Role of Ergonomics in Inducing Dynamicity by Transforming Sedentary Computer Workstation

HARLEEN KAUR KARIR

Keywords: office ergonomics, sedentary working style, work environment, desk-bound job, technological diseases, ROSA, RULA, REBA

ABSTRACT

This paper sheds light upon the effects of the long term sitting, while using a computer at office. It is going to analyze the prolonged sedentary position from both biological and ergonomic perspective. Possible methods and assessments tools have been presented along with suggestions and solutions for setting up the ideal computer workstation and sitting postures with recommendations for setting up a Sit-to-Stand Workstation to incorporate all the neutral body postures and minimizing the effects of prolonged static strains.

INTRODUCTION

The advancement in technology and new developments in the sphere of professional working environment have made the working styles of employees a lot less demanding and complicated when it comes to straining physical work. Work at the office is very vast, the tasks of employees vary from rigorous computing and programming for long hours, analysts and specialists researching, preparing reports and presentations to sitting at a reception and managing appointments. Despite the position of the employee or significance of their work relative to others, everyone tends to spend a decent amount of their time seated in front of the computer.

With the numerous breakthroughs in technology, the effort and struggle in performing a task related to your job has become less challenging compared to the working style of the previous generations. However, this ease in working has led the workers to have a rather sedentary working style, for long working hours, which in return affect the health of the workers without realization. Even if there is some knowledge of the adverse effect of prolonged sitting, it is often hard for the worker to implement any significant or relevant changes given that there might be inefficiency in training regarding the topic. This review paper discusses about the problems caused from having a stationary, desk-bound job for prolonged working hours without the appropriate and convenient work environment and how their physical and mental health are adversely affected by it, along with statistical justification to support the information. The need to maintain a rigid and unhealthy posture at work has been

1Poznan University of Technology, Faculty of Engineering Management, ul. Strzelecka 11, 60-965 Poznań, Poland
researched upon and results provide us with information regarding its effects on the musculoskeletal system that lead to illnesses known as WRMSDs (work-related musculoskeletal disorders) [1]. It will also cover potential solutions in helping reduce the musculoskeletal system disorders.

**SEDANTRY WORKING POSITIONS—BIOLOGICAL AND ERGONOMICAL ANALYSIS**

Musculoskeletal upper extremity symptoms and complaints of neck, shoulder and arms have become much more common among the general population and especially computer users in many industrialized countries [2]. In 2000, for 60% workers computer usage was a requirement of their job, with 80% of those workers reporting daily computer use. This number is up from 50% in 1994, and 39% in 1989. This increasing trend in computer usage in the workplace has not come without a cost to the wellbeing of workers. In a review by the prevalence of musculoskeletal disorders was reported to be between 10 and 62% for all computer workers. Furthermore, since the inception of occupational computer use, there has been a similar increase in the number of musculoskeletal disorders reported [3].

There are several key principles that play a crucial role during sitting ergonomics [4]:

(i) Loads:
   (a) Gravity
   (b) Levers/Moment arms

(ii) Movement is a symptom of observed body being subjected to high loads. If not realized immediately, instinctively the body changes position to find a more comfortable one where the load is the lowest. However, the process of experiencing some sort of load is repeated and so the body keeps moving to after certain periods of times to not be majorly affected by static loads. Movements can be classified into two categories:
   (a) Load-related
   (b) Activity-related

Figure 1 shows the different spheres of actual, intended and adapted dynamic work done by the body. The white field accounts for dynamic movements and variations a human body is capable of. The purple field accounts for the minimum movement and variations humans need to be allowed to stay out to escape being subjected to static loads”. Lastly, the blue symbolizes the actual amount of variations and movements a desk-bound job consists of. If the task at hand can include more dynamicity though natural movements, it would be the most ideal situation however the issue at hand is
more related to the conflict between the goal and logistics to gain efficient flows fused with the completion of the task but the goal is lost then [4].

It is important to consider the duration of the load maintained while the body or body part is in a static position. This is calculated by parameter called percentage of Maximum Holding Time (MHT). Loads are said to be acceptable if the duration of the load is less than 20% MHT [1]. The amount of time after which the body under observation and experiencing certain load can no longer uphold the burden helps acquire the MHT. Prolonged static load on the body can lead to physical discomfort in turn affecting the workers ability to work efficiently and increasing the risk of musculoskeletal system disorders [1].

With the prolonged use of technology, come the “Technological diseases” – Carpal Tunnel Syndrome (CTS), a Mouse Shoulder (MS) and Cervical Pain Syndrome (CPS) [5].

Carpal tunnel syndrome (CTS) is the most common syndrome resulting from pressure on the central nerve in the carpal tunnel. Research reflects that at least 1 out of 10 people develop this disorder or suffer from the symptoms of this syndrome. The symptoms of this disease are portrayed by pain in the palm of the hand near the thumb and first two fingers, numbness and tingling often occur in the thumb and first two fingers and lastly weakness in the muscles present at the base of the thumb [5].

Besides being harmful to the patient, it also causes huge expenses for physical therapy. The conservative methods of treatment include application of corticosteroids and avoidance of repetitive trauma to the affected area. If the cause of the syndrome is mechanical compression, the treatment is surgical (cutting of retinaculum flexorum). A study conducted suggests that treatment with vitamin B6 improves clinical symptoms as well as sensory and electro diagnostic results in patients with carpal tunnel syndrome [5].

Cervical pain syndrome (CPS) refers to a range of disorders caused by changes in the cervical spine and soft tissue surrounding it. Factors contributing to this problem are the modern way of life, prolonged sitting and inadequate, fixed or artificial postures. Symptoms of CPS include sharp pain and tension in the neck with limited and painful mobility, stiff neck interfering with performing daily tasks, slowly the pain radiates to the shoulders and arms associated, in some cases fainting, dizziness, tinnitus, headache, impaired concentration and memory [5].

Treatment without medication should consists of massage hot/cold, rest from certain activities, gently stretching your neck from one side to another for 30 seconds, surgical treatment for severe cases, acupuncture. Some medicaments include analgesics, anti-inflammatory drugs, muscle relaxants [5].

Mouse Shoulder is common among long-term computer worker which leads to inflammation of tendons and in severe cases can lead to tearing of tendons and muscles “rotator cuff”. If inflammation persists, the capsule and ligaments of the shoulder joint becomes stiffer which minimize mobility. Symptoms of Mouse Shoulder consist of intense pain which slowly spreads to the rest of the body and the moderate pain which remains on the shoulder belt which still hinder movement and lead to sleep disorders [5].

The primary method for the treatment of mouse shoulder in a timely manner to reduce the strain on shoulders, mostly working with computer mouse. Props during the use of the mouse on the palm, forearm and upper extremities, and came to the result that 90% of respondents who have used the support arm had less pain in the shoulder girdles.
of those who are not used to. The use of any support results in less tension, and less applied force to a computer mouse during operation, and therefore less hassle and pain in the shoulder [5].

METHODS

Several methods and assessment tools [6] have been developed to facilitate the understanding and evaluation of the stresses and strains observed by a working body operating in an occupational workstation. Some of these include RULA – Rapid Upper Limb Assessment [7], REBA – Rapid Entire Body Assessment [8], and ROSA – Rapid Office Strain Assessment [3].

The method being discussed here is called the Rapid Office Strain Assessment (ROSA), which was created using postures that were described in the Canadian Standards Association Z412 guidelines for office ergonomics and on the Canadian Centre for Occupational Health and Safety website. CSA standard Z412 is based on ISO Standard ENISO9241: Ergonomic requirement for office work with visual display terminals. These documents help outline information by identifying the unique characteristics of office work, achieving a fit between furniture and the worker, and increasing the efficiency of the tasks of the person to the design of the workstations [3].

![Figure 2. An example of scoring of a seating position and object for the ROSA methodology [3].](image)

The scoring charts used to measure the stresses and strains on the working body were developed by matching two office subsections against each other in order to get a complete score for that area. The subsections include - seat pan height and seat pan depth, backrest and arm support, monitor and telephone, and keyboard and mouse. The maximum scores, which can be noted in Fig. 3. below, from each of the sections were used as the horizontal and vertical axes for the sub-section scores (which were subsequently used to create the ROSA final score). The scores from the monitor and telephone, and keyboard and mouse are then compared in another chart to receive the
peripheral score. The ROSA final score (Fig. 2) is derived by comparing the peripheral chart against the chair score [3].

Figure 3. Scoring charts for sub-sections like monitor, peripherals and chair score as well as ROSA final score [3].

SUGGESTIONS AND SOLUTIONS: SETTING UP THE IDEAL COMPUTER WORKSTATION AND SITTING POSTURES

While working at a computer, maintaining a sitting position is often observed. In this position many parts of the body are undergoing certain amounts of loads and stresses. In order not to overload the human body, the body assumes a more comfortable position through its natural tendency to keep on changing positions after some interval of time. However, most seats and chairs offered in the work station are often not thought of as comfortable and compatible with the long working hours a worker must remain seated for. Therefore, there is a requirement and room for changes in the workstation and sitting posture of the worker. Hence the need for better office chairs and adequate information regarding the position the worker must take in order to have a positive outcome on the work and the body.

To set up a compatible workstation, it is crucial to understand the idea of neutral body positioning in order to minimize the adverse effect on the musculoskeletal system. In order to maintain a neutral body position, most of the stresses and strains on the muscles must be reduced to the minimum, to do so the following must be considered while sitting [9]:

- Hands, wrists and forearms must be straight, parallel and in line with the floor.
- Head is level, facing forward, balanced and in line with the torso.
- Shoulders must be relaxed, and upper arms should fall on the sides of the body naturally and easily.
- Elbows stay next to the body and bent at an angle from 90-120 degrees.
- Feet are to be fully supported by the floor or any flat surface under.
- Back is completely supported with comfortable and appropriate lumbar support when sitting vertically or leaning back.
- Thighs and hips should be supported and lie parallel to the floor
- Knees are about the same height as the hips and the feet slightly moved forward

The four postures offering a neutral body position are [9]:
- Upright sitting (Fig. 4)
  The user's torso and neck are approximately vertical and in-line, the thighs are approximately horizontal, and the lower legs are vertical.

![Figure 4. Upright sitting position [9].](image)

- Standing (Fig. 5)
  The user's legs, torso, neck, and head are approximately in-line and vertical with feet slightly apart. The user may also elevate one foot on a rest while in this posture.

![Figure 5. Standing Position [9].](image)

- Declined sitting (Fig. 6)
  The user's thighs are inclined with the buttocks higher than the knee and the angle between the thighs and the torso is greater than 90 degrees. The torso is vertical or slightly reclined and the legs are vertical. This position should not inhibit the ability to easily reach the keyboard or view the monitor.
- Reclined sitting (Fig. 7)
  The user's torso and neck are straight and recline between 105 and 120 degrees from the thighs.

Following 4 spheres of the workstation are recommended to take under consideration while setting it up [10]:

1. Chair
   While sitting, one must push their hips as far back as possible. They must adjust the height of the seat so that their feet lay flat against the floor and the knees are equal or lower than their hips. Reclining angle of the back of the chair should be between 100 – 110 degrees to make sure that the lower and the upper back are comfortably situated. It is advised to use special pillows to provide extra support. As far as the armrests are concerned, adjust them to gain a relaxed position for the shoulders or remove them if they object you from working.

2. Mouse and keyboard
   It is suggested to keep close and be directly in front of the keyboard, maintaining you centre with the most frequently used part of the keyboard. It is important to keep your shoulders relaxed and the elbows open at 100 to 110 degree, while the wrist and hands remain straight. Palm support help maintain neutral postures and pad hard surfaces. However, the palm support should only be used to rest the palms of the hands between keystrokes. Resting on the palm support while typing is not recommended. Avoid using excessively wide palm support, or palm support that is higher than the space bar of your keyboard. The placement of the mouse should be as close to the keyboard as possible.

3. Monitor, Documents and Telephone
   Place the monitor directly in front of you, centralized and above the keyboard. Set up the top of the monitor to 2-3” above the sitting eye level. Carefully reposition the screen to minimize the glare. If the person wears glasses, lower the monitor to a
comfortable reading level. Sit at least an arm's length away from the screen and then adjust the distance for your vision. When sitting near a window, adjust the curtains or blinds and place the screen at a 90 degree angle to the window. Place your telephone within easy reach. Lastly it is recommended to use a headset or speaker phone to avoid handling the telephone near the ear for a long time.

4. Pauses and Breaks

Once the near ideal computer workstation has been set up, it is still crucial to keep switching between body postures to reduce the effects of prolonged static work positions. It is said to take a 1–2 min break, stretch and walk around a bit after every 20-30 mins of working. During lunch breaks one should try their best to stay away from the computer as much as possible. To avoid eye fatigue, rest and refocus your eyes regularly but looking at something other than the screen. Rest your eyes for 10-15 seconds by placing your hands over them.

Several computer software’s have been invented and introduced to the occupational world, these software’s once loaded on to the working persons computer, keep a track of their work time and prompt breaks as and when the software feels it is crucial for the worker to get off of the computer or do some other task which do not involve the use of the same muscles. A few of such software’s include Ergonomix [11], Eyeleo [12], Workrave [13], Big Stretch Reminder [14], PC WorkPace [15] and EVO [16].

As previously mentioned, there are 4 types of postures providing a body with neutral muscle strains. However, sooner or later, the sitting postures become repeatedly used for long hours and instead start affecting the body adversely due to the increase in static force. Since one of the neutral postures includes standing, it is often an alternative to use Sit-to-Stand Workstation. A Sit-to-Stand Workstation enforces the user to, occasionally after certain period, switch positions from sitting to standing meanwhile still working at the same workstation.

Several studies and surveys have been conducted in order to understand the requirement and effect of Sit-to-Stand Workstations. One of them demonstrates a number of benefits associated with switching position from sitting to standing throughout the whole working day. It was noticed that there was less foot swelling in cases where sit/stand was available. Spinal shrinkage was measured in an office which also included people with spinal disorders. The concerned subjects were instructed to stand for 30 minute periods and it was seen they had significantly less measured spinal shrinkage than those who stood for only a 15 minute [17].

Another interesting study examined six sit-stand workstations used by keyboard operators who had been given detailed instructions in how to use and adjust their workstation heights and chairs. Measures of production levels, absenteeism and injuries (as well as a survey of discomfort) compared measures before and after the introduction of this new equipment. There was a large (62%) decrease in reported discomfort, and more than 50% reduction in injuries. In another study for a group of 12 employees who were involved in doing intensive computer work in enclosed offices at non-adjustable workstations, it was found that when moved to sit-stand workstations, the concerned subjects felt more satisfied and less lethargic while doing their work [17].

However, too much of either, standing or sitting has its own side effects. So they must be used in the correct proportion and proper training and knowledge must be provided to the employees who are to use Sit-to-Stand workstations [17].
CONCLUSION

As observed, with the advancement of technology, it is also necessary to understand and learn about the side-effects of the technology we interact with daily. Technology has become a crucial part of our life and most of the times people believe that since they have been developed by scientists who are considered to know better than the rest. However, as it can be seen, they often do not always produce for the best interests of the consumers. Therefore, it is important as individuals and occupational providers to gain proper knowledge about how to limit the ill-effects of a computer workstation. Several ergonomically sound solutions and suggestions have been provided above which should be implemented and incorporated into the work environment. These solutions and suggestions should be encouraged by the work culture, to train and persuade their employees to try to apply these as often as possible for the betterment of their own health and efficient work results.

REFERENCES

1. Suszyński, M., Butlewska, M. and Stempowska, R. 2017. Ergonomic Solutions to Support Forced Static Positions at Work. MATEC Web of Conferences, 137:01015, 10.1051/matecconf/201713701015.
2. Eltayeb, S., Staal, J. B., Hassan, A., and de Bie R. A. 2009. Work Related Risk Factors for Neck, Shoulder and Arms Complaints: A Cohort Study among Dutch Computer Office Workers. Journal of Occupational Rehabilitation, 19(4): 315–322.
3. Sonne, M., Villalta D. L., and Andrews D. M. 2012. Development and Evaluation of an Office Ergonomic Risk Checklist: ROSA - Rapid Office Strain Assessment. Applied Ergonomics, 43(1): 98–108.
4. Malm, E. 2012. A Compendium on Sitting Ergonomics. Malmstolen AB.
5. Tiric-Campara, M., et al. 2014. Technological Diseases: Carpal Tunnel Syndrome, a Mouse Shoulder, Cervical Pain Syndrome. Acta Informatica Medica, 22(5):333, 10.5455/aim.2014.22.333-340. Accessed 22 Oct. 2019.
6. Matos, M., and Arezes P. M. 2015. Ergonomic Evaluation of Office Workplaces with Rapid Office Strain Assessment (ROSA). Procedia Manufacturing, 3:4689–4694.
7. Rani L. 2015. A Proposed RULA for Computer Users. Academia.Edu, www.academia.edu/17449435/A_Proposed_RULA_for_Computer_Users.
8. Maldonado-Macías, A., Realyvásquez, A., Hernandez, J. L., and García-Alcaraz, J. L. 2015. Ergonomic Assessment for the Task of Repairing Computers in a Manufacturing Company: A Case Study, Work, 52(2):393–405.
9. United States Department of Labor. 2019. ETools | Computer Workstations ETool - Good Working Positions | Occupational Safety and Health Administration. Osha.Gov, www.osha.gov/SLTC/etools/computerworkstations/positions.html.
10. UCLA Insurance and Risk Management. Ergonomics. 26 June 2018, ergonomics.ucla.edu/office-ergonomics/4-steps.html.
11. Ergonomix. 2019. Ergonomix Software - Smart Break Reminder Prevents RSI. Keyboard and Mouse Monitoring. Rest Breaks and Micropauses. Stretching Routines and Ergonomic Information and Setup. Publicspace.Net, www.publicspace.net/ergonomix/features.html. Accessed 5 Nov. 2019.
12. EVO. 2019. How To Protect Your Eyesight From Computer Screen? Protectyourvision.Org, www.protectyourvision.org.
13. Workrave. 2019. Workrave - Program That Assists in the Recovery and Prevention of Repetitive Strain Injury (RSI). Workrave.Org, www.workrave.org/.
14. Lester, M. 2019. Big Stretch Reminder. Monkeymatt.Com, monkeymatt.com/bigstretch. Accessed 5 Nov. 2019.
15. Wellnomics. 2017. WorkPace (Stretch-Break Software) - Wellnomics. Workpace.Com, www.wellnomics.com/about/wellnomics/.
16. EyeLeo. 2018. EyeLeo Prevents Eye Strain. Eyeleo.Com, www.eyeleo.com.
17. Dohrmann, M. 2008. The Benefits of Sitting and Standing to Work. https://www.researchgate.net/publication/289978777_The_benefits_of_sitting_and_standing_to_work. Accessed 5 Nov. 2019.