Computer users who use computer daily for more than four hours are more likely subjected to the risks of all these four health disorders.

The simultaneous occurrence of carpal tunnel syndrome, stress, computer vision syndrome and musculoskeletal disorders is more among males than females.

The simultaneous occurrence of carpal tunnel syndrome, stress, computer vision syndrome and musculoskeletal disorders is more among employees than students and those who are both employees and students.

Computer users of age more than 30 years are more likely to experience carpal tunnel syndrome, stress, computer vision syndrome and musculoskeletal disorders simultaneously.

Computer users of age between 25-30 years are more exposed to the risks of computer vision syndrome.

## Conclusion

This study has made an attempt to investigate the simultaneous pervasiveness of the most common computer related disorders among computer users which are carpal tunnel syndrome, computer related stress, computer vision syndrome and musculoskeletal disorders. Employees are current and students are future assets for companies. The revolution of computerized workplace is creating certain health risks for both employees and students. This study is relevant to industry because employees' jobs are making them sick, in turn placing huge burden for organizations. Organizations can provide training of ergonomics to employees, thus, ensuring safety of its human assets. By analyzing the results and findings, it is concluded that

Prolonged computer use (i-e more than four hours daily) creates several problems for its users.

The simultaneous occurrence of several health problems associated with computer use among human beings means that human body is continuously subjected to more and more risks.

By sitting in front of a computer, the individual actually enters into the room of biological menace. His hands, wrist, neck, shoulders, back, brain and most importantly

eyes are captured by the invisible chains of carpal tunnel syndrome, computer related stress, computer vision syndrome and musculoskeletal disorders.

The study further concludes that as the dependence of human beings on technology is increasing, the dangers for human health are also getting enhanced day by day. Man is planning to conquer the universe with the help of new technology, but at the same time his biological system is being kidnapped by some silent forces of these technologies, and man is actually paying the ransom in the form of his health.

The study also concludes that the proper position of work material like chair, keyboard and mouse etc are crucial for human health. It means that by observing some rules of using computers, minimizing and treating of these risks are possible.

Organizations should also pay attention to this issue because healthy employees mean healthy productivity. We believe that only reporting the problems is actually half the picture of this research. By providing real world practical solutions we can complete this picture. Day and night is a universal phenomenon and the journey from problem to solutions is actually moving from darkness to light. For the problem of unsafe and uncomfortable computer work, there are some areas that need attention. These recommendations for safe and comfortable computer workplace are displayed in figure 10. Thus: The recommended distance as shown in figure 10 between eyes and computer screen helps to prevent computer vision syndrome.

Similarly the proper positioning of the keyboard, mouse and hand helps to avoid carpal tunnel syndrome and use of proper chair and sitting position aids in putting off musculoskeletal disorders.

For preventing employees' absenteeism and increasing employees' productivity organizations must pay a little more focus to this area.

By creating awareness and providing on the job training about proper ergonomics can bring considerable benefits for organizations in form of workers productivity.

For individuals, use of computer screen protectors and computer glasses is also suggested.

This study has some limitations. First, it has biasness' of methods associated with survey research because the study relied on a single source of data gathering i.e. questionnaire. Secondly the sample size is small. Thirdly, the study could not investigate the presence of other effects like skin ageing, cancer, malfunctioning of endocrine glands, premature aging, tumors, and cancers. Fourth, the study lacks in the context of strong empirical or statistical assessment about the relation of computer use with health disorders. Future research should be conducted with rigorous methodologies. A longitudinal study is also suggested to reveal the exact amount of effects of computer use on skin ageing, cancer, malfunctioning of endocrine glands, premature aging, tumors, cancers, computer vision syndrome, carpal

tunnel syndrome, stress and musculoskeletal disorders.

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