

## Ergonomics for Desk Job Workers - An Overview

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### ABSTRACT

The present paper aims to illustrate the overview of improper designed workstations leading to consequences of vision and postures at work. The objective of this paper is discuss about the possible problems, their effects on various body parts, proper positioning and how to design the ergonomically fit workstation for desk job workers.

**Key Words:** Ergonomics, Workstation, Bad posture, Desk job Workers, Physiotherapy, and Optometry.

### INTRODUCTION

Ergonomics is the science of making the workstation essentially fit, comfortable, safe, secure and efficient for the workers so that they enjoy giving more productive output to the organization they belong to. [1] In general, the purpose of ergonomics is to fit the task to the individual and not the individual to the task. [2] Chronic addiction to gadgets, handheld devices now-a-days increase chances of many musculoskeletal disorders which cannot be neglected. Many researchers' claims that prolonged working on these gadgets results in faulty postures with a high risk of developing injuries. [3]

The demand for any task in reference to workers capacity over a specific period of time needs to be analyzed for making an ergonomic fit working environment. The worker's task is accomplished in either desk sitting position, in standing or in walking depending upon the type of occupation they belongs to. According to the Occupational Requirements Survey conducted by the

Bureau of Labor Statistics and National Compensation Survey program on Standing or walking versus sitting jobs in 2016 rationalizes that standing versus sitting varied by the Occupation for example waiters and waitresses spent 96.3 percent of their workday standing or walking and just 3.7 percent sitting. Similarly, the average rate was found to be 90 percent in the software developers, 80.7 percent in the accountants and 80.3 percent in insurance sales agent for spending an average of their workday sitting in 2016. [4]

It was estimated that about 40.7 % of the global population was surfing the computers in the year 2012 as compared to 2006 of only 26.2%. (Acc to the key 2006-2013 ICT data for the world in the year 2013). Marshall (2001) study reveal that on average, six out of 10 employees used a computer at work and the number was expected to grow. [5]

The ergonomic fit workstations have become a standard practice in various countries like the European Union and

America. Scott (2008) stated that the application of ergonomic principle for developing countries increases the office productivity and benefits than in the developed worlds.

Many researchers report that working 5.41 hours sitting at the desk and 7 hour sleeping at night had a great impact on the physical and mental health. [6] According to government regulation such as the Occupational Safety and Health Administration (OSHA) standards, an ergonomically fit workstation required to (a) Decrease Injury risk. (b) Increased Productivity (c) Healthier vision and joints (d) Reduce tension, headaches (e) Improved job satisfaction, work quality and improved morale of workers. [2]

We need ergonomically fit and modular designed lifestyle which is free from injuries and risks. There are a large number of facts and shreds of evidence describing the number of risk factors like repetitive strain injuries, awkward posture, forceful exertion, a static posture which may lead to work-related musculoskeletal disorders (WMSDs). [7] Dembe AE (2005), Strazdins L (2004) stated that WMSDs are the primary causes of absenteeism and disability. [8,9] Garvan TN (1997), Berge Z (2002) reported that prolong sitting in static posture results in pain in the neck, back, shoulder, wrist, prolapsed intervertebral disc, visual fatigue and mental stresses. [10,11]

Vision trouble is an unspoken antagonist that appears due to exposure on display for an extended period of time. Many researchers investigated in their epidemiological studies that indoor environment is the cause of an eye-related complaint like burning eyes and soreness, itchiness, dryness, blurry vision, eye irritation. [12,13] Hedge A (1996) and Begley CG (2002) investigated that the frequent cause of office disorders are tiredness and strained eyes followed by mental fatigue and headache. [14,15] The grounds on which the eye complaints crop up might be variations (thinning or rupture) in the

precorneal tear film which protects the outer eyes from the high room temperature, low relative humidity and dusky indoor environment. [16]

The eye-related disorders are seen extensively among computer users. The office personnel's such as government offices, academic institutions, and banking systems in today's context give first priority to computers and its related gadgets. Prolong working on it can lead to computer vision syndrome. American Optometric association defines computer vision syndrome as a multiple eyes and vision-related problems which results due to prolonged exposure to computer and experiences several conditions related to the eye like dry and irritated eyes, eye strain and fatigue, blurred vision, red eyes, excessive tearing, headache, light sensitivity, and changes in color perception, etc. [17]

### **Biomechanical properties of sitting posture**

The posture is defined as the upright position embracing the body parts in relation to standing, lying down and sitting with least amount of stresses on the supporting ligaments and muscles during weight-bearing activities or any movements. [18]

The correct posture not only maintains the natural curve of the spine but also minimizes stresses on the human body. Therefore more emphasis should be given on adopting a correct sitting posture while working in the office. The sitting position in which the body weight is transferred to the supporting areas mainly by the Ischial tuberosities of the pelvis and their surrounding tissues (Schoberth 1962).

In upright sitting posture, 2/3rd of body weight is distributed to the chair seat with backrest, armrest and to the floor. The weight is transferred through the chair seat and then to the floor, foot directly to the floor, forearm load to the armrest and then to the floor. The back and the pelvis to the backrest and then to the floor. Sitting in

posture which inflicts stresses on tissues results in injuries and trauma.

It is seen office bearers adopt a posture according to their ease and habits such as slouching, crossing legs, etc. These habits in the later stages if continued were found to be more comfortable for the worker's which increases chances of many work-related musculoskeletal disorders. Prolonged and rigorous application of the visual display terminal (VDT) is an important risk factor for work-related musculoskeletal disorders. [19]

### Types of Posture in sitting

Sitting on a chair is one of the most common positions adopted by humans. Mathew CE (2003) epidemiological study in the United States report reveals that children and adults spend approx. 55% of their working hours or 7.7 hours/day in sedentary postures. [20] Many researchers elucidate the fact that prolonged sitting is the root cause of increased intradiscal pressure and use of lumbar support helps in preventing the lumbar lordosis. [21-24]

There are different types of posture the office bearers adapt

#### (a) Forward posture

It is lesser than 90 degrees in which COG lies in front of the Ischial tuberosity and floor supports more than 25% of body weight with increase disc pressure.

#### (b) An upright posture

In this posture the trunk is upright & straight 90 degrees and COG lies above the Ischial tuberosity and floor supports 25% of body weight.

#### (c) The reclined posture

The posture of 100 degrees & above with COG lies behind the Ischial tuberosity and floor supports less than 25% of body weight. This posture reduces pressure on the disc.

Sitting on duty for more than 8 – 9 hours develop load on the spine which is more than standing. This load can cause strain in the back, neck, shoulders and leg muscles. Sitting in 90° position increases lumbar pressure to 140 mm.

In Desk Sloucher's 80° position, the pressure increases to 190 mm. [55] In Lifting a 20 kg weight while sitting and leaning forward to 20 degrees increases a pressure on the disc to 275 kg. [56]

Disc pressure seems to be greater during sitting than standing. This might be due to the changing from a standing to sitting causes the top of the pelvis rotates backward and flattens the lumbar curve with increased uneven pressure on the intervertebral discs.

CHU C (2011) research revealed that prolong sitting and working on computers has significant differences in viewing when comparing with the hardcopy condition. [25]

### The repercussion of Vision and Posture at work

#### 1. Digital Eye Strain

It is a syndrome characterized by a group of symptoms like eyestrain, headaches, blurred vision, dry eyes, neck and shoulder pain, etc due to prolonged exposure to digital gadgets when viewing screens for an extended period of time.

N Shantakumari reported in her study that the risk of developing headaches was 38% which was significantly less when viewing the computer at a distance of 50-100 cm as compared to viewing at a distance of <50 cm furthermore she also concluded that dry eyes symptoms exaggerated by 89% when no screen filters are used. [26] Moreover Blehm et al (2005) suggested that the ocular related symptoms for regular and continuous users may results from one of the following reasons 1) environmental factors producing corneal drying 2) Reduced blink rate 3) Incomplete blinking 4) Increased corneal exposure 5) Age and gender 6) Systemic diseases, medications, and contact lens wear. [27] An increase in active myofascial trigger points of suboccipital muscle due to forward head posture causes chronic tensional headaches. [54]

#### 2. Bad Posture

Prolong sitting in a poor posture not only affects the neck region but also

impinge lower back, shoulders, and wrist leading to very serious problems like slip disc, painful joints, Carpel tunnel syndrome, etc. Daneshmandi H (2017) report revealed that neck (53.5%) lower back (53.2%) and shoulder (51.6%) symptom were the most widespread disaster among the office workers in the past 12 months. [43]

### 3. Slip Disc

Sitting in 80 degrees slouch position produces excessive strain on the disc and overstretching of the supporting structures. Gregory G. Billy analyzes that the greatest change in disc height is at the L4-5 level after prolonged sitting without intermittent breaks. [28]

### 4. Backaches

Back pain is the feeling of discomfort, achiness and pain around the mid-thoracic spine (according to the type of sitting). Prolong sitting also leads to shortening and tightening of hip flexors and hamstring muscles with weakness of muscle supporting the spine causing low back pain. Tasneem Borhany (2018) studied 150 participants between the age group of 18-50 years among office workers and students and found that prolong working on the computer for at least > 3 hours per day had reported symptoms of headaches and back pain. [29]

Many researchers in their study found that the person who sits for the lengthened period of time suffers from the neck, upper back musculoskeletal pain due to improper adjustment to the computer screen and chair height. [30,31]

Rohmann A and colleague's interpretation that high forces are continuously acting on the spine when changing from one body position to another. These loads can be minimized with proper elimination of the upper body by the arms. [32]

### 5. Eye muscle fatigue

Seong Chin (2018) reported that people with excessive fixation of their eyes are unable to tolerate extended periods of static contraction of eye muscles making it difficult to maintain a single fused image in

binocular viewing, if repeated it over a long time by staring at the computer screens, desk work, and handheld devices resulting in eye muscle fatigue. Further concluded that working prolong strain the eye muscle, creates stiffness on head, neck, and shoulder and if this persists can cross the threshold into spasm and cramps. [53]

### 6. Text Neck.

We are living in the 21st century where most of the work is executed via digital approaches (advanced Computers, laptops, and mobiles). Teenagers in comparison to adults more profoundly spent most of the time surfing these gadgets devices in a neck bent position resulting in neck and back strain. [33] As sitting in forwarding head posture exerts pressure on the extensors like semispinalis capitis and levator scapulae muscles.

According to Kenneth k. Hansraj, MD chief of spine surgery and rehabilitation medicine New York reported in his study that the average adult head weighs 10 to 12 pounds and in a neutral position, the ears lined up with the shoulders and the shoulder blades are pulled in resulting in little stress on the neck. So when the head is tilted to 15 degrees, its effect on the head is equal to 27 pounds and if tilted to 60 degrees, the effect can reach up to 60 pounds and as that weight increases and the spine falls further out of alignment the undue pressure is added to the spine. Over time, this improper posture can lead to neck pain and herniated discs. Surgery is even indicated if the condition gets worse. [49]

### 7. Poor heart function

Gluing several hours on chair causes decreased blood flows and muscles burn less fat becomes easier for the fatty acids to obstruct the heart. An article Published in the Journal of the American College of Cardiology demonstrated that when women sit for 10 hours a day they may have a much greater risk of developing heart diseases.

J.N Morris (1953) conducted a study on sitting versus standing job workers and found that physically inactive pursuits (desk job workers) develop a larger risk of

coronary heart disease as compared to standing occupations. [39]

Many researchers' reveals that sitting prolongs increase pro-inflammatory cytokines which are associated with the development and progression of many cardiovascular disorders.

### **8. Poor Breathing Problem**

A report by the American Academy of Physical Medicine and Rehabilitation (2006) that leaning over at your desk for hours can affect your breathing, lung capacity, and blood flow. This might be due to diaphragm get restricted and compressed resulting in decreased lung function with less oxygen into the body leading to breathing difficulty and less overall energy and functions.

Ali albaratti (2018) demonstrated that leaning forward and prolong sitting reduced the diaphragm strength and movement as compared to sitting in upright posture. [35] Fang Lin et al (2005) concluded that prolong slumped sitting significantly decreased Lung capacity, expiratory flow and lumbar lordosis. [41]

### **9. Varicose Veins**

Sitting for extended period leads to poor circulation in legs. In this position, veins work harder to move blood to the heart. The blood falls backward and pool in the lower leg this can lead to swelling in the ankles, varicose veins, and even blood clots, also known as deep vein thrombosis (DVT). Seung Namkoong (2015) established a fact that upper leg cross and normal sitting decline blood flow to the lower extremity resulting in a decrease of temperature and cross leg sitting worsen the condition. [42]

### **10. Carpel tunnel syndrome**

The most common nerve entrapment syndrome is generally attributed to insulting usually a compression of the median nerve within the wrist due to the continuous bearing of pressure and force from hard working surface which exerts pressure in the wrist and hands. Initial complaints of CTS include sensations of pain, numbness, and tingling in one or both hands at night.

Turner and Buckle demonstrated that occupational risk factor contributed to forcing, repetitiveness, and posture; systematic risk factor like acromegaly, rheumatoid arthritis accounts for 20-30 percent of threat .Other risk factors like family history, gender, acute trauma, pregnancy, etc also account for the development of CTS. [47]

### **11. Poor Performance**

Ammy cuddy a social psychologist article published in 2018 demonstrated that sitting in low power pose create a negative impact which others may also perceive resulting in unmotivated, tired and disinteresting environment with lesser opportunities at workstation. Sitting in a high power pose for a period of 2 min during work results in high performance, more attention and focused. [48]

Hadi Daneshmandi (2017) reported that prolonged sitting can cause suppression of lipoprotein lipase activities, induces insulin secretion, interferes with the uptake of blood glucose by skeletal muscles and also had an effect on job satisfaction along with exhaustion during the working day. [43]

### **Postural mistakes while working**

**I. looking up and down at the screen.** It results in forced neck extensors along with compression at the intervertebral joints resulting in muscle fatigue, inflammation, pain, and headaches. Prolonged working while looking down strained the neck muscles resulting in slouched posture for rest of the spine & contributing to upper and lower back issues. It is estimated that 75% of the world's population spends hours daily hunched with digital gadgets with their heads flexed forward. [34]

### **II. Slouching posture.**

Ali Albarrati et al in his study demonstrated that sitting prolong in the slouch posture fuels breathing disorders with affection at the contiguous structures like heart, phrenic nerve. [35] Prolong sitting results in disc issues and degenerations. Youp Cho in his study concluded that Sitting causes a reduction in Lumber lordosis when compared with standing. It

might cause spino-pelvic imbalance and result in chronic LBP. [38] (Fig-1a).

### III keeping leg stable and cross.

Keeping leg stable for an hour can damage the soft tissues around the leg & foot and decrease the blood flow. [42] (Fig- 1b).

### IV Hunching the shoulder.

It causes repetitive strain and trigger points in the shoulders and lower neck. Sitting on the Chair without armrest can lead to fatigue also.

### V Reaching too far for mouse and keyboard.

It results in muscle fatigue in the neck, upper back, shoulders, and arms. Raising the back of the keyboard with a regular mouse, and failing to stretch hands results in an increased risk of carpal tunnel syndrome due to incorrect wrist and hand position. Andersen et al (2003) and Palmer KT (2007) found substantial evidence for prolonged use of any handheld device increases the chances of CTS with a higher risk especially on the wrist. [36,37]

### VI continuous cradling the phone to the ear.

Cradling phone to the ear while working stresses not only the upper back but also the neck region. (Fig-1c).

### VII manual material handling while sitting.

It develop load onto the spine resulting in lower back issues. The National Safety Council [44] testimony reveals that in USA 4, 00,000 workers mug into the disabling back injuries every year. The NIOSH report reveals that the back injuries resulting from manual materials handling activities are a major source of lost time and compensation claims. [45]

b) c)



Fig 1 a) Slouching posture b) Sitting with Cross leg c) Cradling phone to the ear while working

### Workstation Ethics

1) Avoid static work as it can hasten the fatigue level this might be due to, the workstation is either too high or too low, making it difficult for the upper extremity to hold in one's position for a longer period resulting in muscle fatigue. [2]

2) Adjust the chair in such a way that when putting the fingers on the middle row of the keyboard the forearm and hands are horizontal and in line with elbows vertically under the shoulder and no angle to be formed at the wrist joint and feet rest flat on the floor.

3) Keep blinking eyes at frequent intervals every 2 hourly. Use screen glare filters for proper illumination (Fig-2a).

4) Wear ARC coating computer eyeglasses. (Fig-2c)

5) Alter position at an hour by getting up for a quick walk or spending a few minutes on a different task.

6) Stretching exercises of neck and back in either direction for a minute. Mehrparvar A. houshang (2014) suggested that stretching exercises at the workplace helps in producing short term effect in reducing musculoskeletal pain in office workers. [51]

Cecily Smith explained that taking an active mini-break for neck exercises at the workstation creates a greater reduction in neck pain symptoms rather than modifying the workstation alone. [5]

Yafa Levanon 2012 body posture adjustments, muscle activity training and exercises accompanied by biofeedback training help in reducing musculoskeletal disorders among computer operators. [52]

Kathryn Doyle (2016) recommended regular exercises, avoiding prolonged sitting, modular sit-stand work stations and activity-permissive desks may be useful to lower sedentary time and cardiovascular diseases [40]

Dr. I-Min Lee, a professor of medicine at Harvard Medical School from Annals study suggested making use of mobile app for reminders after every half an hour of working to spare 2-3 minutes of

their time to move around the office corridors.

7) Apply lumbar support pillows, if the chair is not ergonomically designed. Avoid sitting in an unnatural posture with consent on altering it frequently.

8) Sit in an upright position and in line with the torso.

9) The monitor is at eye level with a distance of 20 -40 inches (Fig-3a). It should not be too close leading to eyesight problem or not to one side resulting in uneven pressure on the neck muscles.

10) The keyboard is at a comfortable height and elbow to be placed close to the body. Work with both the hands in a symmetrical way.

11) Use of footrest reduces the pressure at the thigh which is evenly distributed while sitting on the chair using footrest support (Fig-2b).

12) Use a document holder or a Table Top in the office to avoid loading of neck and spine (Fig-3b). Position it at the same monitor height and distance. Position all the desktop accessories e.g. Phones, paper tray, bottle, etc in a reachable place. Avoid reaching & twisting.

13) A hands-free headset like Bluetooth device is the better option to avoid cradling while working on the desk.

14) Ergonomic fit workstation required in which eyes look at the monitor, shoulder relaxed, back fully supported, reference material s are within the reach, Feet resting on the footrest with moderate pressure on the thigh, proper illumination.(Fig-3c).

15) The National Institute for Occupational Safety and Health in 1981; Snook and Ciriello (1991) and, Mital et al. (1997) [46] published a guideline which will assist, evaluate and reduce the risk of manual material handling conditions.

16) Kishore P Madhwani 2017 concluded that the effective office ergonomics awareness program with quick 10-minute training is highly promising for boosting the employee's confidence. [50]



Fig 2 a) Screen Filters b) Sitting with footrest c) ARC coating glasses



Fig 3 a) Monitor distance b) Tabletop c) Ergonomic fit workstation with correct placement of reference material.

## CONCLUSION

The protocol standards clarify that working in an environment which is ergonomically fit is accomplished by a) employee's participation in a pain-free environment b) Understanding the biomechanical properties of sitting and its types. c) Perceptive Hazards information's and its consequences at work. d) Administration of ergonomic principles into the sedentary lifestyles. Knowing these facts helps in facilitating the productivity to successful management of human resources. The proactive ergonomics are the stepping stone towards a successful outcome and is a more cost-effective way to improve performance, health and well being rather than the reactive ergonomics. Available literature reviews from many sources and articles reveal that setting a good ergonomics regime is extremely beneficial to both employers and employees health. We cannot avoid our duties, but can transform our functional approach of working for a better health.

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