MINISTRY OF HUMAN RESOURCES
DEPARTMENT OF OCCUPATIONAL SAFETY AND HEALTH

GUIDELINES ON OCCUPATIONAL SAFETY AND HEALTH FOR SEATING AT WORK 2024

GUIDELINES ON OCCUPATIONAL SAFETY AND HEALTH FOR SEATING AT WORK 2024

COPYRIGHT

First Printing
Guidelines on Occupational Safety and Health for Seating at Work 2024

Guidelines on Occupational Safety and Health for Seating at Work 2024

e ISBN 978-629-99979-1-7

Publisher
Department of Occupational Safety and Health, Malaysia
Ministry of Human Resources
Level 1,3,4&5 Setia Perkasa 4,
Setia Perkasa Complex,
Federal Government Administrative Centre,
62530 Federal Territory Of Putrajaya.

PREFACE

These guidelines may be cited as the Guidelines on Occupational Safety and Health for Seating at Work 2024. These guidelines also replace the previous and first version of Guidelines on Occupational Safety and Health for Seating at Work 2003.

The aim of these guidelines is to promote and assist all stakeholders in the industry towards a safe and healthy working environment at all workplaces where seated work is being performed.

Within these guidelines, the risk factors of ergonomics, health effects, mechanisms of injuries, the basic principles of seating workstation, seating design, work surfaces, working with peripherals and other aspects of control and improvement are described. Alternative practices are acceptable if they provide employees with equivalent level or higher standard practices than being provided by those described in these guidelines.

Employers, safety and health practitioners, designers, manufacturers and employees should understand the importance and rationale of seating at work as well as its management in order to prevent Occupational Musculoskeletal Disorders associated with seating at work.

The Department would like to thank all committee members for their efforts and contributions in the preparation of these guidelines.

Ir. Hj. Mohd Hatta bin Zakaria
Director General
Department of Occupational Safety and Health
Malaysia
2024

ACKNOWLEDGEMENT

The Department of Occupational Safety and Health Malaysia would like to thank the following individuals for their most valuable contributions during the drafting of these guidelines.

The main committee and technical committee involved in the preparation of these guidelines are as follow:

Main Committee

Name	Organization
Ahmad Nazri bin Abd Kader	DOSH
Mohd Yunos bin Talib @ Khalid	DOSH
Dr. Ishkandar bin Md Yusoff	DOSH
Hjh. Noor Azurah binti Hj. Abd Rahman	DOSH
Hjh. Nor Maizura binti Yusoff	DOSH
Ts. Dr. Hamidi bin Saidin	DOSH
Ts. Fauziah binti Kamaruddin	DOSH
Dr. Rajinderjit Singh Hullon	DOSH
Ir. Rizal Azizi bin Ghazali	DOSH
Mohd Norhafiz bin Ibrahim	DOSH
Mohd D'Azmir bin Kamarudin	DOSH
Ts. Mazlina binti Yusof	DOSH
Musna binti Rappe	DOSH

Technical Committee

Name	Organization
Assoc. Prof. Dr. Ng Yee Guan	Universiti Putra Malaysia
Anas Khairul Fazian bin Aning	Sime Darby Plantation Berhad
Bakhtiar bin Dollah	Shinko Electronics (M) Sdn Bhd
Nor Azman bin Md Isa	Permodalan Nasional Berhad
Nurul Ain binti Zali	Petroliam Nasional Berhad
Zulfarena binti Mat Rasidi	Telekom Malaysia Berhad
Mohd Hafzi bin Md. Isa	SOCSO
Ismail bin Abdul Rahman	NIOSH

ABBREVIATION

CTS	Carpal Tunnel Syndrome
DOSH	Department of Occupational Safety and Health
ERA	Ergonomics Risk Assessment
ERF	Ergonomics Risk Factors
NIOSH	National Institute of Occupational Safety and Health
OMSD	Occupational Musculoskeletal Disorders
OSH	Occupational Safety and Health
OSHA 1994	Occupational Safety and Health Act 1994
SOCSO	Social Security Organisation

TABLE OF CONTENTS

TABLE OF CONTENTS

1.0 INTRODUCTION

In line with the continuous global technological advancements, the nature of work tasks in Malaysia continues to evolve leading to sedentary lifestyle. In this regard, sitting for work has become more prominent over the past 20 years and is expected to continue becoming a norm at workplaces in Malaysia. Regardless of the nature of business, the industries have seen the fair share of consequences arising from sitting for work.

Sitting for work is not limited to office-based work tasks such as computer usage. There are various other job tasks which require or provide a sitting workstation as shown in **Figure 1.1**. Among examples are microscope users, certain assembly tasks employees, various types of vehicle drivers, etc. These work tasks can present various ergonomics risk factors (ERF) associated with development of Occupational Musculoskeletal Disorders (OMSD).

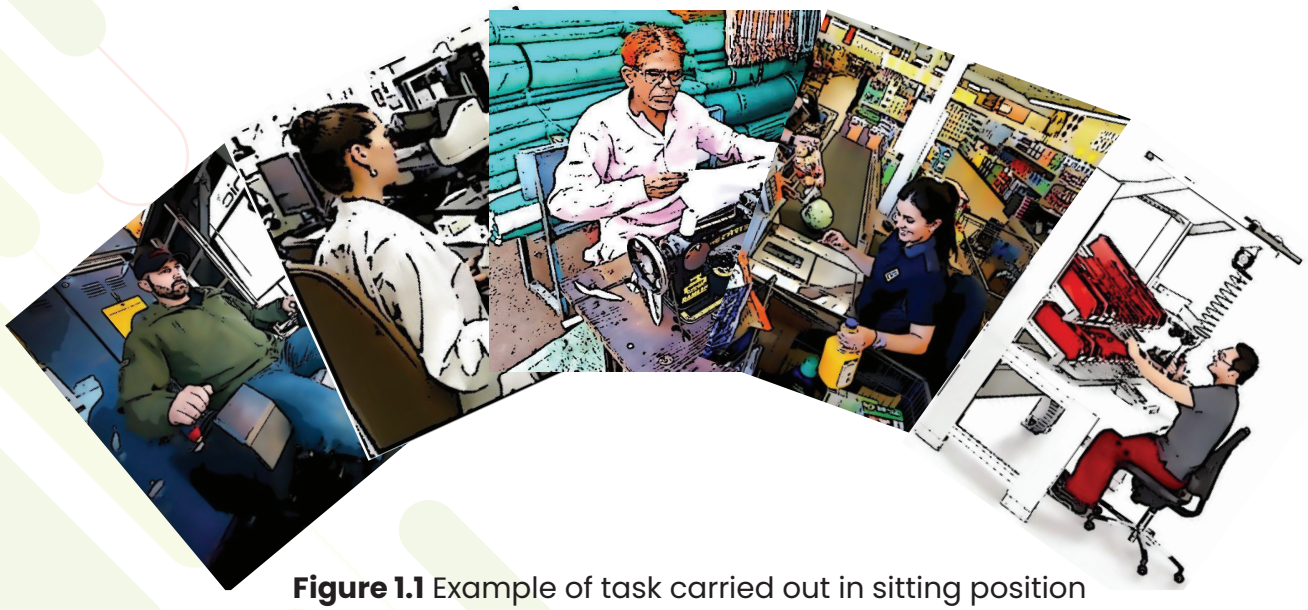


Figure 1.1 Example of task carried out in sitting position

Based on National Occupational Accident and Disease Statistics 2022, total number of confirmed cases of Occupational Disease is 7,143 where OMSD cases is the second highest after Occupational Noise Related Hearing Disorders with 678 cases.

1.1 Purpose

The purpose of these guidelines is to provide guidance on knowledge, awareness and best practices for seating tasks at the workplace. Additionally, these guidelines also provide various considerations of design and selection of seating and some examples of seating arrangements for different kinds of work.

It is one of the general duties as prescribed under the Occupational Safety and Health Act 1994 (OSHA 1994) for the employer to provide a safe workplace to their employees and other related persons.

1.2 Objectives and Benefits

The objectives of these guidelines are to:

a. explain the ERF associated with seating at work;

b. explain the potential of health effect arising from seating at work; and

c. highlight the principles of ergonomics for seating workstation and control measures to prevent OMSD.

The benefits are :

a. enable employers to plan, implement and monitor preventive measures related to seating at work;

b. reduction of potential health effect as a result of exposure to ERF related to seating at work; and

c. reduction of medical expenses and employee absenteeism.

1.3 Scope and Application

The scope of these guidelines covers the issues related to seating at work which are part of the physical ergonomics domain in the workplace. These guidelines are applicable to the workplaces which are covered under OSHA 1994.

These guidelines generally applied to all seated work in most workplaces, however the application is emphasized on seated work with minimal movement more than 30 minutes continuously.

These guidelines are intended to be of interest mainly to employers, employees, safety and health practitioners and to manufacturers, designers and suppliers of industrial and office furniture.

2.0 LEGAL REQUIREMENT

The OSHA 1994 aims to secure the safety, health, and welfare of persons at work, for protecting others against risks to safety or health in connection with the activities of persons at work. Under the Act employers, employees and self-employed person are required to meet certain standards on safety, health and welfare. The general provision related with seating at work are as follows:

a. Section 15 of the Act describes the duty of every employer to ensure; so far as is practicable, the safety, health and welfare at work of all his employees.

b. Section 17 of the Act describes the general duties of employers and self-employed persons to conduct his undertaking in such a manner as to ensure; so far as is practicable that he and other persons not being his employees, who may be affected thereby are not thereby exposed to risk to their safety and health.

c. Section 20 of the Act describes the duties of a person who designs, manufactures, imports, or supplies any article for use at work.

d. Section 24 of the Act describes the duty of every employee while at work.

3.0 TERMS AND DEFINITON

Term	Definition
Carpel Tunnel Syndrome	Carpal Tunnel Syndrome arises from the intermittent or continuous compression or entrapment of the median nerve in its passage through the carpal tunnel from the wrist to the hand. Increased pressure on the nerve in the tunnel can result in progressive sensory and motor disturbances in parts of the hand corresponding to the median nerve distribution, eventually leading to pain and in the most severe cases, loss of function.
Medial Epicondylitis	Medial Epicondylitis is an overuse syndrome characterized by inflammation of the flexor tendons at the medial epicondyle of the humerus. Medial epicondylitis is also known as golfer's elbow.
Thoracic Outlet Syndrome	Thoracic Outlet Syndrome is a condition in which there is compression of the nerves arteries, or veins in the superior thoracic aperture, the passageway from the lower neck to the armpit, also known as the thoracic outlet. There are three main types: neurogenic, venous and arterial.

4.0 ERGONOMICS RISK FACTORS RELATED TO SEATING AT WORK

ERF are defined as aspects of a job or task that impose a biomechanical stress on the employee therefore may cause ergonomics related injury or OMSD. These ERF arise from the physical strain and discomfort associated with seating at work for extended periods, which can contribute to OMSD and other health issues. Understanding these risk factors is essential for developing effective workplace interventions and promoting employee well-being.

4.1 Seating at Work

A seated person is subjected to gravitational force which naturally and constantly exerts a downward force on the bodies. Depending on the contact point, the body parts in contact with the supporting structure (buttock, arm, leg, back, etc.) will feel pressure from the structure and concurrently exert an upward force to balance the gravitational force.

An upward counterforce to the gravitational force is therefore exerted by the body parts (including muscles, tendons, and ligaments) that are not in contact with the supporting structure in order to balance the force of gravity. The body position that has the highest strength to handle the pressure felt by the supporting structure, while causing the least amount of strain on the muscles, tendons and ligaments, is called the neutral or balanced body position as shown in **Figure 4.1.**

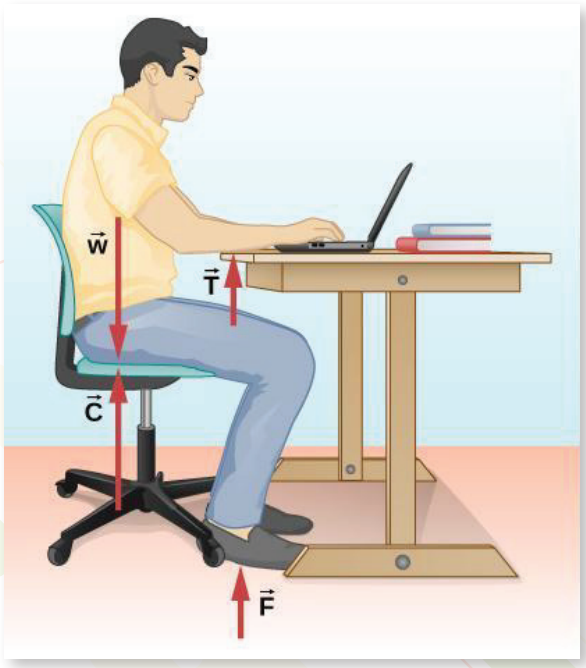


Figure 4.1 Illustration of forces acting on a seated person

A static working position restricts blood flow to certain areas of the body parts, particularly the vessels supplying the muscles. This situation can accelerate fatigue and cause muscles to be prone to injuries. Concurrently, the sedentary nature of seating (limited mobility) creates less demand on the circulatory system resulting in lower heart activities and hence slowing down blood flow and indirectly compounding the problem further.

The pioneering research in spine biomechanics on determining the load of lumbar discs in different posture paved ways for the proliferation and progression in the spine biomechanics. **Figure 4.2** shows the lowest disc pressure is in the laying down (supine) position while the highest disc pressure is when lifting weight from a seated, forward leaning position

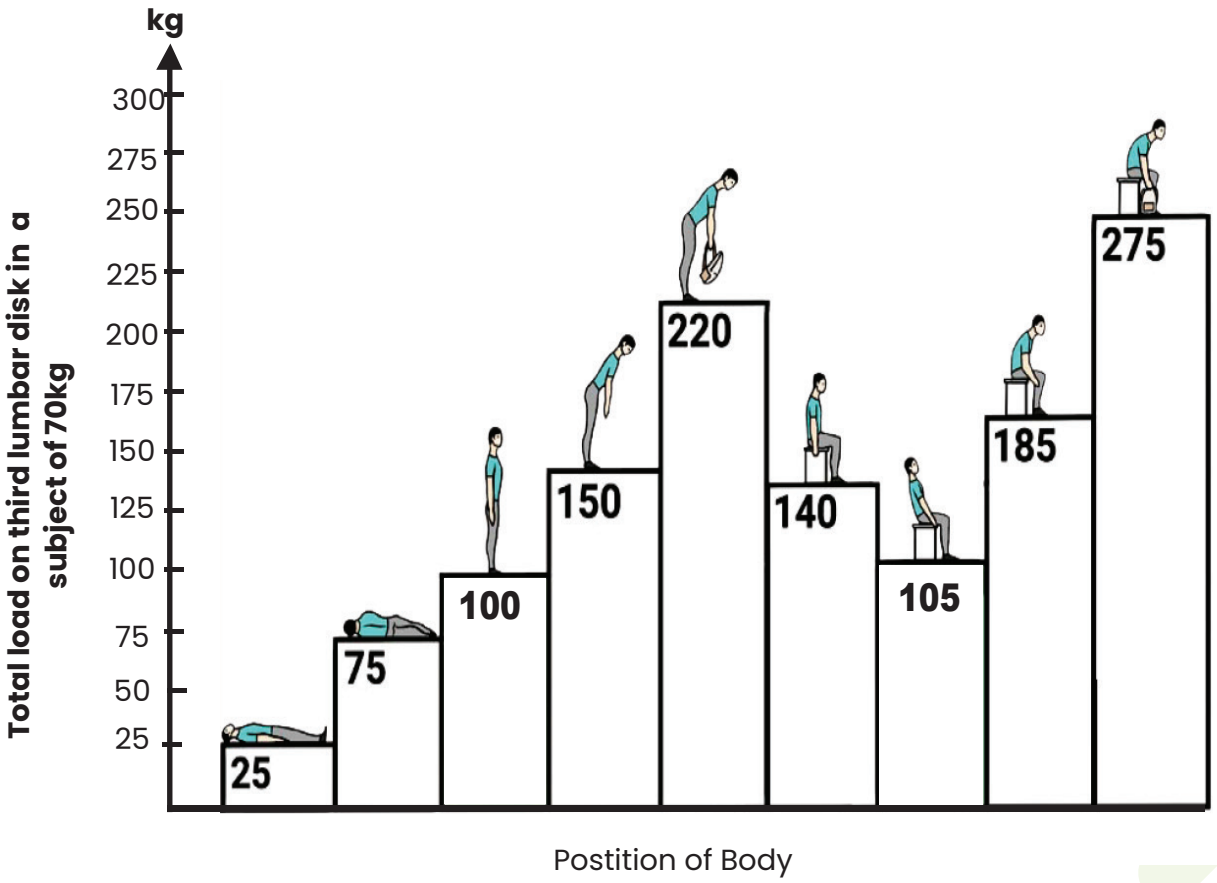


Figure 4.2 Total load on the L-3 disc in different positions

4.2 Ergonomics Risk Factor

4.2.1 Awkward Posture

There are various occasions in which a seated employee can experience awkward postures. For example, sitting by slouching or leaning, slumping or sliding forward in his or her chair, cradling a phone between the ear and shoulder, keeping the head held too high or looking down excessively, reaching up and over to access the keyboard or mouse and bending at the waist to load a copy machine, bending forward to look into microscope at angle which also forces the neck (cervical) to bend forward, etc. An example of seating with awkward posture as shown in **Figure 4.3.**

Figure 4.3 An example of seating with awkward posture

Regardless, evidence from various studies in the past and present finds that the pressure in the intervertebral discs increases significantly particularly during poor sitting posture as indicated in the study as shown in **Figure 4.4.**

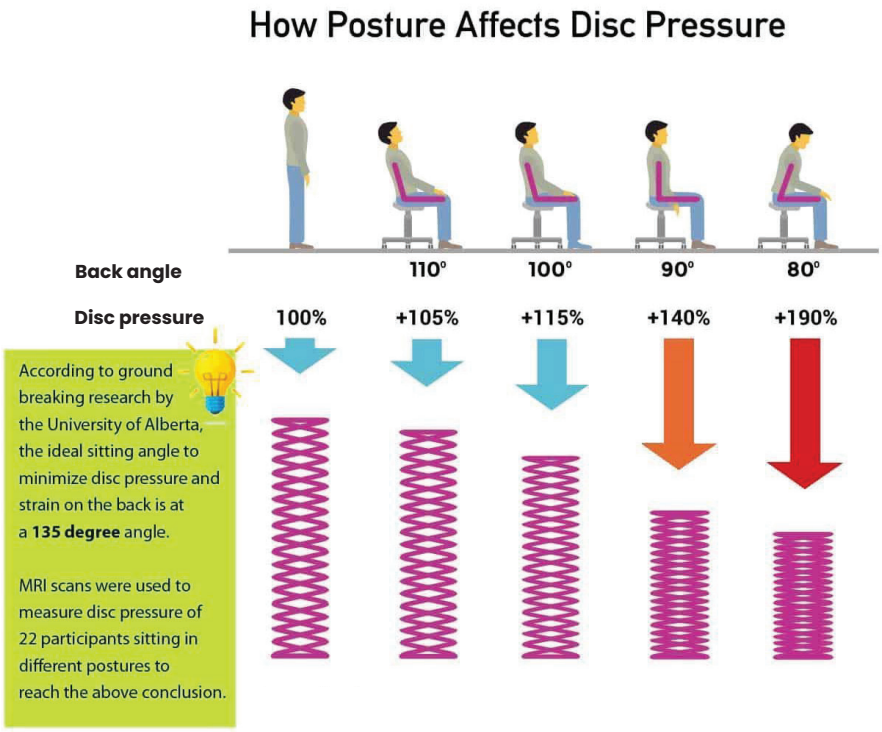


Figure 4.4 How different sitting posture affects disc pressure

4.2.2 Static and Sustained Posture

Static and sustained postures refer to physical exertion in which the same posture or position is held with minimal or restricted or no movement for a prolonged period of time. In a sitting posture, the lack of movement is worsened because the sedentary posture is fundamentally bad for the back and various other parts of the body. An example of static and sustained posture while sitting as shown in **Figure 4.5.**

Figure 4.5 Example of static and sustained posture while sitting

The exertions sustained during a prolonged sitting posture put an increased load or forces on the muscles and tendons, which contributes to fatigue. The problem is further compounded by the fact that being static not only impedes the blood flow that is necessary to bring nutrients to the muscles and all the anatomical parts of the body, but also in transporting the waste products of metabolism away to be processed and eliminated.

4.2.3 Contact Stress

In sitting posture, contact stress can be experienced at the forearms when they are resting on the leading edges of the workstation or if the nerves in the forearm are affected, fingers and hands may tingle and feel numb. An example of contact stress is shown in **Figure 4.6.**

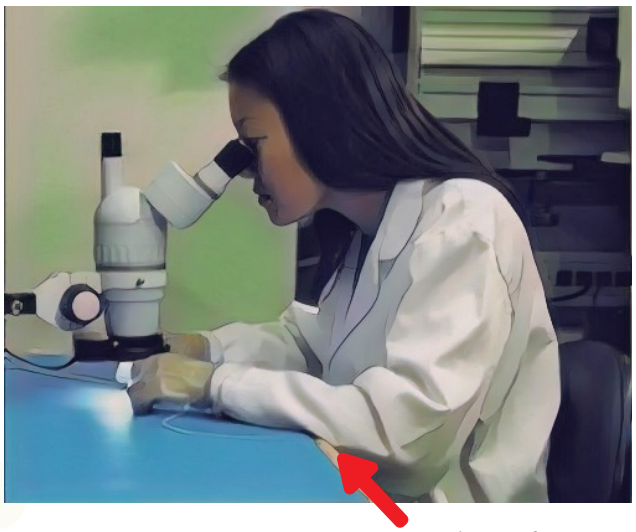


Figure 4.6 Contact stress caused by compression of hard surfaces (edge of table) on soft tissues (hand-wrist)

Sitting on a chair that places pressure on the back of an employee's thighs can cause pain and numbness in the legs if blood circulation is cut off by contact with the leading edge of a chair as shown in **Figure 4.7.**

Figure 4.7 Contact stress caused by compression between of hard surface (seat pan) on soft tissues (back of thighs)

4.2.4 Repetitive Motion

Many work tasks are repetitive in nature and are frequently controlled by hourly or daily production targets and work processes. High task repetition, when combined with other ERF such as static posture and / or awkward postures while sitting, can contribute to the formation of OMSD. This ERF is commonly associated with the duration of work tasks, intensity and work or tasks design. The same motions repeatedly throughout the day, such as assembly tasks, sewing, typing on keyboard, flipping through paperwork, clicking a mouse or using a calculator can result in trauma to joints and surrounding tissue. An example of repetitive while seating as shown in **Figure 4.8**

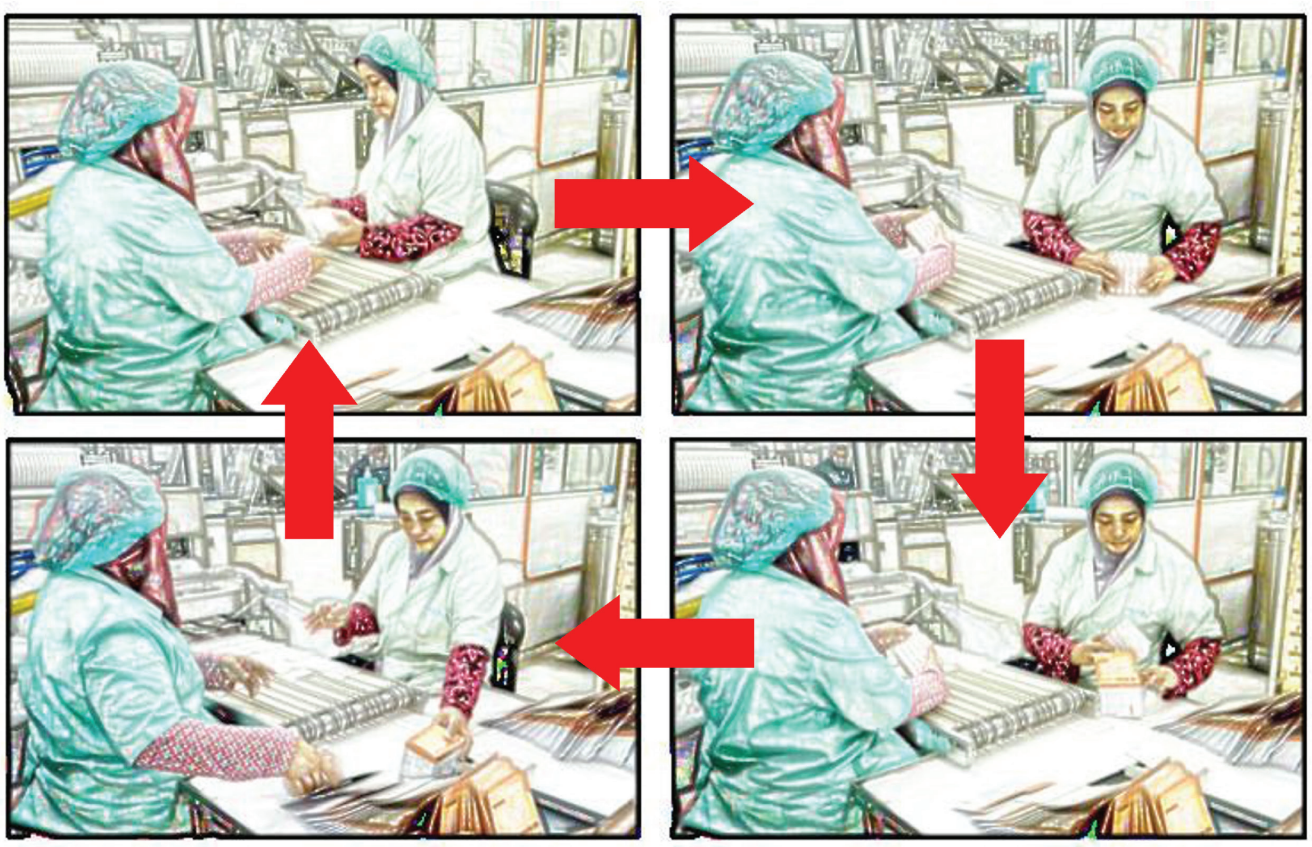


Figure 4.8 An example of repetitive work tasks in seated position – packaging in manufacturing industry

4.2.5 Forceful Exertion

Although it is uncommon for seating at work to be designed with forceful exertion, the existence cannot be ignored. Short bursts of forceful exertion may still be possible even though the limitation it presents in seated position. The amount of force used in a specific task directly affects the level of risk of employee injury. A number of sitting tasks require a moderate amount of force to be applied to small muscles, which may result in muscle and ligament strains, swelling and fatigue. An example of seated tasks that may exert too much force on an employee include using a hand-tools such as hammer, chisel or screwdriver, inserting or clamping in assembly tasks, grasping or transferring heavy loads as shown in **Figure 4.9**.

Figure 4.9 An example of seated work which require forceful exertion

4.2.6 Vibration

Vibration is a form of kinetic energy that is directly transferred to our body parts when in contact with the oscillating object. Employee can be exposed to either whole body vibration (WBV) or hands-arm vibration (HAV) depending on the nature of exposure. Past studies, particularly epidemiological data in the past, has shown an abundance of evidence on the health effects of vibration affecting spine, muscles, tendons, ligaments, joints and nerves. WBV is particularly experienced by vehicle operators not only among land vehicles such as crane operators, truck, bus drivers and etc. in a seated position, but also among employees working or travelling in the sea via vessels or boats. HAV exposure on the other hand are typically caused by usage of power tools.

4.2.7 Environmental Risk Factors

A good physical working environment is important, not only for health and well-being but also because an inadequate environment can have a negative impact on concentration and communication therefore impairing work performance or productivity. Extreme temperatures, inadequate air ventilation, inadequate lighting and excessive noise are examples of environmental risk factors which lead to adverse impact on employees while sitting at work.

Hot temperature generally causes discomfort which compromises focus, efficiency, accuracy and overall productivity. In prolonged exposure, heat can lead to dehydration and muscle fatigue as the body attempts to regulate temperature to maintain homeostasis by increasing perspiration. The general discomfort potentially causes dissatisfaction leading to stress which may contribute to development of or aggravate existing OMSD. On the other hand, cold temperature leads to reduced sensory feedback, tensed up muscle causing less dexterity and flexibility resulting in muscle strains and pulls as the body homeostasis regulation kicks in, constricting blood vessels to prevent heat loss.

Poor lighting setup at the workplace can be divided into two extremes: dim, dark, gloomy environment or too bright glare (direct or indirect) to the users. For seated work, poor lighting setup potentially causes employees to adopt awkward posture particularly for the trunk and /or neck as they adjust their position to see better. Such prolonged adoption of awkward posture could lead not only to job dissatisfaction but ultimately OMSD.

Continuous exposure to excessive noise or poor ventilation (including indoor air quality) are environmental ergonomics risk factors that can cause discomfort and stress may aggravate existing OMSD. For employees who are seated at work, this can be particularly irritating as they may be unable to follow their biological instinct to move away from these environmental stressors. While these factors can contribute to discomfort and stress, it is important to note that they do not directly cause OMSD instead, they may exacerbate existing conditions or contribute to a broader context of workplace discomfort.

4.2.8 Other Risk Factors

Psychosocial risk factors such as excessive workloads, conflicting demands, lack of influence over the way the job is done, job insecurity and lack of management support or colleagues can further aggravate the existing stress and strain.

Many of these risk factors are encountered in office work, with or without the use of computers such as in call centers where operators may receive verbal abuse, working in isolation, bullying, etc. In some cases, the impact of computing technologies on how jobs are structured can play a major role such as in using software with glitches, slow systems, unfamiliar or relatively new software.

The potential impact of these factors is two-folds. Firstly, they can have a direct impact on the mental and physical health of employees. Secondly, there is a growing body of evidence that they can exacerbate musculoskeletal problems. It is important that these risk factors are taken into consideration during risk assessment.

Individual risk factors such as age, body mass index (BMI), physical activity, unhealthy diet, etc. can further contribute to OMSD. As opposed to older individuals whose physiological system has worn after years of exposure to various ERF, a younger adult has a higher tolerance and flexibility against external stressors. Besides that, being engaged in certain hobbies such as gardening, fishing, knitting, etc. as well as intensive sports activities can further increase strain on the body musculoskeletal system which results in fatigue leading to OMSD and further aggravated by work.

4.3 Ergonomics Risk Assessment

Ergonomics Risk Assessment (ERA) is a systematic and objective approach to identify, assess and control ERF associated with the work tasks and activities in the workplace. Methods for implementation of ERA at the workplace are described in the relevant guidelines on ergonomics risk assessment published by DOSH.

5.0 HEALTH EFFECTS RELATED TO SEATING AT WORK

OMSD refer to conditions affecting the muscles, tendons, ligaments, nerves and other soft tissues including joints and at various parts of the body which arise or have contributing factors from the workplace. The term covers conditions with specific medical diagnoses (e.g.: Chronic Tenosynovitis, Carpal Tunnel Syndrome, etc.). **Figure 5.1** illustrate the anatomy of body parts;

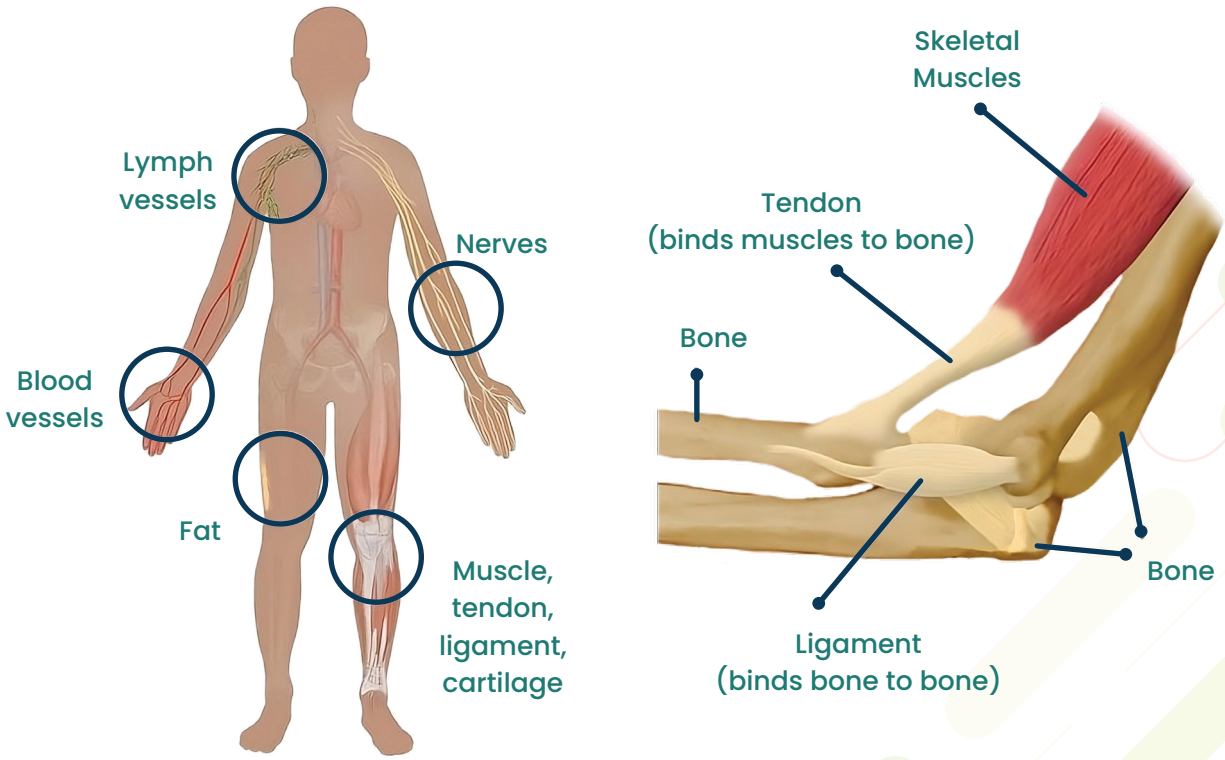


Figure 5.1 Illustration depicting soft tissues (left) and differences between muscles, tendons and ligaments (right)

Being one of the oldest ergonomics concerns, not only do the affected employees suffer from OMSD, but also from the various metabolic diseases associated with sedentary work, particularly seated work. Ultimately, the organizations may stand to lose in terms of productivity, employees' morale and other associated costs. **Table 5.1** provides examples of different working situations or environments with potential symptoms to the body.

Table 5.1 Examples situation and potential symptoms for seating at work

SITUATION / ACTIONS / ERF	POTENTIAL SYMPTOMS
Awkward Posture	
• Monitor positioned too high or low • Cradling a phone between the ear and shoulder • Shrugging of shoulder due to table being too high • Slouching or leaning forward • Hand stretched out to reaWch equipment such as mouse or keyboards being position further away	Neck pain, shoulder pain, low back pain, hands and wrists pain, tingling and numbness sensation over fingers

SITUATION / ACTIONS / ERF	POTENTIAL SYMPTOMS
Static and Sustained Posture	
• In a sitting posture, the lack of movement over a prolonged period • Sitting in awkward position over a prolonged period • Sitting on chair too high or too low over a prolonged period • Inadequate or absence of back support over prolonged period of time	Neck pain, shoulder pain, upper back pain, low back pain, leg pain, tingling and numbness sensation over lower limb
Contact Stress	
• A wrist rests on a sharp, hard, leading edge of a desk while typing or when elbows lean against a hard armrest • Forearms rested on the leading edges of the workstation • Sitting on a chair too high or with a hard solid edge of the seat pan	Hands and wrists pain, tingling and numbness sensation over fingers, stiffness or rigidity of the fingers, elbow pain
Repetitive Motion	
• The same motions repeatedly throughout the day, such as assembly tasks, typing on a keyboard, flipping through paperwork, clicking a mouse, or using a calculator	Stiffness of upper limb, wrist pain, rigidity of the finger
Forceful Exertion	
• Tasks that require employees to exert force on a seated position (i.e.: lifting boxes, or loads, using a hammer or screwdriver, inserting with substantial force or clamping to hold objects tightly in assembly tasks, grasping heavy folders or objects, etc.)	Muscle strain and pain, low back pain
• Whole body vibration such as experienced by truck and bus drivers on a seated position • Hands-arm vibration exposure caused by power tools	Low back pain, tingling and numbness sensation over fingers, stomach pain
• Working in cold or hot environment • Glaring caused by inappropriate workstation setup • Working in excessive noise environment	Eyes strain, muscle strain and pain, ear pain, dizziness, fainting episodes, tingling and numbness sensation over fingers

Exposures continuously to ERF can lead to the development of permanent and disabling illnesses such as Carpal Tunnel Syndrome, Medial Epicondylitis, Thoracic Outlet Syndrome, Chronic Tenosynovitis, etc. All the symptoms experienced by the employees should be assessed by an Occupational Health Doctor. The complaints from the employees who are subjected to seating at work needs to be assessed on an individual basis, since there can be many other contributing factors e.g. lifestyle, congenital diseases and environmental factors that can cause or aggravate the health conditions experienced by the employees.

6.0 PRINCIPLES OF ERGONOMICS FOR SEATING AT WORK

The design of the workstation, including seating should be based on a careful assessment of all aspects of the job and any special needs of the individual employee. The aim should be to ensure that each task can be carried out safely, comfortably and as efficiently as possible. Such an approach helps in the selection of appropriate seating and also ensures that the layout of workstation, the method of working and the order in which tasks are carried out are properly matched. There are several principles of ergonomics for seating at work that can be considered in seat design such as workspace envelope, sitting mechanics, sitting postures, seating comfort and anthropometry.

6.1 Workspace Envelope

In a well-designed workstation, an employee should be at a comfortable height and position in relation to the work. All equipment in frequent use, and the work itself should be kept within easy reach based on the frequency of handling as shown in **Figure 6.1** and **Figure 6.2**. It is important to eliminate the need for employees to make repeated twisting or stretching movements (overreaching), as these are common causes of injuries.

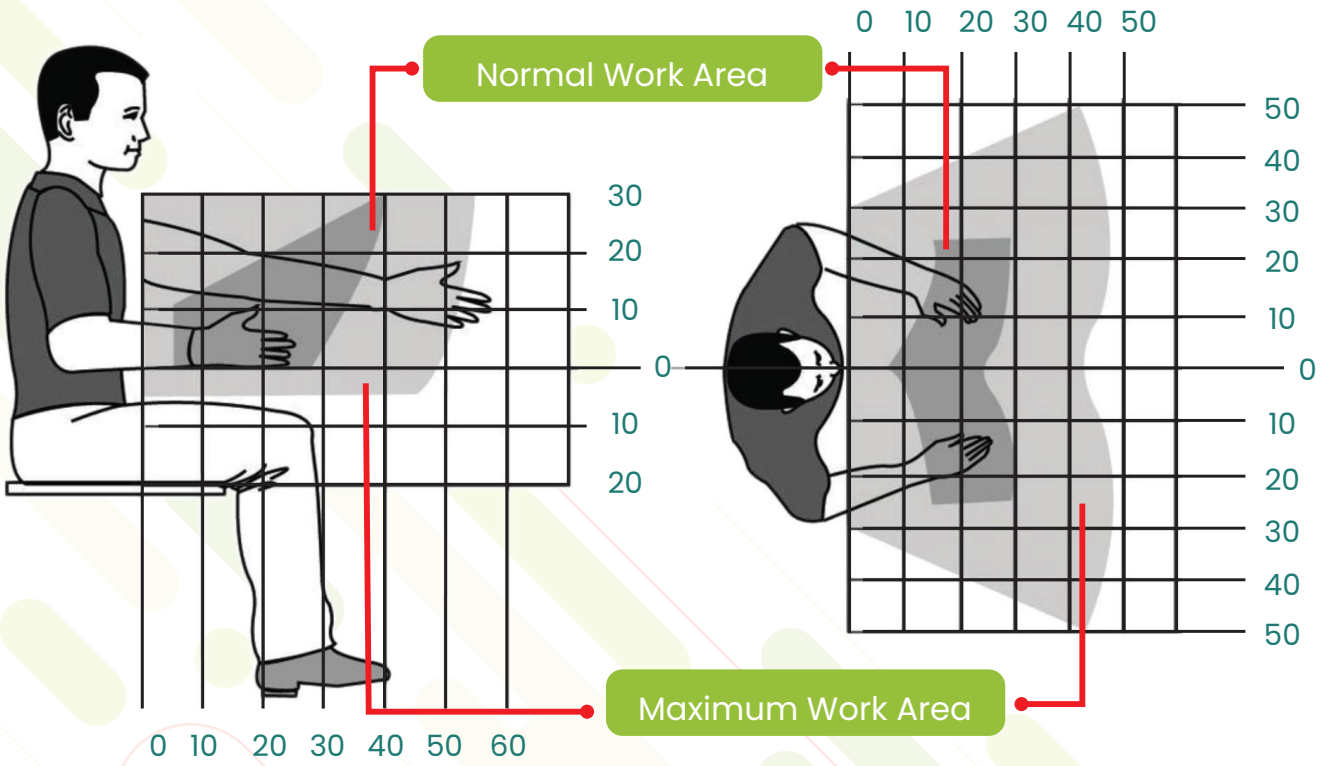


Figure 6.1 Workspace envelope – reach in vertical plane (left picture) and horizontal plane (right picture)

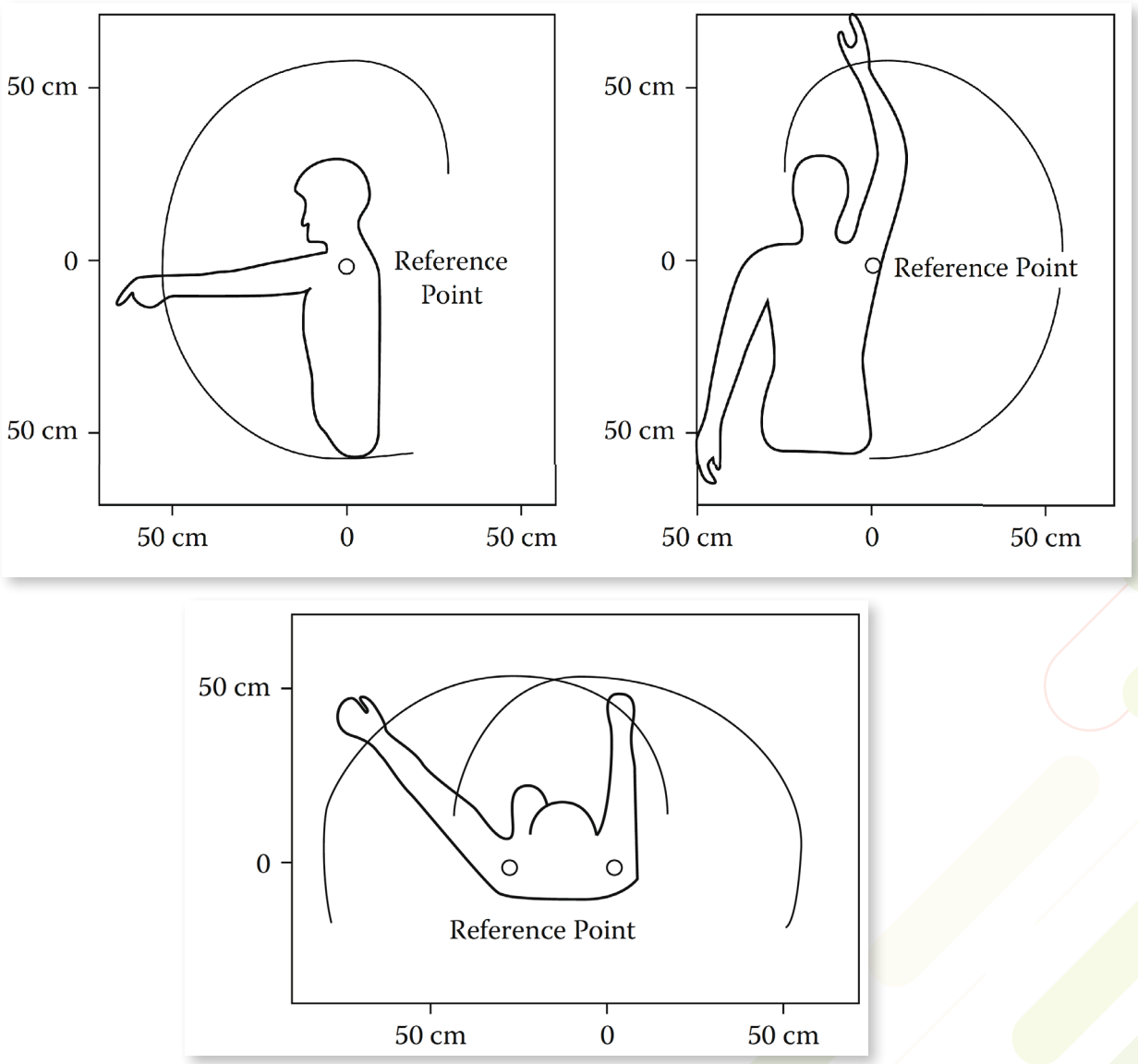


Figure 6.2 Workspace envelope – reach in 3-dimensional view

A seated employee will normally prefer to work with both hands at roughly elbow level or slightly lower (above the waist) as raising of the forearms above the horizontal for any length of time is tiring. Lifting load while seated can cause strain on the back and lifting should be kept close to the body.

As a general rule of thumb in terms of workstation design and configuration, the primary considerations are heights of the tables (or workbench), chairs (or stools) and the posture at work. Properly adjusted height tables and chairs will allow employees to work optimally as they assume neutral posture and distance appropriate to exert their strength without unnecessary or excessive stress on the musculoskeletal system.

Where applicable, the following are among considerations of workstation design and configuration:

a. Task

b. Work surface (smooth, rough, etc.)

c. Layout and spaces (heights and adjustability)

d. Equipment and accessories (computers, monitor, printers, keyboard, etc.)

e. Environment (lighting, temperature, etc.)

6.2 Sitting Mechanics

Sitting is a body position in which the weight of the body is transferred to a supporting area mainly by the ischial tuberosities of the pelvis and their surrounding soft tissue. Providing a seated workstation is essential among the employee in order to remove weight from the feet and maintain a stable posture so muscles that are not directly involved with the work can relax and recover.

6.3 Sitting Posture

There is no single ideal sitting posture. Illustrated 90-degree person sitting posture is for anthropometric reference only. A variety of chairs that allow different users to each sit in a variety of postures is necessary as there are no chairs that are being designed for the best single way to sit.

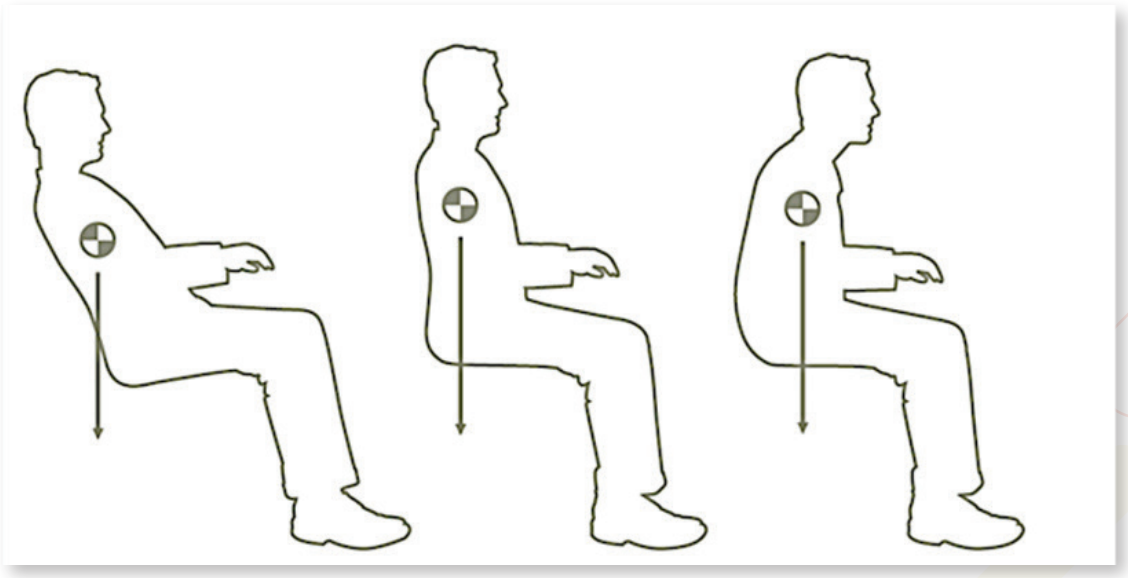
Depending on chair and posture, some proportion of total body weight is transferred to the floor via the seat pan and feet, armrests and backrests. Sitting with the knees and hips flexed, pelvis rotated backward leads to minimize lordosis, flat or even kyphotic lumbar spine.

There are three types of sitting postures normally distinguished as per **Figure 6.3** which are:

a. Posterior / Rearward tilt – in this position, the centre of mass is located behind any ischial tuberosities where the back is typically inclined on the backrest for resting. Less than 25% of body weight are transferred to the floor via the legs.

b. Middle / Upright – in this position, the centre of mass is located directly above ischial tuberosities where the back is relaxed, lumbar spine straight or slightly kyphosis. About 25% of the body weight is transferred to the floor via the legs.

c. Anterior / Forward leaning – in this position, the centre of mass is located in front of the ischial tuberosities commonly adopted for desk work. More than 25% of the body weight is transferred to the floor via the legs.



(a) Posterior : Rearward tilt | (b)Middle : Upright | (c)Anterior : Forward leaning

Figure 6.3 (a-c) Typical sitting working posture

6.4 Seating Comfort

Comfort is associated with feelings of relaxation and well being. The sensation of comfort may be amplified by an aesthetic design of the chair or office. Normally employees find it more comfortable to sit rather than stand whilst working unless the type of work requires constant stretching or twisting to reach or lift objects. Employers therefore need to ensure that work is organized to allow people to be seated wherever possible.

However, sitting for long periods can lead to discomfort and may result in long term health problems, so it is important that employees have the opportunity to change position, stand up and move around. If possible, the workstation and seating design should allow free movement as shown in **Figure 6.4.**

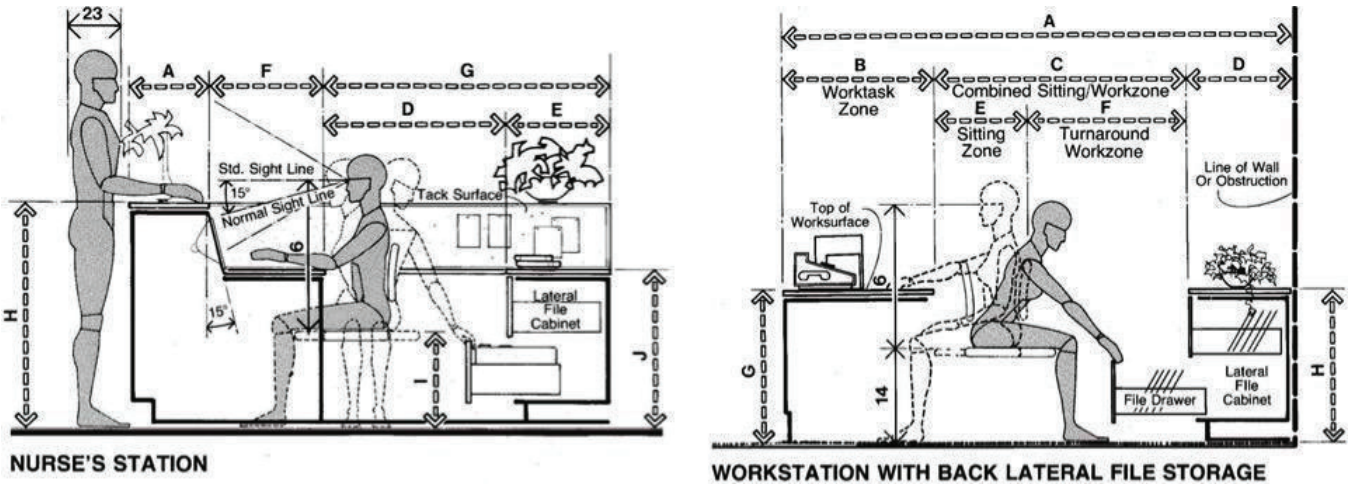


Figure 6.4 Workstation which allow free movement for employees (left: nurse's station, right: typical office)

If this is not possible, an employer can provide opportunities for movement by giving employees a variety of tasks or introducing task rotation or by ensuring that employees take adequate rest breaks away from the workstation. Employers need to be able to spot the signs that suggest seating is uncomfortable. For example, people may use cushions of their own to serve as footrest or makeshift footrests.

It is better for employers to take the initiative in providing suitable seating and not wait until complaints are received or until employees take time off with back pain. Employees also need to play their part by inform their employers or those responsible for safety and health, if seating is unsuitable or unsafe.

6.5 Anthropometry

Anthropometry is concerned with the measurement of size and proportions of the human body which is an essential consideration for workstation design in prevention of OMSD. The science of anthropometry stems from the fundamental fact that each individual is distinctively different. When plotted on a graph, the dimensional descriptors would form a symmetric bell shape curve commonly known as normal (or Gaussian) distribution as shown in **Figure 6.5.**

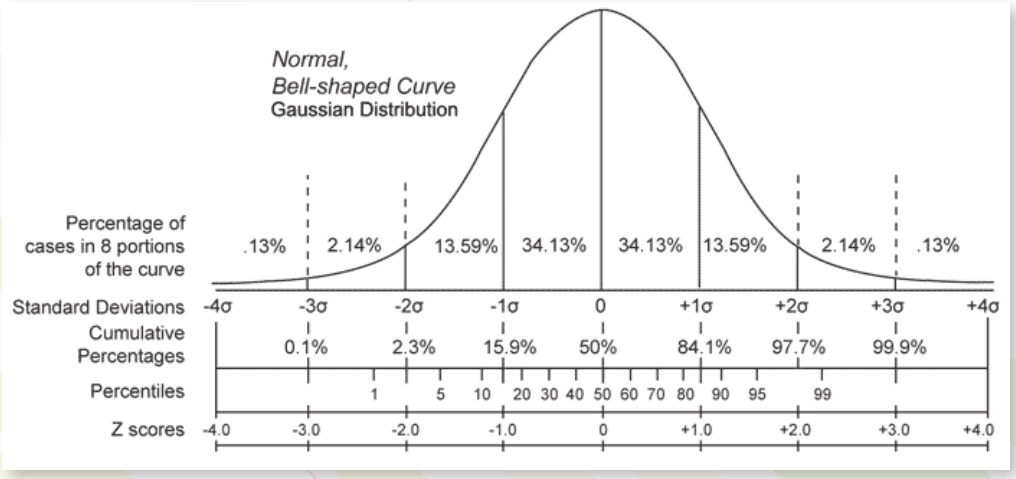


Figure 6.5 The variation of anthropometric dimension of a population follows a normal distribution

Figure 6.6 shows the various approach in accounting for the body size differences of the potential users a designers should holistically consider when designing seated work arrangement, tasks, workstation, facilities, furniture, machines, equipment, tools, accessories and such like as follows:

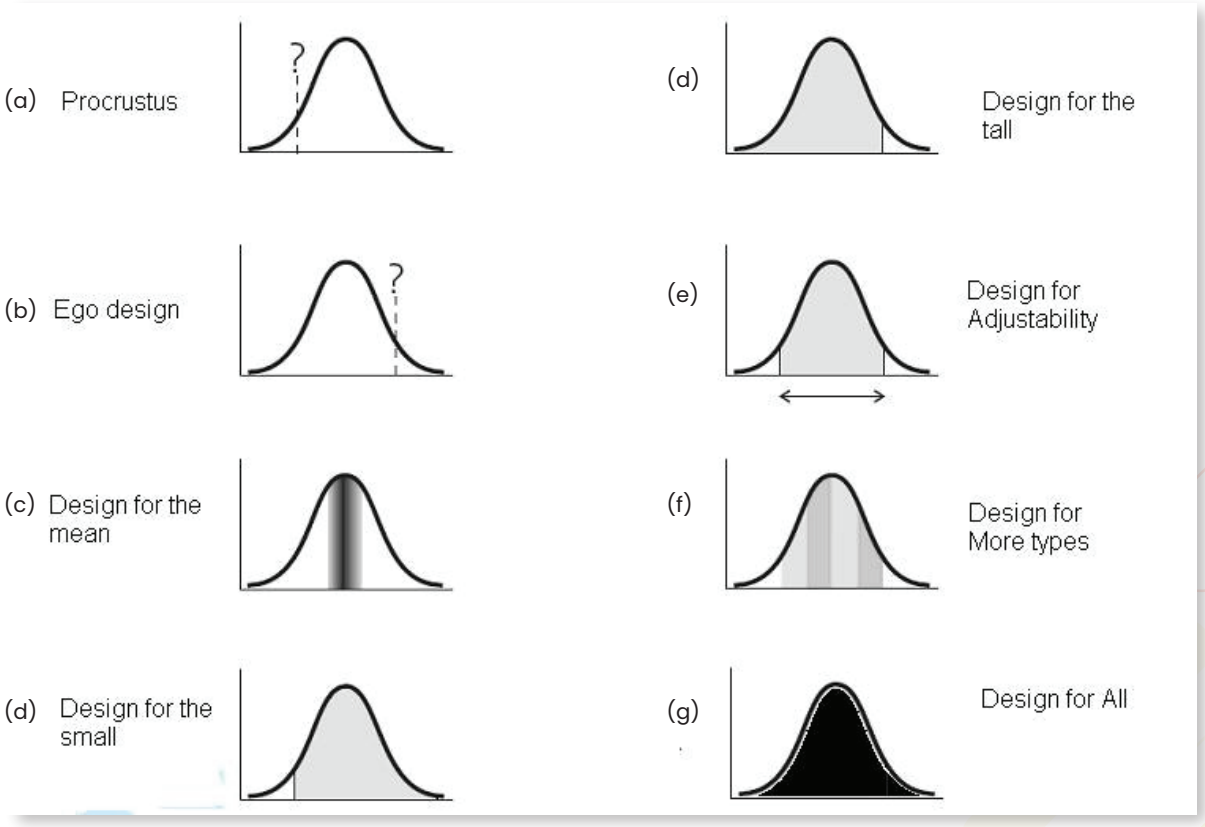


Figure 6.6 The various design approach with different anthropometric consideration

a.

Procrustes

This approach should by all means be avoided as the design does not at all attempt to accommodate or consider the anthropometry of users and instead require the user to adapt to the product. The word is derived from a Greek Mythology book entitled: "The Bed of Procrustes" written by Nassim Taleb provides an interesting aphorism to the field of anthropometry.

b.

Ego design

As the designer uses his / her own anthropometric dimension as a reference, the product can only be used by a limited range of population. Typically, designers used this approach for convenience as a starting reference point (initial prototype).

c.

Design for the mean

While design for the mean seems to be a good idea, the approach is flawed as indicated by the graph in **Figure 6.6** where many of the population are excluded or unable to use the designed product (only a small range of people falls within the range) which fits the dimension of the product.

d.

Design for the small / tall

For a certain situation or in some cases, designing for either one end of the spectrum may be required or beneficial. For example, when designing a door or entrance, it would probably be best to use the tallest which would be expected to fit everyone.

e.

Design for adjustability

While designing for adjustability may sound like a good idea as it accommodates a broad range of users in the distribution, the approach may involve higher cost of production and complexity due to the need for some form of mechanism. In many cases, they may not be practical as the product can be unreliable especially if frequent and manual adjustment is required.

f.

Design for more types

Similar to design for adjustability, this approach caters the variation of users via several types of same products each for a defined range within the distribution. A typical example of this approach in the simplest form of application are apparels which consist of small (S), medium (M), large (L), etc.

g.

Design for all

Used interchangeably with Inclusive Design, this approach does not mean that the design has to fit all the approximately 8 billion people on earth. Rather, the design process would require consideration to fit the entire range of an anthropometric dimension. Although it may sound idealistic, in some cases, this is technically possible as the human anthropometric distribution is not infinite.

7.0 CONTROL MEASURES

7.1 Design of Seating

There is no single, standard formula for the design of seating used at work. The purpose of well-designed seating is to provide stable body support in a dynamic posture which is comfortable over a period of time, physiologically satisfactory and appropriate to the task or activity which is to be performed.

There are several references which provides reference data on the design standard of furniture, specifically for office chairs and visitors chairs; MS ISO 1711-1: 2003 [Furniture - Office chair (adjustable): Part 1: Dimensions - Determination of dimensions], MS ISO 1791:2005 (Furniture - Office furniture - Visitor chairs) as well as MS ISO 14738:2002, Safety of machinery -Anthropometric requirements for the design of workstations at machinery.

The way in which designers and engineers interpret seating requirements will provide various of products and alternatives. The seating design needs to fit the employee body via anthropometric measurement and the dimensional criteria of the published standard. It should be stable, dynamic, active, natural motion allowing sitting in any position.

As such, a chair needs to be able to support the users for various seated activities: from sitting at a computer to talking on the phone to interacting with others; from turning or reaching to bending or stretching whilst providing comfort as shown in **Figure 7.1**. In addition, one should beware of the limitations as outlined in the standards as well as consider the integration with the workstation (i.e.: table, cabinet, and other furniture).

Figure 7.1 Various sitting postures are adopted during seated activities

To ensure that seating designs effectively accommodate diverse user needs, it is essential to consider existing human body dimensions. A thorough understanding of these variations, achieved through anthropometry, will guide the development of workstations that provide optimal support and comfort for all employees. Guidance to design for each component of the chair is explained in next sub-chapter.

Figure 7.2 shows an array of various examples of chairs design with different features, mechanisms and purposes available in the market; (a) Office-tasks chairs, (b) Electrostatic discharge (ESD) chairs, (c) laboratory / industrial production chairs. As addressed in **Chapter 6.0** the selection of chairs should take into consideration various factors.

Figure 7.2 (a) Office-tasks chairs

Figure 7.2 (b) ESD chairs

Figure 7.2 (c) Laboratory / Industrial production chairs

7.1.1 Seat Adjustability

The most common adjustments included in seating design are seat height, backrest height and tilt while some other extended features including adjustability mechanism such as neck support, seat pan depth, armrests height and pivot, lumbar support, etc. Uncommon but are available in premium range products which typically are more expensive.

A chair which is suitable for a person of average stature can be unsuitable for a tall or short person (extreme population). As such, adjustability of chairs provides a solution to accommodate the differences of users' anthropometric measures in a specific range and concurrently allow the chairs to be used by several people of different anthropometric dimension as shown in **Figure 7.3.**

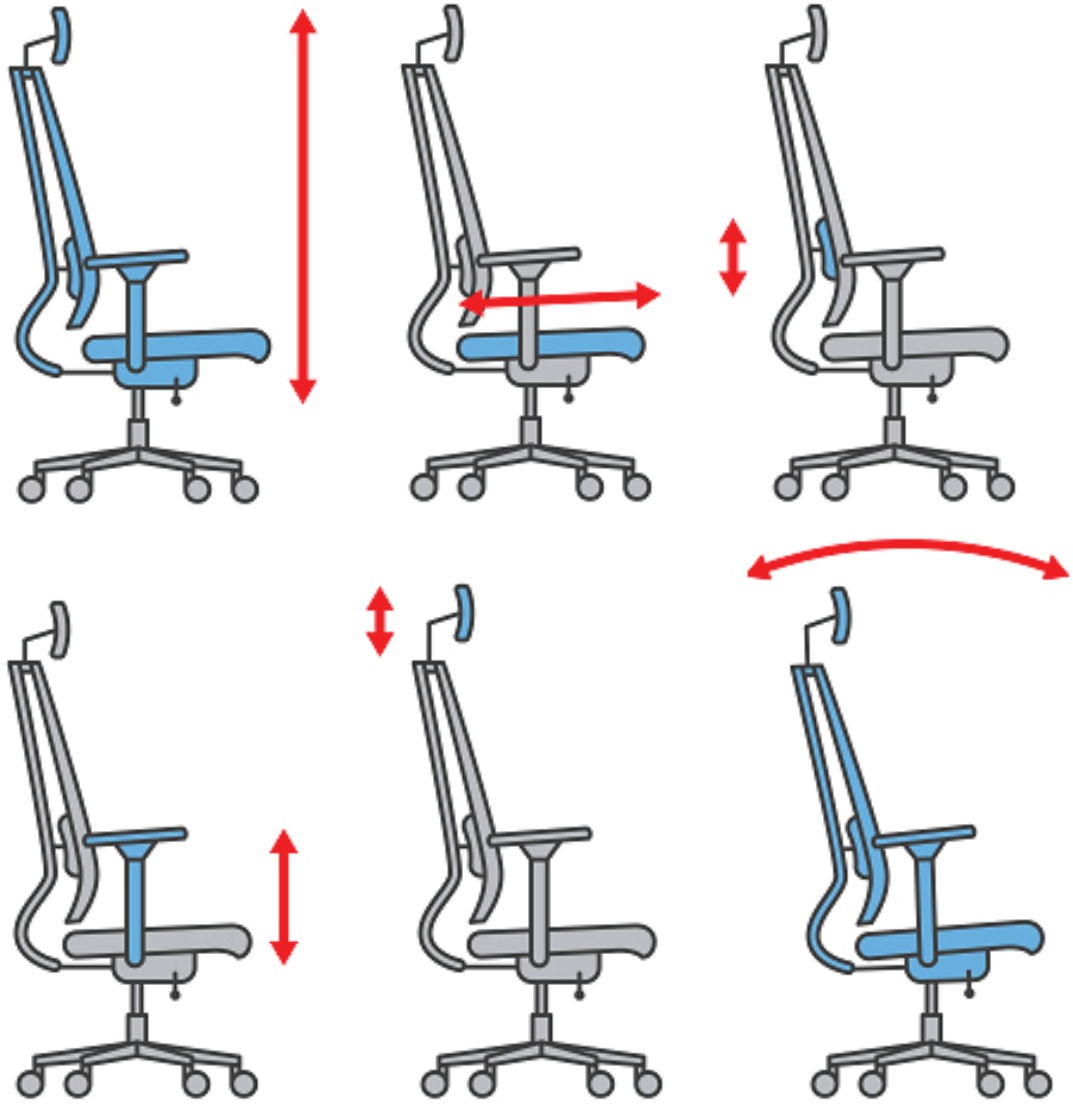


Figure 7.3 Some of the common adjustability features of office chair (highlighted in blue) that supports seated work activities and the range of adjustment (red arrow)

Figure 7.4 provides the essential parameters of seated anthropometric measurements corresponding to chair dimensions for the references of specific parameters of seat dimension.

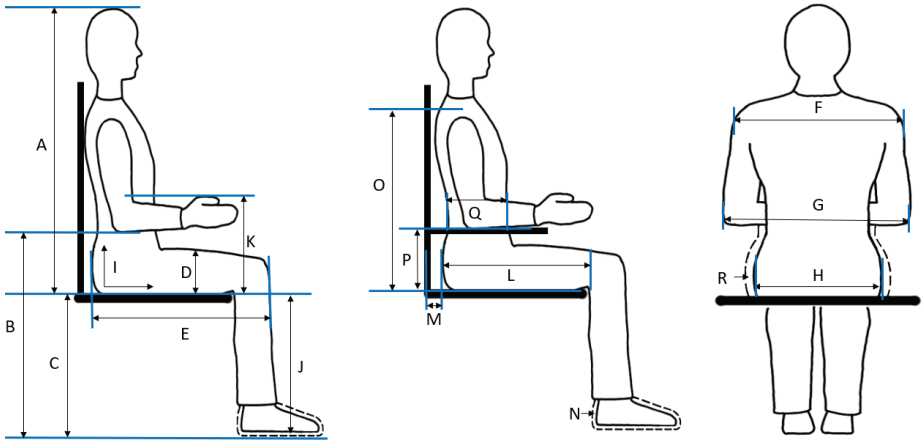


Figure 7.4 Anthropometric measurement in design for seated workstation

Where;

A. Sitting height	from sitting surface to top of head
B. Elbow height	from floor to radiale of elbow
C. Seat height	from sitting surface to floor
D. Thigh thickness	from seat surface to top of thigh
E. Buttock-knee height	from back of buttock to front of kneecap
F. Shoulder breadth	maximum breadth across shoulder to protrusions of deltoid muscle
G. Elbow breadth	distance across lateral surfaces of the elbows
H. Hip bread	maximum horizontal distance across hips in sitting position
I. Torso-to-thigh angle	90° angle between thigh and torso
J. Popliteal height	from floor to popliteal angle underside knees
K. Tenth rib mid spine	from sitting surface to the 10th rib bone
L. Buttock popliteal length	from back of buttocks to popliteal angle at the back of knees
M. Clearance allowance	from back of buttocks to popliteal angle at the back of knees
N. Footwear allowance	add 25mm for men, 45mm for women
O. Acromial height	from acromion bone to sitting surface
P. Elbow rest height	from seat surface to underside of the elbow
Q. Abdominal extension depth	from vertical reference plane to the front of abdomen in standard sitting position
R. Clothing allowance	correction depend on type of clothing

However, it should be noted that the parameters for design of a seated work activity may not be limited to those provided in **Figure 7.4**. Seated work activities can consider more comprehensive set of anthropometric data being applied such as shown in **Figure 7.5.**

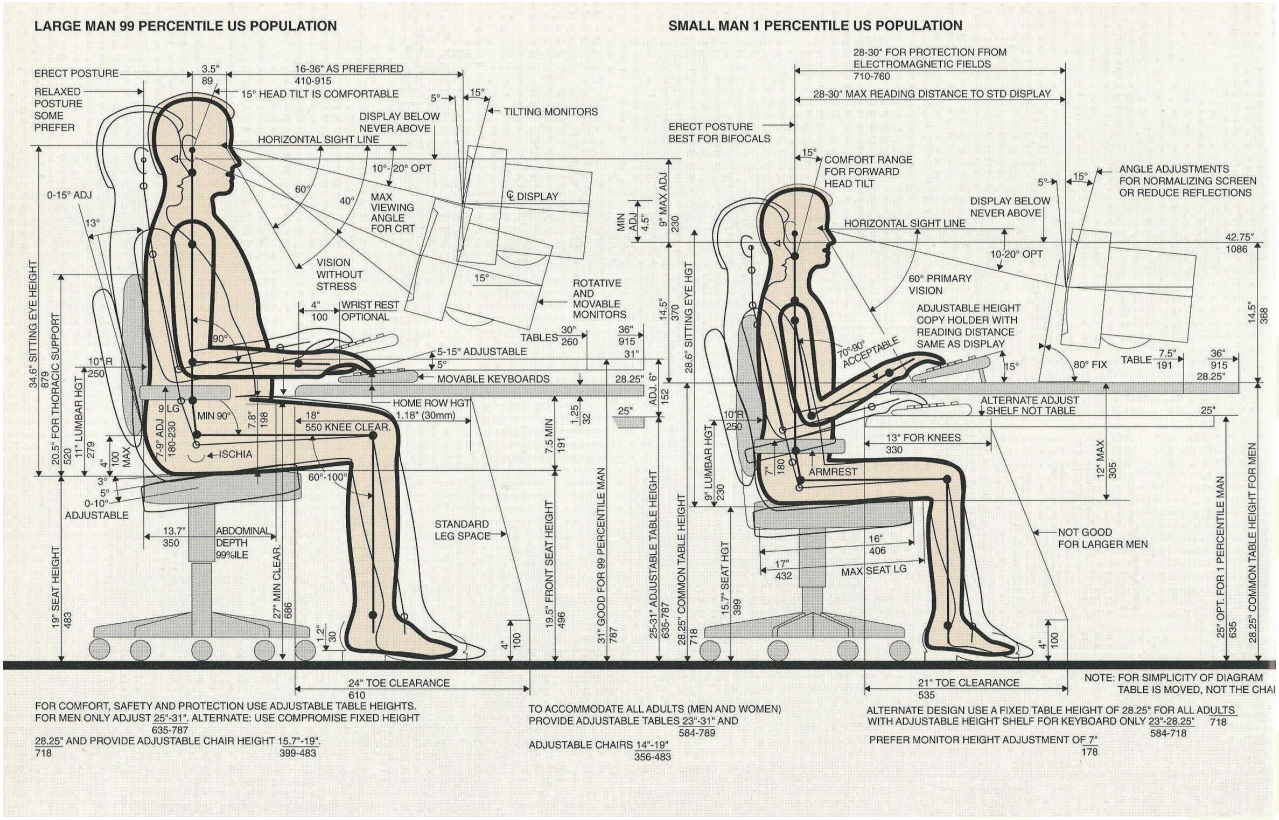


Figure 7.5 An example of anthropometric data which shows significant variation between the 2 extreme end of a normal distribution

One potentially overlooked area during the design of adjustable chair are the adjustment mechanisms, i.e.: lever, knobs, press-release button, etc. These mechanisms should be positioned to allow rapid and relatively effortless reach with convenience to use from a seated position especially where the workspace is confined. The mechanisms must also be designed in such a way that the user cannot trap (or injure) his or her fingers even when carrying out the adjustments.

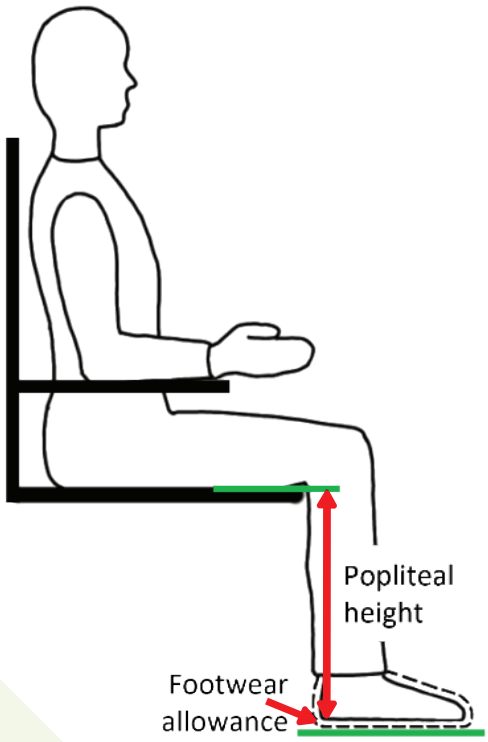
Most users preferred controls with long levers as compared to those with short levers or push buttons. In the same experiments, although it took significantly more time to adjust chairs with the greatest number of control mechanisms (adjustability), they were also judged to be the most comfortable. The adjustment mechanism must also be strong and reliable as employee will have their weight on the seat when adjusting as any sudden slip or failure could be dangerous.

7.1.2 Seat Pan

i. Seat Pan (Chair) Height

Chairs used for seated work activities designed to accommodate a specified user population must fit the range suitable for the intended user population. Proper seat height ensures the comfort of the lower limbs by distributing pressure on the underside of the thighs and help to maintain proper torso-to-thigh angle. For this purpose, the appropriate seat height for a user for sitting in the upright position is as provided in **Equation 1.**

Equation 1 :



Seat height = Popliteal Height + Footwear Allowance (sole thickness)

For a static (non-adjustable) chair, the seat height should be no higher than 5th percentile of popliteal height of female for both feet to be rested firmly on the floor. However, to suit the majority of the employees population, it is highly recommended to design an adjustable chair where the primary mechanism of adjustment lies at the pneumatic gas lift cylinder as shown in **Figure 7.6**

Figure 7.6 Adjustable height chair relies on the pneumatic gas lift cylinder (indicated with bright green colour)

Highlight;

- Regardless of the formula, the height of the chair can be subjectively adjusted to ensure that the thighs are parallel to the ground with both feet flat on the floor.
- Adjusting the chair too high results in higher contact stress on the thigh of the legs, potentially affecting blood circulation.
- If the chair is too low, only a smaller portion of the buttock and thigh is in contact with the chair resulting in higher contact pressure for that area.

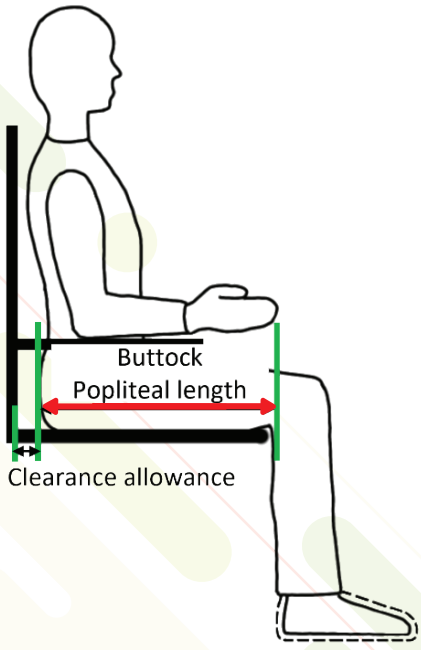
ii. Seat Pan Depth

Chairs with a fixed seat pan depth limit the range of users (especially population at the extreme ends of a normal distribution) who can use the chair comfortably. In order to overcome the limitation, the seat pan of a chair can be designed to accommodate a broad range of users by either adjustability or by using different sizes of the seat pan for the range suitable for the intended user population as shown in **Figure 7.7.**

Figure 7.7 Adjustable seat pan of the chair allow user to slide-adjust outward (front) or inward (back) depending on the buttock-popliteal length of the user

The fit for seat pan depth is achieved if the depth is slightly less (a few centimeters) than the buttock-popliteal length of the user as given in **Equation 2.**

Equation 2 :



Seat pan depth = Buttock Popliteal Length – Clearance Allowance (2 to 3 inches)

Highlight;

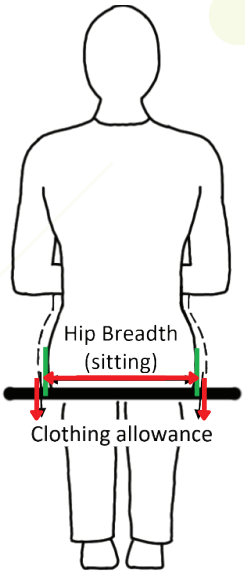
- Typically, a taller person will require more seat pan length while a shorter person will require less corresponding to the buttock-popliteal length.
- A shorter person sitting on a long seat pan will experience pressure behind the knees, or, if they perch on the edge, will not benefit from the seat back support.
- As a rough guide, the user can ensure that the distance between the back of the knee to the seat pan are about two to three fingers width from the edge of the seat.
- A taller person sitting on a short seat pan length will have inadequate support resulting in higher contact pressure under the thighs.

iii. Seat Pan Width

Adequate seat pan width allows users to maintain comfortable pressure distribution across the seat and adjust their posture. The seat should be wide enough to accommodate the seated contact area of the user to prevent any pressure on the thighs as shown in **Figure 7.8**. A fit is achieved when the seat (pan) width is slightly wider than the width of the hips as provided in **Equation 3.**

Figure 7.8 Width of seat pan for a chair are typically fixed and not adjustable

Equation 3 :



Seat (Pan) Width = Hip Breadth (Sitting) + Clothing Allowance

Highlight;

- The issues of seat (pan) width are typically a problem for person with large hip who is at the extreme end of a normal distribution.
- The simplest way to ensure the fit of the seat (pan) width to the user is where he / she can enter or exit easily without brushing against either armrest, if they are available.
- In addition, the seat pan width should not limit the ability of the user to comfortably use the armrests without extending, abducting, or contracting the arms.

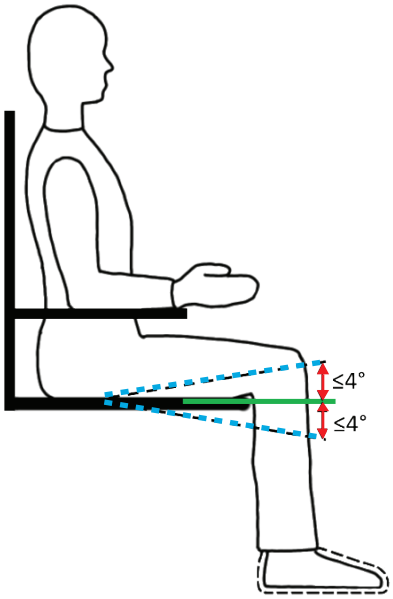
iv. Seat (Pan) Angle

The feature of tiltable seat (pan) angle is not ubiquitous in many common chairs as it is not deemed as an essential feature for general seated work activities. A seat pan that supports forward tilt angles as shown in **Figure 7.9** help the user to maintain contact to the backrest in varying seated working postures forward and backward.

Figure 7.9 Seat pan angle adjustability provides the user the flexibility to carry out active movement-sitting, varying between forward or backward tilt posture

Minimally, the tilt angle of a seat pan should be designed to accommodate the range between 0 – 4° (as per **Equation 4**) while some references recommended slightly more, up to 10°.

Equation 4 :



Seat (pan) Angle = 0° (horizontal) until 4° (rearward)

Highlight;

- Most of the seat (pan) angle are designed to tilt according to posture of users in seated work activities although some do provide manual control.
- Adjustable or tiltable seat (pan) angles, when used properly, may promote active seating varying from one seated posture to another.
- As the seat pan tilts forward during upright or forward sitting posture, the torso-to-thigh (pelvis) angles synchronously tilt forward allowing the lumbar spine to curve naturally and concurrently increases the activity of your lower leg muscles.

7.1.3 Backrest

A proper backrest provides adequate back / lumbar support for the back in various postures and accommodate the protuberances of the buttocks resulting in an acceptable curvature in the spine, thereby minimizing musculoskeletal loading and reducing the likelihood of back pain or any other associated health effects.

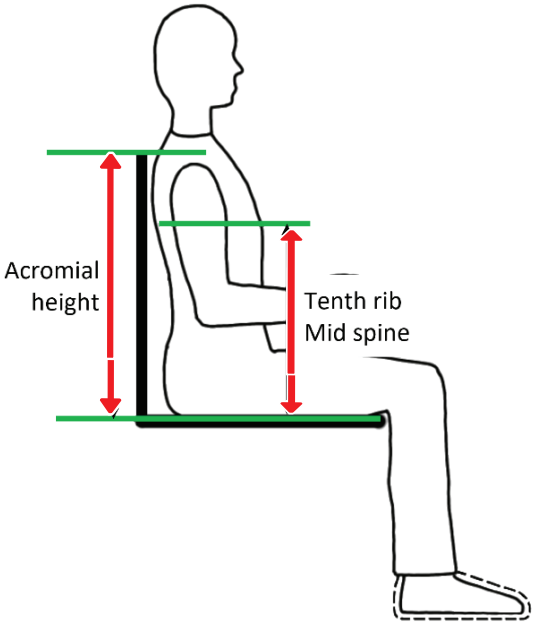
However, depending on seated work tasks, a backrest may not be needed or practical if dynamic movements are required. Besides that, many other variables can affect the requirement of different backrest design including the type of seated work tasks, height, width, tilt / recline angle, flexibility, and contour of the backrest.

i. Backrest Height

Backrest height and shape may affect arm and shoulder movement. While no research has shown sufficient evidence to support recommended or minimum backrest height, it should at least support the lumbar region as given in **Equation 5**. Depending on the seated tasks, the backrest height as shown in **Figure 7.10** can be either low, medium or high.

Figure 7.10 Backrest height should be sufficient to accommodate and support the backrest of the user thus allowing postural change and promote active sitting

Equation 5 :



Low Backrest Height = Tenth rib Mid spine, sitting
or
Medium Backrest Height = Acromial Height, sitting

Highlight;

- A low backrest height should minimally support the lumbar region which is best for tasks which require upper body mobility.
- A medium height backrest provides supports up to the entire shoulder. The seated tasks do not require frequent or any movement of the trunk (i.e.: office chair, car seat)
- A high backrest height comprehensively supports the entire head and neck (i.e.: seat on a plane) although some chairs provide neck support as an optional accessory which can be added to medium height backrest.

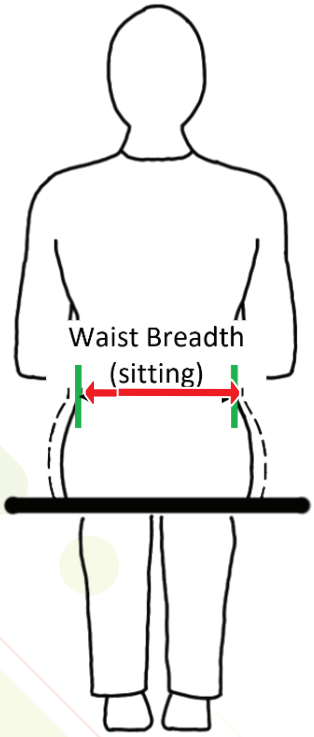
ii. Backrest Width

Adequate backrest width provides proper support for the back in a variety of postures. Although wider backrests provide support for the shoulder blades, but depending on their torsional flexibility, the overall movement of the upper body may be limited.

Narrower backrests allow greater movement of the upper body but may not provide adequate support for the upper back including shoulder blades, especially when reclining. An appropriate backrest width as shown in **Figure 7.11** would be the breadth of waist in seated position for it to sufficiently accommodate a seated person as in **Equation 6.**

Figure 7.11 Sufficient backrest width provides support to the upper body of the user, allowing users to rest during recline sitting

Equation 6 :



Backrest Width = Waist Breadth, Sitting

Highlight;

- Similar to backrest height, there is no research that clearly outline the exact width of the backrest particularly at the lower back to provide comfortable support in the lumbar area.
- While there are several anthropometric measures that provide guidance regarding backrest width in the thoracic region, there is no clear evidence regarding the appropriate amount of support required.

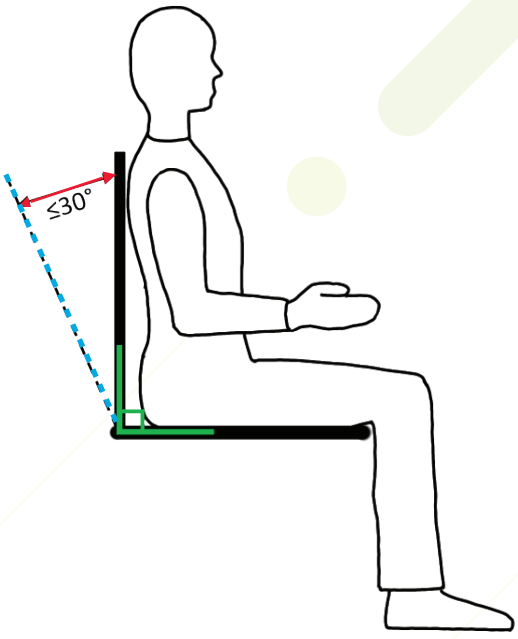
iii. Backrest Angle

Backrest of a chair should be able to recline or tilt rearward independently of the seat pan and fixed or locked at a specific reclined angle as shown in **Figure 7.12**. The backrest tilt adjustability allows some of the upper body weight to be transferred to the backrest of the chair.

Figure 7.12 Adjustability of backrest angle allow users to switch between rearward tilt sitting posture and sitting upright when used correctly hence promote active sitting

When seated, the angle **(Equation 7)** between the thighs and back should be more than 90° resulting in a reclined or rearward posture thus reducing spinal compression and muscle activity in the back.

Equation 7 :



Backrest Angle = Torso-to-Thigh Angle > 90° (adjustment up until 30°)

Highlight;

- Adjustable backrest usually has tilt tension that allows the user to lean back with minimal effort while concurrently providing enough resistance to support the back at any tilt range.
- In some chairs, the seat and backrest tilt forward together; this feature can reduce neck discomfort and improve the employees reach over the work surface.
- It is acceptable to sit upright or recline slightly in a chair as long as the backrest is designed for reclined seating, but the backrest should be straight up during forward sitting postures.

7.1.4 Lumbar support

The backrests should be designed to give support particularly for the lumbar region of the body. Lumbar support is intended to avoid flattening of the lumbar spine that can occur when seated and is used best in conjunction with a tilting seat. It helps maintain the natural curvature of the spine at the small of the back, encourages postures that evenly distribute pressure within the intervertebral discs and minimizes back strain.

The preferred lumbar height and a protrusion will vary depending on the multitudes of individual's age, gender, BMI, anthropometry, posture and personal preference. Lumbar support areas that are too prominent or inappropriate in either size or location may encourage undesirable postures or localized pressure points. Adequate lumbar support is also highly dependent on the shape, location and firmness of the support material.

Females have been shown in previous research to have an increased lumbar curvature (lordosis) compared to the male suggesting the need for a more prominent lumbar support in chairs. Besides that, lumbar curvature has also been shown to decrease with age which results in lower preference of support in the lumbar region. On the other hand, for those with higher BMI who preferred higher lumbar support height.

Research does not support any specific lumbar depth (protrusion); therefore, no depth recommendation is given as gender, age and the trend towards obesity, all affect the characteristics of the lumbar support a user prefers as shown in **Figure 7.13**.

Figure 7.13 Adjustability of lumbar support may include depth adjustment (left) and height adjustment (right)

7.1.5 Armrest

For most seated work tasks, armrests are not essential. The presence of armrests can restrict the arm movements required for certain tasks. However, for many other jobs they do provide extra comfort as the muscles of the upper limb are rested and can be an aid to standing up and sitting down. Supporting the weight of the arm reduces the stress on the spine, however, for them to work, they must fit the anthropometry of the user.

To minimize the potential for contact stress, armrests should be used intermittently while working. It is also preferable that the armrests are adequately padded. Armrests should not restrict the user's working posture. Armrests that are not adjustable and cause contact stress in the vulnerable areas of the elbow and forearm can increase the risks of injuries to these areas.

Armrests are for rests and not for supports when performing any seated work tasks. As such typing with the arms constantly on the armrests is not recommended and must be avoided

i. Armrest Height

Height adjustable armrests can be useful in jobs which require a steady arm. The height of the armrest should allow users to sit in a variety of postures, provide alleviation from workload for the shoulder and upper back whilst supporting the upper body musculature. To avoid contact stress, armrest should be padded so that the fleshy part of the forearm is not affected by the hard surfaces of the armrest.

The armrests should be adjustable in height as shown in **Figure 7.14** so they should neither be so high that employees hunch their shoulders, nor so low that employees had to lean forward (slumped / forward posture) to use them. **Equation 8** provide a guide for setting up the height of the armrest.

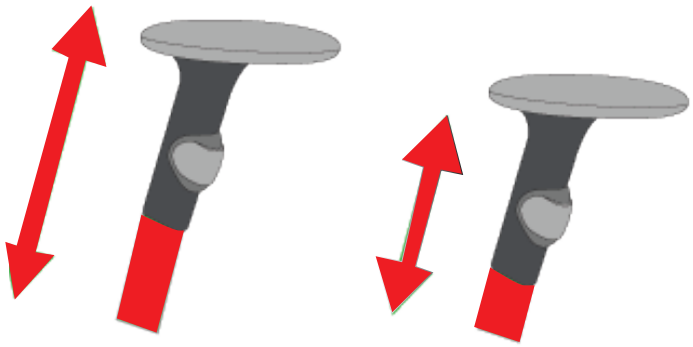
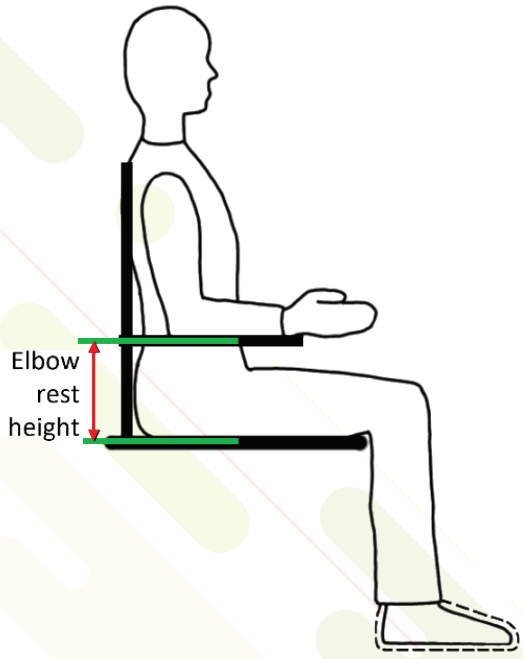


Figure 7.14 Height adjustable armrest allow users to position to adjust to their sitting elbow height

Equation 8 :



Armrest Height = Elbow rest Height (Sitting)

Highlight;

- Armrest should be set back from the front edge of the seat to allow the chair to be drawn up close to the work surface even when the seat is at the high adjustment.
- Armrests should be padded and engage the fleshy part of the forearm and not engage the bony parts of the elbow where sensitive ulnar nerve is close to the surface.

ii. Armrest Width and Pivot

It is important to ensure that not only the hips are clear of the armrests when getting into and out of the work chair but also offer a comfortable resting position for the arms without being too cramped. To effectively accommodate the variation in the width of user size as shown in **Figure 7.15** , it is necessary to provide adjustment in armrest width and pivot as given in **Equation 9.**

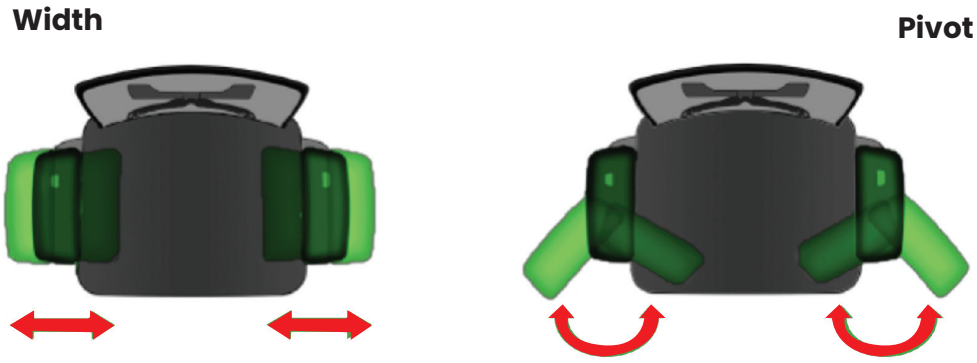
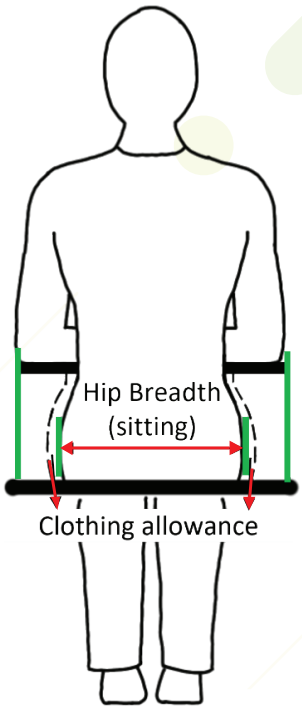


Figure 7.15 Extended adjustability of armrest allow users to increase the width of the armrest horizontally (left illustration) as well as pivoted to angle (right illustration) that support elbow position based on postural requirement of seated work tasks

Equation 9 :



Distance between armrest (width) = Hip Breadth (Sitting) + Clothing Allowance

Highlight;

- Width and pivot adjustability ensure that individuals of wider girth can sit the chair without being obstructed while at the same time allow smaller, narrow girth or petite individuals to use the armrest without the need to shrug the shoulder, abduct the arm sideway or slouch forward in awkward posture.
- Armrests that are width – adjustable to slide over the seat pan until they are right under the elbow or armrests that pivot inwards are much more functional that simple height adjustable armrests.

iii. Armrest Length

Armrest length is an important feature to maintain the ability of the user to get as close as possible to the work surface and in using the backrest effectively. The length should preferably support the entire forearm and if desired, up to the knuckles including during reclined posture and non-desk seated activities.

A forward-to-backward slide adjustable armrest (like a telescope) is not a common feature available in many chairs. Where available, the mechanism allows the armrest to be retracted /recessed during desk work to easily access the work surfaces as shown in **Figure 7.16.**

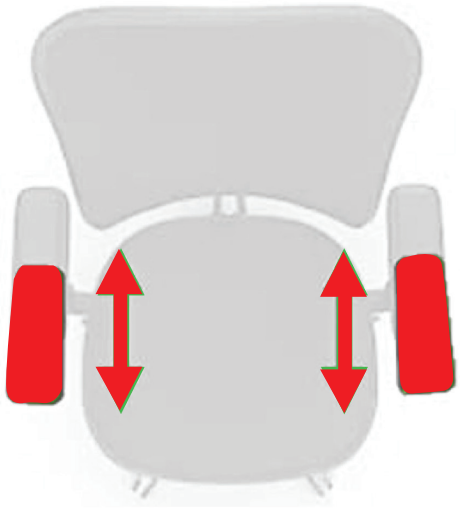
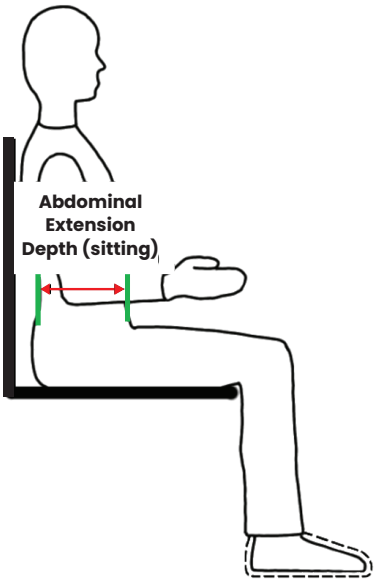


Figure 7.16 Adjustable armrest can be slid adjusted to the front or back

The correct length of the armrest should allow resting of the forearm as given in **Equation 10.**

Equation 10 :



Armrest Length = Abdominal Extension Depth, Sitting

Highlight;

- Noted that the length of the armrests can interfere with the ability to get close to the work surface, inhibit wrist movement and affect the median and ulnar nerve depending on contact area.
- Armrests that are width – adjustable to slide over the seat pan until they are right under the elbow or armrests that pivot inwards are much more functional that simple height adjustable armrests.

7.1.6 Mobility – Chair Castor

Swivel-action chairs with castors or glides as shown in **Figure 7.17** have great advantages over static chairs in most work situations. They make simple action such as getting up, drawing the chair up to the work, and turning from one task to another more comfortably and place less stress on the body. They help to make everyday tasks safer, for example by helping the employees to avoid awkward twisting movements when reaching into a low desk drawer.

Figure 7.17 The design of the castors which includes the armrests wheel sizes, materials and joints

It is important to ensure that chair with castors do not present a hazard by sliding away too easily, for example when the user gets up or sits down. This can be a problem with chairs used on hard floors, and those with a high or tilting seat. Chairs with four (4) castors have been found to easily tip over whereas a five-pedestal base with five (5) castors provide stability and in most cases serve as temporary footrest for active seating for switching posture.

Some castors are designed for use on carpeted floor, others for hard floors. It is important to choose the type which best suits the intended use as follow;

- Some seating is designed so that a brake is applied when the chair is sat on, or brake released when a load is removed.
- Some castors are designed to thread on carpets, some on hardwood, tiles or laminate floors.
- The various sizes of the wheels of the castors are also pertinent to provide more stability as well as sustain weight of the users.

7.2 Ergonomics Accessories For Seated Work

7.2.1 Back Support Cushion

A back support cushion, also known as a lumbar support cushion, is a specialized pillow designed to provide additional support to the user's lower (lumbar) and / or upper back regions to promote proper spinal alignment. These cushions are typically used in various seating arrangements, including office chairs, vehicle seats and home furniture. Example of back support cushion as shown in **Figure 7.18.**

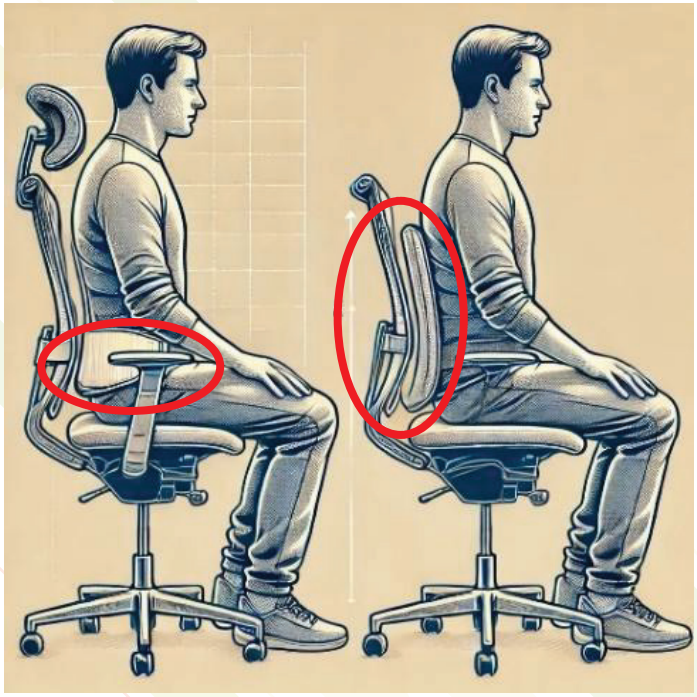


Figure 7.18 Example of back support cushion

Back support cushion types vary in terms of:

- Materials used (memory foam, gel, air and others)
- Shape, contour, sizes, thicknesses and firmness
- Attachment, portability and adjustability features

The primary aims of a back support cushion are to promote proper sitting posture, reduce strain on back muscles, prevent the onset of back injury and provide comfort during prolonged periods of sitting.

A well-chosen back support cushion should:

- Provide effective back support
- Be firm enough to maintain the natural curvature of the spine, particularly the lumbar curve
- Prevent sagging
- Distribute the body's weight evenly across the support surface
- Retain supportive properties over prolonged use

Followings are scenarios when and employee needs a back support cushion for prolonged seated work:

Medical Advice

- Based on recommendations from physicians due to specific medical conditions.

Suffering from Chronic Back Pain

- Providing a back support cushion (after testing it) helps to alleviate discomfort and provide necessary support.

Substandard Chair Features

- The current chair does not provide adequate back support and promotes poor sitting posture. If attempts to adjust the chair's features fail to correct the situation, using a back support cushion may be necessary.

7.2.2 Footrest

The use of footrests as shown in **Figure 7.19** should be as a last resort to shift postures or provide support for the employee if the chair cannot be lowered. Using a footrest when the chair is too high (feet do not reach the floor) can ease leg problems and lessen lower back issues. Sitting in a chair without proper support for the leg can cause poor circulation, back discomfort and overall contributes to fatigue.

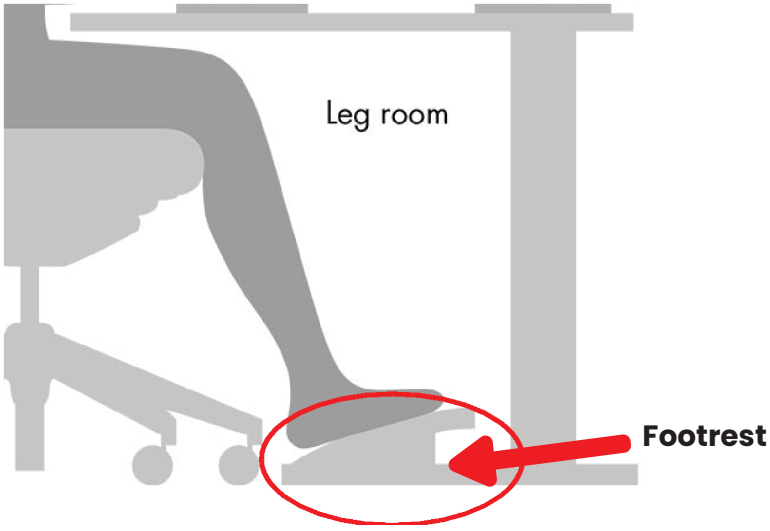


Figure 7.19 Provision of footrest should consider various aspects

Unfortunately, the downside of using a footrest when the chair is too high provides only one place for the feet to rest. The seated person only has the footrest and the castors under the chair as places for their feet and this limits the postures they can shift through throughout the day. Thus, it is advised to shift postures frequently when using a footrest.

Some footrests are designed with a rocking feature that allows the user to rock the footrest, increasing circulation and helping avoid static postures. The preferred solution would be to find a suitable chair or be adjusted according to the user's sitting height and / or lower the desk height with sufficient clearance underneath the table.

7.3 Work Surfaces

7.3.1 Workbench Top (Height)

The workstation top should be big enough to allow space not only for all necessary equipment, but also for paperwork, manuals, and other materials needed for the job. Working with materials on chairs and at odd angles has the potential for neck and other body strain. Frequently used items should be kept close to avoid long reaches as shown in **Figure 7.20.**

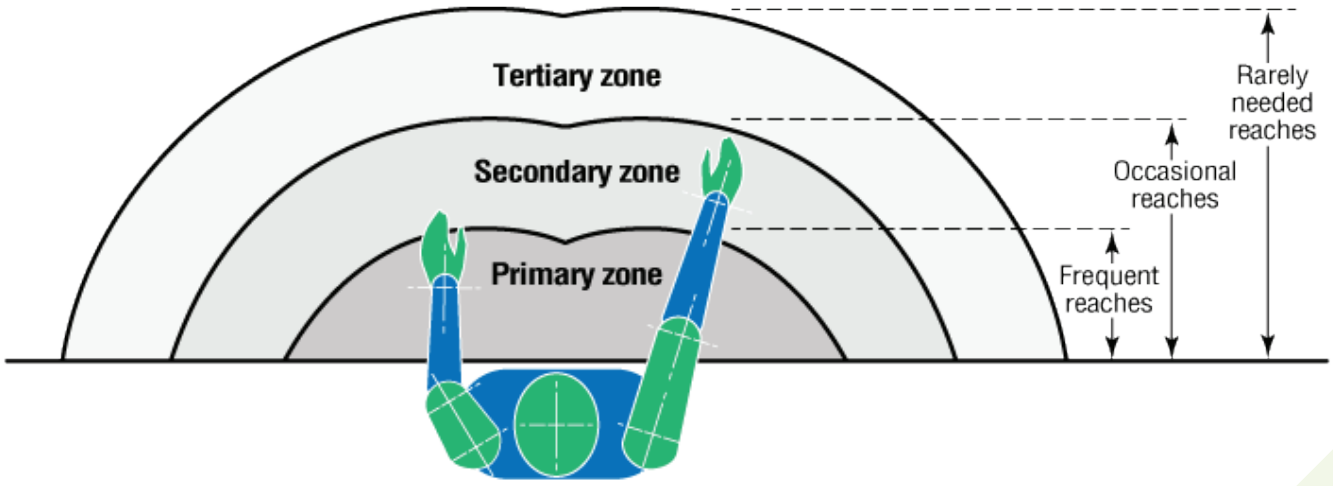


Figure 7.20 General guidelines for seated work reach (zones)

Among standards which provides workstation configuration which can be used as a base reference are MS 1839: Part 1: 2005 - Furniture – Office tables: Part 1: Dimensions which stipulates work surfaces for offices as well as ISO 14738:2002, Safety of machinery - Anthropometric requirements for the design of workstations at machinery which outlines the derivation of workstation design at non-mobile machinery based on anthropometry measurements.

Ideal height for a workstation is dependent upon several factors; user anthropometry, the nature of seated tasks, as well as the equipment and tools used. In order to cater for individual differences, sitting elbow height of each individual is an essential reference point as there are no absolute recommendation for workstation height but depends on the three (3) common features of static seated work tasks as described in the following;

i) Keyboard Tasks (Typing)

For tasks involving typing on keyboards, the surface of the workstation should be about 30 – 50 mm below the sitting elbow height. This setup is expected to accommodate the keyboard (thickness) such that the fingers would be typing around at the elbow height with shoulders relaxed (not hunched or shrugged).

Unfortunately, this setup may not suit well for several situations such as unskilled keyboard employees (also known as 'hunt-and-peck typist') as shown in **Figure 7.21** who type with one finger of respective arm (where they inevitably spend much time looking at the keyboard) or those who use built-in keyboard on laptop (where the screen is typically lower than the eye level).

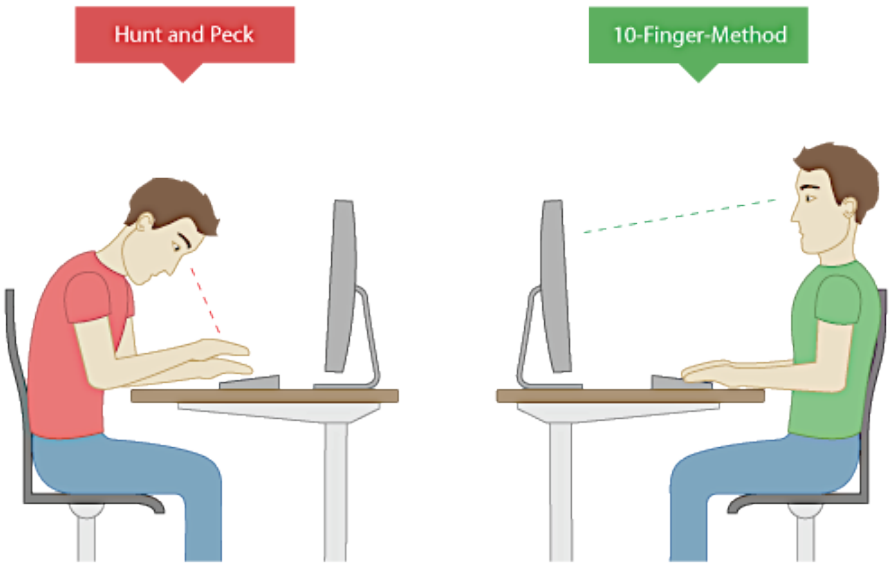


Figure 7.21 A 'hunt and peck' typist typically adopt poor posture (looking downward on the keyboard) due to the constant need to identify the location of the alphabets on the keyboard

As different situations are uniquely distinctive, the setup will require much more holistic consideration; sometimes the trade-off between two poor postures by adopting the one with lesser risk and compensating or mitigating the other risk of poor posture with another form of approach such as administrative control by reducing duration spent.

If the surface of a table is used for placement of the keyboard, the desk height should be adjusted to sitting elbow height. In the event that a table of fixed height is provided where the height of the surface is higher and not adjustable, a keyboard tray can be provided or retrofitted underneath the table, preferably with height adjustable features.

Alternatively, the height of the seat can be adjusted to satisfy the above requirement. However, the adjustment should consider the effects on the other body parts. For example, by increasing the height of the seat, the leg may not reach the floor or result in smaller clearance underneath the table for the thigh. In that case, a footrest can be provided.

ii) Manual Handling (Including Heavy Manipulative Tasks)

For lifting, lowering, transferring or heavy manipulative tasks such as applying downward force, hammering or clamping on a workpiece which requires a significant amount of force to be applied, the tasks should not be designed to be performed in a seated posture. As they may be injurious particularly to the back due to the high potential of awkward posture being adopted besides the fact of marked reduction in exertion of strength when working in seated position.

As such, a sit-stand workstation should be considered where tasks which require exertion of force are performed standing. However, where exertion during seated work tasks is unavoidable, the force exerted should be within box zone as shown in **Figure 7.22**, low to moderate force only (as a reference, not exceeding 3 kg for female and 5 kg for male) and with low frequency of repetition (seldom to occasional).

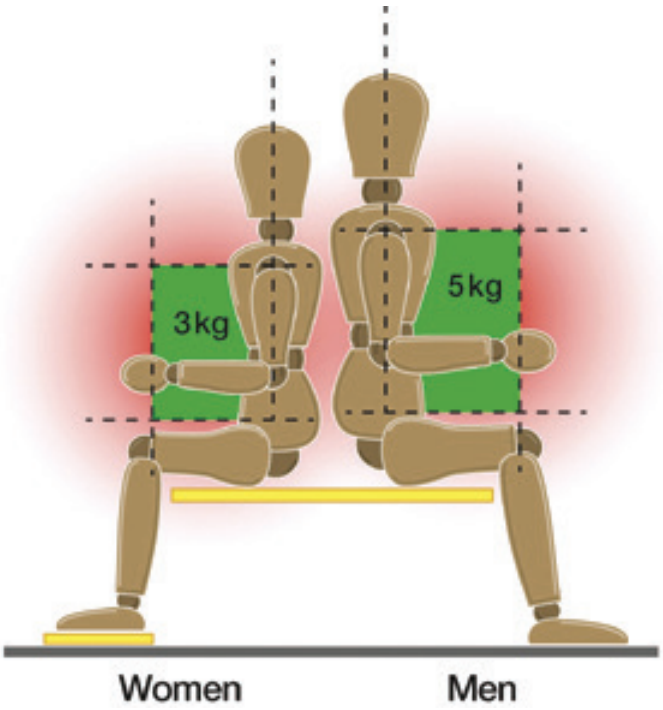


Figure 7.22 Weight and spatial limit for handling in seated position

Precaution must be taken such that the seated work tasks which involve exertion of force should never cause or require forward bending of the trunk and further controlled administratively with long recovery period in between exertion – low frequency of repetition for the muscles to rest adequately before another exertion is required.

There is no standard recommended height of the work surface in a seated position which requires exertion. The height is subject to situation and task dependent as they are influenced by various other factors that must be considered concurrently such as:

- size (dimension – height) and weight of objects being handled
- amount (or direction) of exertion required
- posture during exertion
- nature of tasks such as working with tools or equipment
- etc.

As a general rule of thumb, the height of the hand in seated position should not be working higher than the heart as the upper limit. For the lower limit, the height of the hand should be about sitting elbow height where the work surface would be about a few centimeters below elbow height as shown in **Figure 7.23.**

Figure 7.23 The height of the hand when working in seated position should not be above the heart

iii) Precision / Delicate Manipulative Tasks (Including Writing)

For tasks which require light force but a great deal of dexterity and concentration involving precision or delicate manipulative tasks such as assembly, soldering, pottery, sewing, writing, etc., the typical work surface height should be (between 5 – 10 cm) above the sitting elbow height (the upper limit for height of hand below the heart). This is primarily due to the need to balance visual requirements of the tasks.

However, additional consideration should be given to the fact that the task now performed above sitting elbow height may present significant risk of contact stress to the lower arm when rested at the edge of the work surface. As such, the edge of the work surface provided should be rounded instead of sharp or if option is not available, retrofit by padding with soft material such as foam / gel or in some cases adjustable armrest or forearm support.

7.3.2 Clearance Under Work Surfaces

Adequate clearance underneath the work surfaces allows the user to sit in close proximity to their work surface and allow free unrestrictive postural changes or movement within the space provided. The main considerations are for clearance for thighs, knees, lower legs and feet in all 3 axes of direction – lateral (sideway), forward and vertical (top-bottom) leg room as shown in **Figure 7.24.**

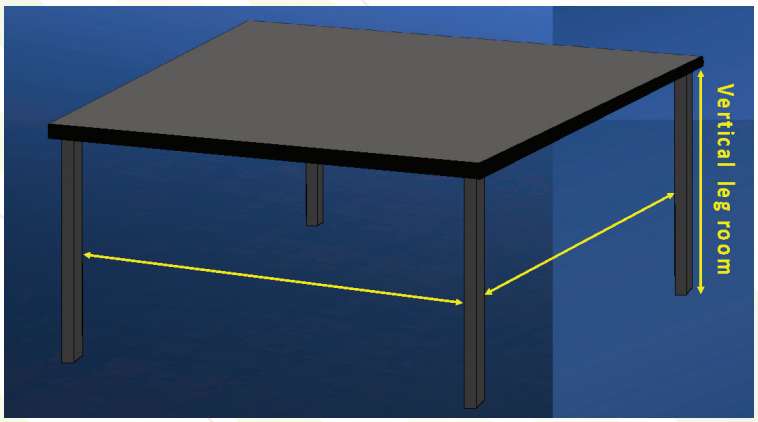


Figure 7.24 A workstation should consider all three dimension of leg room or clearance for the leg

For forward leg room, the spatial requirement is rather more difficult to be determined as it relates to the depth of the workstation except where the space underneath the workstation (desk / table) is clear (without back support or safety partition). For a fixed seat (i.e.: chair bolted into the floor), 95th percentile male buttock-knee length would provide a minimum clearance would be required as shown in **Figure 7.25.**

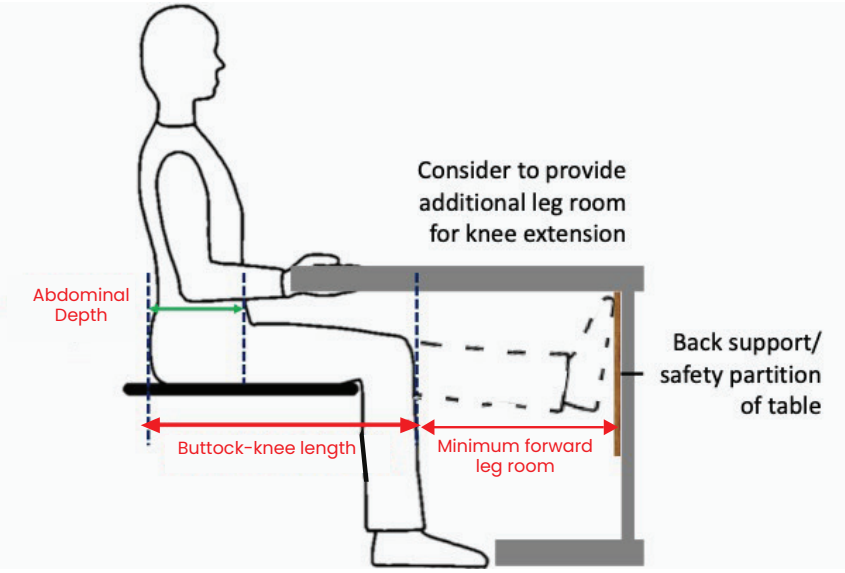


Figure 7.25 The spaces underneath of the table plays important roles in ensuring room for movement and prevent awkward postures

Equation 11 :

Minimum forward leg room = Sitting buttock to knee length – abdominal depth

However, if the seat is movable, the space underneath the workstation (desk / table) should consider the limitation when the abdomen comes into contact with the edge of the table. Where such ample space cannot be afforded, the 95th male buttock-knee length minus abdominal depth (as provided in **Equation 11**) would give the minimum forward leg room clearance although extensive provision should be considered to allow for knee extension.

For lateral leg room, it is important that the space is adequate for the legs and knee in the space provided under the work surface without contacting the support structure on either side (left or right) of the workstation.

This is however a little tricky to determine as larger lateral width underneath the table would be required where leg may be slightly spread apart or in horse-stance sitting when changing posture in active seating as shown in **Figure 7.26.**

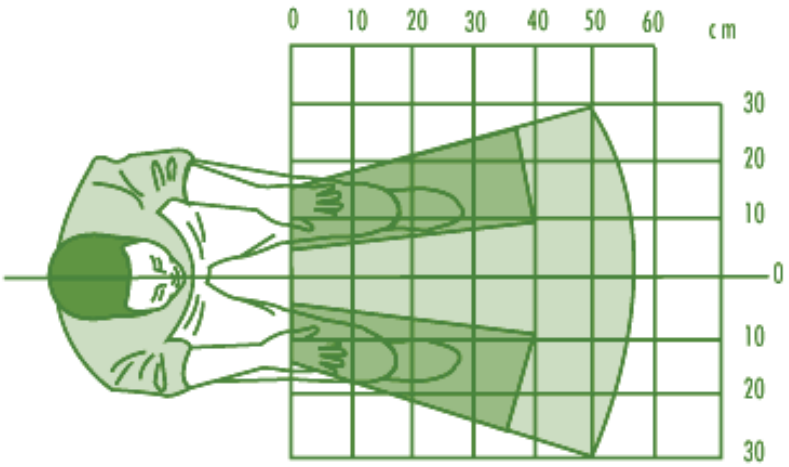


Figure 7.26 A top view of seated work activities showing examples of lateral leg room required underneath the work surface.

For vertical leg room, the required space may appear straight forward but is not necessarily the case. Various considerations are required-a holistic consideration of the workstation setup for the leg to slide in and out without the thigh brushing the bottom side of the work surface. For example, there should be additional allowances of spaces for thigh / leg movement, footwear correction, seat height and tasks requirement or nature of tasks (leg operated switch, visual display height, keyboard tray, footrest, etc).

As a general guide, the vertical leg room should take 95th percentile of the male sitting thigh height measured from the floor, taking into consideration necessary space for thigh clearance and footwear height **Equation 12** and as illustrated by **Figure 7.27**

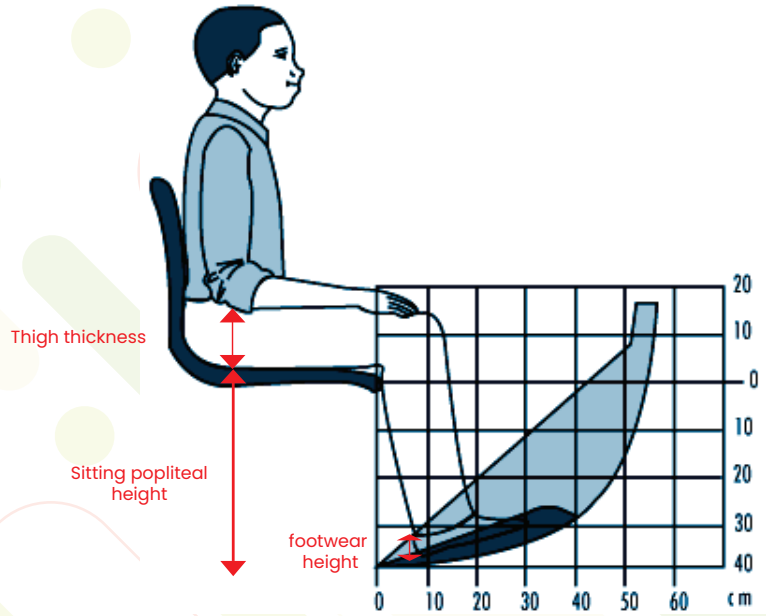


Figure 7.27 A lateral view of a seated work activities showing example of vertical leg room required underneath the work surface.

Equation 12 :

Vertical leg room = Sitting popliteal height + thigh thickness + thigh clearance + footwear height

7.4 Implement Ergonomics Intervention

The core of an ergonomics programme is the intervention itself where the control measures planned or strategized are being implemented to minimize the risk of OMSD of the seated work tasks. In addressing the ERF, hierarchy of control is perhaps the most widely recognized and accepted approach promoted as a standard practice by numerous safety and health organizations in the industries.

The idea behind the five rungs of inverted pyramid in hierarchy of control is that the step-by-step sequence of actions (control measures) which are most effective and protective at the top of the graphic as compared to those in the bottom as shown in **Figure 7.28**. The resources for application of hierarchy of control are abundantly available in the literature published in public domain by various prominent organizations.

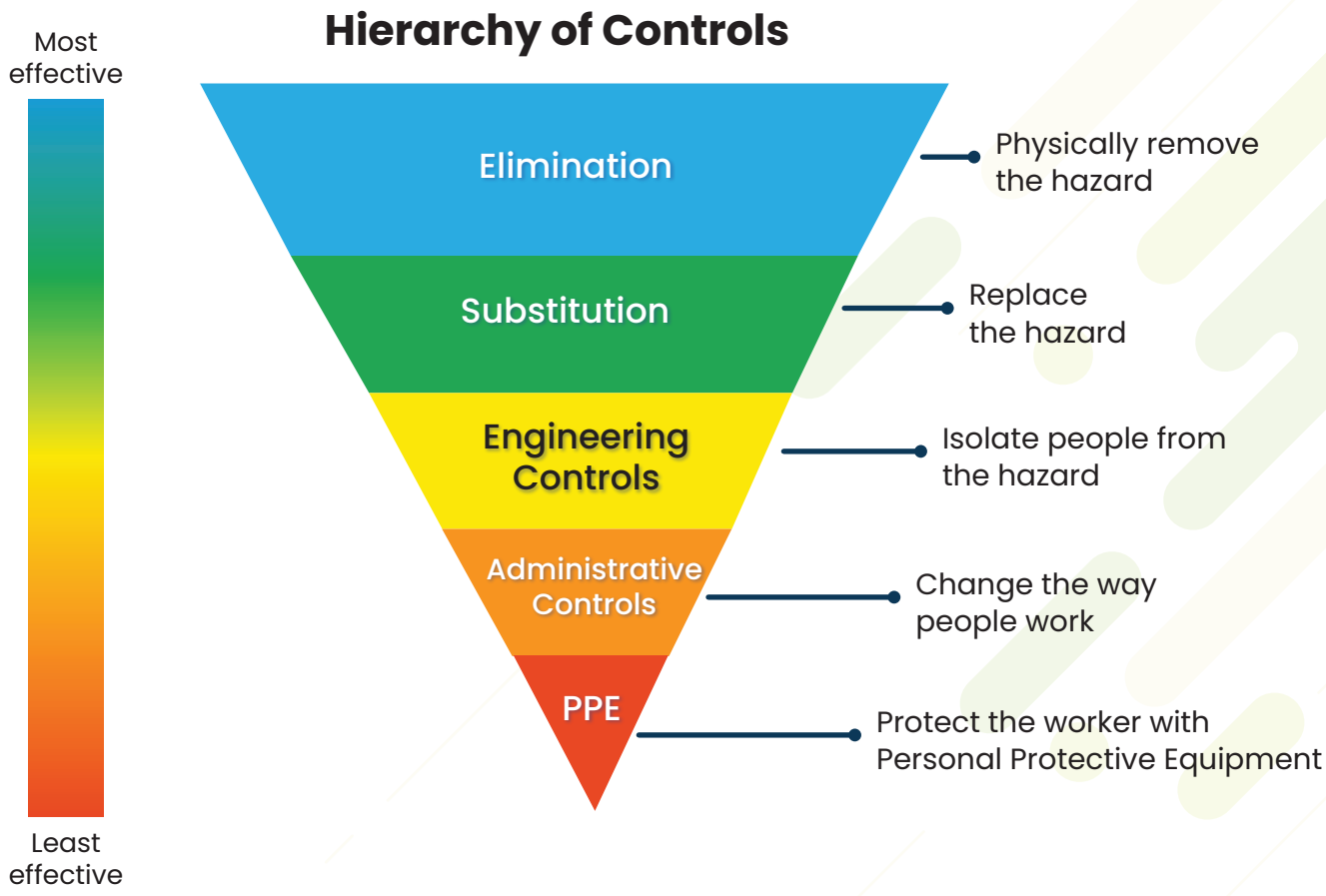


Figure 7.28 Hierarchy of Controls

For seated work activities, control by elimination in principle can be applied by directly removing the work process, situation, tools, equipment, environment or nature of work tasks which give rise to the ERF (i.e.: awkward posture, forceful exertion, repetitive work tasks, environmental factors, etc.). As an example, if the armrest of a chair or keyboard tray is not required (not being used) or is causing awkward posture to the user, they should be removed.

If elimination is not practical, substitution is the next-in-line approach that should be considered. Substitution can be applied in numerous situations to address the ERF for sitting at work. Among examples would be to substitute chair or desk (table) without adjustability features with one that can be adjusted to eliminate awkward posture, prolonged sitting, contact stress, etc.

For seated tasks involving the use of tool or equipment (i.e.: screwdrivers, pliers, jigs, etc.), they can be substituted with a lighter alternative (weight-force) or those which does not cause awkward posture or contact stress (design of handle), hands-arm vibration (electric over pneumatic if task does not require high torque). The risk of excessive whole-body vibration can be mitigated by substituting a better seat suspension or vehicle suspension that absorb vibration better.

Where direct elimination and / or substitution were not practical or applicable, the next tier of hierarchy of control is to apply engineering control. This intervention approach targets the ERF arising from the work tasks either by introducing a mechanical solution or modifying the existing work system to eliminate (engineered out) or minimize / reduce the ERF.

For seated work tasks, a wide variety of engineering intervention can be applied for different nature of work. For example, an existing chair without an armrest or table without a keyboard tray can be retrofitted with one. Monitor arm can be installed to allow height adjustment of the display screen, desk or workstation that are too low can be reconfigured / modified to accommodate the user, a leg rest (bar) can be installed underneath the table and etc.

For microscope users, a robust and comprehensive solution can be achieved by using a digital camera with external display monitor to the eyepieces or a cheaper alternative by retrofitting a compatible eyetube extension to resolve awkward neck posture and improve productivity. Besides that, sloping armrests can also be used to prevent contact stress of the arm at the edge.

The workstation layout including the tray, tools or equipment can be modified using engineering concepts to consider reach zones for operators who work in seated positions. For example, a tool caddy with a swing arm can be attached to the side of the workstation frame or install an attachment tool board with hook to hang and organize tools or equipment.

Besides that, issuance of raw material (parts) can be automated using push buttons while jig or fixtures can be custom-built. Typically, intervention or solution which employs engineering approaches addresses a variety of ERF; potentially eliminating or reducing awkward posture, forceful exertion, contact stress, vibration and etc.

7.5 Administrative Control

ERF of seated work tasks also can be addressed by using the administrative control. Administrative control relies on the attitude or behavior of employees to comply with the instruction or procedures being outlined. As such, consider combining administrative approach with other approaches in the hierarchy of control to achieve best outcomes.

In implementing certain administrative control, consultation between employer and employees is important to avoid dissatisfaction with the changes implemented. Otherwise, the management may find that the intended administrative control to be ineffective to achieve the desired outcomes contributing to non-compliance.

7.5.1 Standard Operating Procedures (SOP) and Work Instructions (WI)

An organization can review the existing standard operating procedures and working instructions for seated work activities or where previously unavailable establish one that is infused with ergonomics provision. This includes specification for design of the work tasks, tools, equipment and seating arrangement, working hours, duration, breaks and etc.

For example, specific provision for ergonomics elements or standards can be outlined in purchasing, supplies, hire or rental process of furniture, tools, equipment, design, installation, or modification for seated work activities which exemplify the definition of ergonomics.

In another example, the work instruction for seated work tasks can also specify weight limit for object handled, the postural requirement, task distribution, the duration and speed of the tasks, the physical environment or any other factors that proactively consider functional capacity of the employees towards the prevention of OMSD.

7.5.2 Introduce Short Break

Employees should be encouraged to take short breaks to give the body a rest, reduce discomfort and improve performance. Break reminder is one of an administrative strategy particularly useful for seated workstation employees to take break intermittently in order to prevent prolonged or static posture. This includes switching from seated work to standing work. There are many softwares available in the market that would assist industries in promoting this effort. On an individual basis, many smartwatches these days provide a break reminder after detecting he has sat for a prolonged period.

7.5.3 Stretching

Planned stretching helps relax the musculoskeletal system and push the oxygen-rich blood into the muscles. Regular stretching helps to reduce tiredness, discomfort and pain and to prevent chronic injuries reducing the risk of OMSD due to prolonged sitting risk.

The X-Break Program introduced by the Ministry of Health Malaysia is an example of movements or stretching steps that can be done during working hours.

Within these recommended breaks, the infusion of planned or choreographed group stretching programmes using a theme song as an administrative measure is an effective way to create a culture while serving as a strong message on the importance of health to the employees.

7.5.4 Workstation Arrangement

Arrangement of the workstation should be designed to facilitate seated employees to stand up to walk around. One key strategy is to treat the facility as an entire system and consider how the workplace facilities will be utilized by employees. Among examples when designing the workplace facilities that encourages movement are such as:

a. Centralize shared equipment (i.e.: printers, filing systems, etc.).

b. Relocate shared amenities (i.e.: pantry, water station) or even meeting rooms in a distant location from main work area.

c. Provide adjustable sit / stand workstation and policies that allow people to stand to work periodically in workplace including meeting rooms.

8.0 TRAINING AND INFORMATION

Employees who are exposed to ERF should be provided with training and information, so that they understand their roles and responsibility in the control, prevention and mitigation of OMSD. Training and information programmes should be updated to be consistent with changes in ergonomics control measures and work processes.

It is the duty of employer to ensure that all employees receive the necessary information to maintain safety and health at the workplace. Training and information should be conducted for the employees at all level. The contents and scope of training should be as follows:

- Specific ERF related to seating at work;
- Sign and symptoms of ergonomics related injuries and OMSD;
- Control measures to mitigate risks related to seating at work; and
- Skill and knowledge to perform work that meet ergonomics requirement.

9.0 ACTION BASED CHECKLIST FOR SEATING AT WORK

Action Based Checklist provides a rapid or quick assessment using a comprehensive list of predetermined set of benchmarks or standards for a known situation or items. In this regards, **Appendix 1A, 1B** and **1C** in this Guidelines provides three (3) sets of checklists adapted for different seating work activities at work as shown in **Figure 9.1**.

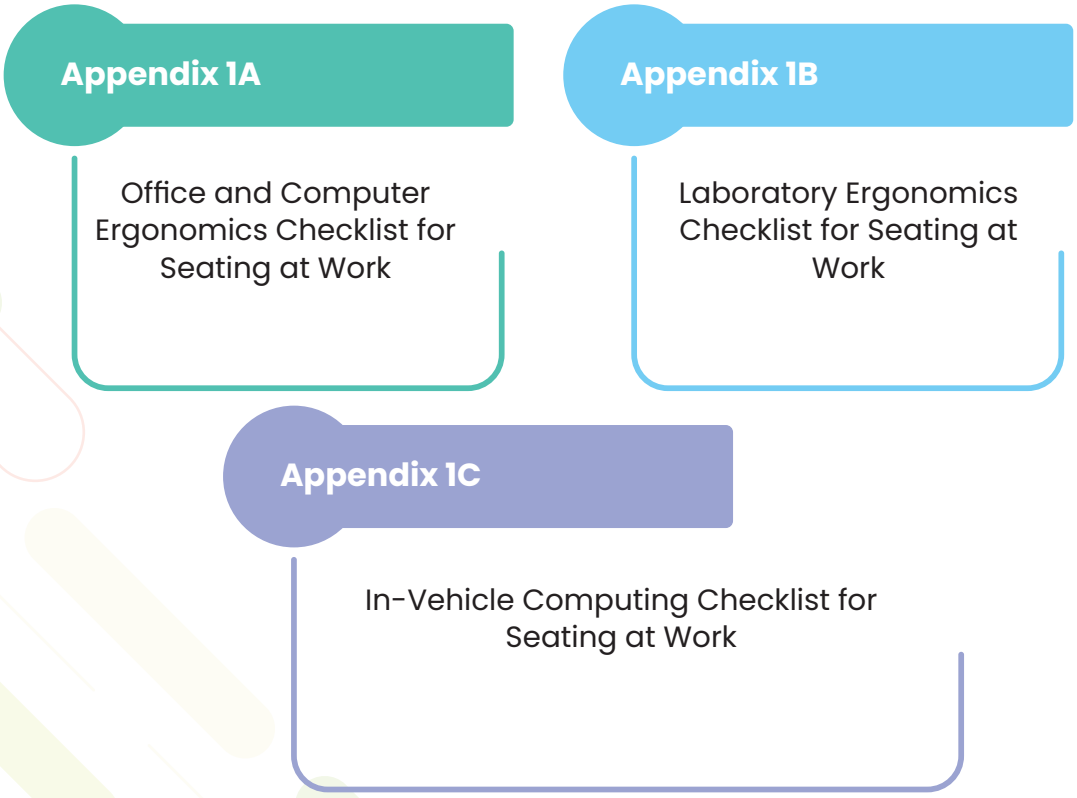


Figure 9.1 Action Based Checklist for Seating at Work

Each checklist addresses the elements and consideration as the best practices in the workstation design primarily on the seated work characteristics.

Unfortunately, the usage of checklists does not provide an indication of risk. Rather, they stipulate specific consideration of potential areas of improvement for each item within the checklist which can be undertaken to address the ergonomics issues related to the existing seated work. This action based checklist can be used as a guide to implement control measures for seated workstation.

REFERENCES

Books, H. S. E. (2004). Manual handling.

CSA-Z412-00 (R2016) Guideline on Office Ergonomics (Canadian Standard Association) – Can be accessed through: http://ohsviewaccess.csa.ca/

DOSH. (2017). Guidelines on Ergonomics Risk Assessment at Workplace.

William, M., Samuel, J. L., & Jeff, S. (2016). University Physics Volume 1. OpenStax. https://openstax.org/books/university-physics-volume-1/pages/1-introduction

Nachemson, A. (1966). The load on lumbar disks in different positions of the body. Clinical Orthopaedics and Related Research (1976-2007), 45, 107-122.

Dul, J., & Weerdmeester, B. (2003). Ergonomics for beginners: a quick reference guide. CRC press.

Panero, J., & Zelnik, M. (1979). Human dimension & interior space: a source book of design reference standards. Watson-Guptill.

Molenbroek, J., & de Bruin, R. (2005). Enhancing the use of anthropometric data. Human Factors in Design, Safety, and Management. Maastricht: Shaker Publishing, 289-297.

MS ISO 1711-1: 2003. Furniture - Office chair (adjustable): Part 1: Dimensions - Determination of dimensions.

MS 1839: PART 1:2005. Furniture - Office tables - Part 1: Dimensions.

MS ISO 14738:2004. Safety Of Machinery - Anthropometric Requirements For The Design Of Workstations At Machinery.

Tilley, A. R. (2001). The measure of man and woman: human factors in design. John Wiley & Sons.

11.0 APPENDICES

APPENDIX 1A

OFFICE AND COMPUTER ERGONOMICS CHECKLIST FOR SEATING AT WORK

Company Name :	
Company Address :	
DOSH Registration No :	
Date of Assessment :	
Location Name :	
No. of Employee :	**Male :** **Female :**
Prepared By :	

Note:

1. Tick "Yes" answers in column "RESULTS", if items have been considered.
   Tick "No" answers in column "ACTION REQUIRED" which further action is not required.
2. Tick "No" answers in column "RESULTS", if items have not been considered.
   Tick "Yes" answers in column "ACTION REQUIRED", which further action is required.
   In column "RECOMMENDED ACTION", write down necessary action to be taken.
3. Tick "N/A" answers in column "RESULTS", if items is not applicable.

RISK FACTORS	RESULTS	ACTION REQUIRED?	RECOMMENDED ACTION
Chair			
Is/Are the employee familiar with all the adjustment mechanisms on their chair?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is/Are all the chair adjustment mechanisms in good working order?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is/Are the chair suitable for employee's weight?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Does the chair allow for easy access so that person can safely step away at regular intervals?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Are shoulders relaxed (not elevated). Upper arms are in-line with torso (not elevated or stretched forward unless supported by work surface)?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is/Are the elbows being close to the body (not extended forward or outward unless supported by work surface or chair armrests)?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Does the chair have a sturdy 5 leg base?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Are the casters being appropriate for the floor surface. (i.e.: they move easily on carpet of other soft surfaces but do not move so easily on tile or hard surfaces that the chair "scoots" away during sitting down or getting up from chair)?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is the head rest (if provided) adjustable and does not push the head forward past neutral?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	

RISK FACTORS	RESULTS	ACTION REQUIRED?	RECOMMENDED ACTION
Chair			
Is the head rest (if provided) adjustable and does not push the head forward past neutral?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is the adjustment straight forward and easy to perform while seated in the chair?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is the seat surface height adjustable, such that the person is able to set it at an individually comfortable height in relation to the required work activities?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is/Are the feet flat on ground or footrest without too much pressure from the seat of the chair on the back of the leg?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is the seat surface of appropriate size, such that it is deep and wide enough to comfortably accommodate the specific person?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is the seat slope adjustable, such that the person is able to achieve a comfortable angle, either forward or rearward sloping?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is the seat cushioned and rounded ("waterfall" front edge), such that the person does not experience excess pressure on the underside of the leg due to the forward edge?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is there at least 2 cm between the front of the person's seat pan and the back of the person's knee?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Can the person easily adjust its height to provide mid-lumbar support (lower back region)?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	

RISK FACTORS	RESULTS	ACTION REQUIRED?	RECOMMENDED ACTION
Seat surface			
Can the person easily adjust its angle relative to the seat surface (forward/backward direction)? An angle of 100-120 degrees (i.e.: slightly more than a right angle) between the trunk and thighs enables better spinal posture.	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Can the person easily adjust it to alter the depth of the seat?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Seat Backrest			
Was a 'free-floating' back support mechanism incorporated into the backrest? This enables the backrest to move through a pre-set range as the back moves. The user is able to move through a range of acceptable postures while still remaining in a supported seated position.	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	

RISK FACTORS	RESULTS	ACTION REQUIRED?	RECOMMEND-ED ACTION
Worksurface / Desk			
With the lower limbs in comfortable positions and feet on the floor, can the person achieve a comfortable work surface height?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is the width of the work surface appropriate, such that all required task accessories and duties located within comfortable reach and viewing distance?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is the depth of the work surface appropriate, such that the computer, and keyboard if necessary, can be placed directly forward of the person with the work orientation parallel to the plane of the upper body?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is the area under the desk large enough to accommodate the legs (to comfortably stretch legs) and any accessories, such as footrests and arm rests?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is/Are spaces under the desk clear from items that encroaches on this space or compromises sitting posture?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Does the work surface have a flat smooth surface for the keyboard and mouse so they can be used on the same level?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Are the most frequently used items kept in the top drawers?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	

RISK FACTORS	RESULTS	ACTION REQUIRED?	RECOMMENDED ACTION
Support for the Hands and Arms			
Are seat or other padded armrests available? If present, armrests should be short, fit under the desk and adjustable (some armrests can be removed by unscrewing them).	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Are armrests adjustable (height, lateral position)?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is a broad, flat keyboard palm support available to support the hands in a neutral posture in between bursts of typing movements? (Not a wrist rest. They can put extra pressure on the carpal tunnel which lies at the wrist increase, and this increases the risk of an ergonomic injury).	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is/Are chair arms free about to move in, out or around the desk (including able to sit in close to desk, getting up/down from chair/turning chair)?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Can the armrest be used comfortably in such way that does not result in the trunk bending sideways when leaning on the armrest (being too low)?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	

RISK FACTORS	RESULTS	ACTION REQUIRED?	RECOMMENDED ACTION
Support for the Feet			
Are the feet flat on the floor when the person is sitting comfortably at the workstation?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is a footrest available if needed and can the person easily adjust its height and its tilt?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Does the footrest have a nonslip surface large enough for both feet to rest comfortably (about 30 x 30 cm)?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Does the footrest have an adjustable slope (10-20 degrees) to allow a comfortable ankle position when feet are resting on it?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is a footrest being stable enough, so it does not slide or move?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Break and Rest			
Is the person rotating and encouraging a variety of work tasks and short regular breaks so that there is variety in posture throughout the day?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is the person using opportunities to move between sitting and standing positions at the workstation?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is the person taking micro pauses e.g., moving the hand off the mouse or keyboard when not in use?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	

RISK FACTORS	RESULTS	ACTION REQUIRED?	RECOMMENDED ACTION
Other comments and remarks			
Has this checklist covered all the problems the user may have while working with computer?	☐ Yes ☐ No, please provide details:		
Does the workstation and equipment have sufficient adjustability so users are in a safe/supportive working posture and can easily make occasional changes in posture while performing computer tasks?	☐ Yes ☐ No, please provide details:		
Is/Are the computer workstation, components and accessories are maintained in serviceable condition and function properly?	☐ Yes ☐ No, please provide details:		
Does the items that must be accessed frequently are within easy reach, generally with the elbows close the body? Items used occasionally can be at nearly full arm reach.	☐ Yes ☐ No, please provide details:		

APPENDIX 1B

LABORATORY ERGONOMICS CHECKLIST FOR SEATING AT WORK

Company Name :	
Company Address :	
DOSH Registration No :	
Date of Assessment :	
Location Name :	
No. of Employee :	**Male :** **Female :**
Prepared By :	

Note:

1. Tick "Yes" answers in column "RESULTS", if items have been considered.
   Tick "No" answers in column "ACTION REQUIRED" which further action is not required.
2. Tick "No" answers in column "RESULTS", if items have not been considered.
   Tick "Yes" answers in column "ACTION REQUIRED", which further action is required.
   In column "RECOMMENDED ACTION", write down necessary action to be taken.
3. Tick "N/A" answers in column "RESULTS", if items is not applicable.

RISK FACTORS	RESULTS	ACTION REQUIRED?	RECOMMENDED ACTION
Lab Benches			
Is/Are work items within close reach?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	If not, reposition tools and supplies "easy-to-reach" distance
Is/Are the lab bench edges rounded and/ or well padded?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	Don't rest your wrist on harsh edges. Work with arms parallel to the ground.
Is/Are there adequate leg and foot room at all seated work areas?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	To create foot room, modify benches, re-move drawers and/or move equipment.
Is/Are bench cutouts available for seated employees?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	a. Minimum 15" depth b. Minimum 20" width
Is/Are seated bench available for tasks requiring precision and close inspection?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Chair			
Can all laboratory chairs be adjusted to accommodate all employees who need to use the chairs?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Can employees comfortably rest their feet on the floor, a foot ring, or footrest?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is employee sitting with their back against the back of the chair?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	If not, consider using a footrest
Does the chair go high enough for employees?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is/Are the seat pan too long or too short?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is/Are the backrest adjustable to support lower back while working at the bench?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is/Are the feet supported on the floor or on a footrest or foot ring?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	

RISK FACTORS	RESULTS	ACTION REQUIRED?	RECOMMENDED ACTION
Chair			
Is/Are the feet supported on the floor or on a footrest or foot ring?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is/Are chairs free of armrests or can they be removed to allow for freedom of movement?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Are the chair casters appropriate for the flooring?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Does the seat and/or seat pan tilt forward?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Microscopy			
Is the microscope pulled out to the end of the workbench?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Can user view the eye piece (neck and head in neutral position) while sitting in an upright position?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is/Are the arm supported and relaxed when using the microscope?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is/Are arm rested on soft and curved edge of the desk?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Do user work with neutral shoulder postures (without rounded shoulders or in a hunched position)?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Can the user adjust the microscope with arms supported and relaxed?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Has the user been trained to properly use the microscope workstation?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	

RISK FACTORS	RESULTS	ACTION REQUIRED?	RECOMMENDED ACTION
Fume Hoods and Safety Cab			
Are user arms relaxed when work seated in the fume hood?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	If not, consider standing. If a prolonged standing is required, provide sit-stand chair.
Can user see his/her work without tilting head and neck in awkward posture?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
If sitting, is/are the chair high enough or adjustable for comfortability?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is/Are leg and knee clearance available to promote neutral sitting postures when using the hood or cabinet?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	If not, consider standing. If a prolonged standing is required, provide sit-stand chair.
Is/Are materials inside the hoods and cabinets as close as possible to the employee to avoid over-reaching?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Breaks			
Are breaks provided?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	Provide frequent short breaks (every 30 minutes) to stretch, move around and close their eyes or focus on something 20m away.
Are user encouraged to change tasks every 30 minutes?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	

APPENDIX 1C

IN-VEHICLE COMPUTING CHECKLIST FOR SEATING AT WORK

Company Name :	
Company Address :	
DOSH Registration No :	
Date of Assessment :	
Location Name :	
No. of Employee :	**Male :** **Female :**
Prepared By :	

Note:

1. Tick "Yes" answers in column "RESULTS", if items have been considered.
   Tick "No" answers in column "ACTION REQUIRED" which further action is not required.
2. Tick "No" answers in column "RESULTS", if items have not been considered.
   Tick "Yes" answers in column "ACTION REQUIRED", which further action is required.
   In column "RECOMMENDED ACTION", write down necessary action to be taken.
3. Tick "N/A" answers in column "RESULTS", if items is not applicable.

RISK FACTORS	RESULTS	ACTION REQUIRED?	RECOMMENDED ACTION
Driver Seat			
Is there space between the seat pan and the back of the legs?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	Two fingers space between the seat and the legs is ideal. If necessary, using a back support to move yourself further forward in seat
Do the seat pan side support or cradle the thighs?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	Side cushions should not put excessive pressure on the thighs
Is the seat cushion soft at the front and firm under the buttocks?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	Frequent entry/exit can degrade seat cushions and decrease seat support
Is the backrest tilt adjustable?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	Seat pan-seat back angle should be 90-120 degrees If seat back is not adjustable, then insert cushion (i.e.:ObusForme) to make your sitting angle more upright
Does the seat back have a curved lumbar support?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	A 3-5 cm deep lumbar support can improve low back posture Position lumbar support (if available and adjustable on seat) in small of lower back
Is the headrest positioned such that top third of headrest is at eye level?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Is the driver are seated on the seat evenly (so that driver legs are even, and body is not tilted to one side or the other)?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	Remove wallets, key, etc. from back pock-ets. If condition of seat is poor, or padding is unevenly distributed on either side, report to vehicle management.
Can driver reach all vehicle controls (radio, wipers, temperature) while seated?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	Repeatedly leaning forward to reach controls can cause discomfort.

RISK FACTORS	RESULTS	ACTION REQUIRED?	RECOMMENDED ACTION
Driver Seat			
Is the steering wheel position adjustable?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	Elbows should be at the side while reaching to 9:00 and 3:00 on the wheel. If steering column is not adjustable, change arm position frequently
Is there sufficient head room in the vehicle?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	Lack of headroom can lead to slouching and poor back posture
Ingress / Egress			
Can driver exit the vehicle without adjusting the seat and/or steering wheel position?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	Repeatedly adjusting seat can lead to inappropriate setup while driving
Can driver exit vehicle with 3-point contact?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	3-point contact helps maintain balance, stability, and good postures
Is the mobile computer position adjustable?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	Self-selected position can reduce discomfort and physical demands
Can driver reach mobile computer without twisting low back?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	Extended use in a twisted posture can lead to low back injury
Can driver reach mobile computer with two hands and elbows at the sides?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	Reaching can cause shoulder loading and discomfort
Can mobile computer swivel left, and right?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	Keyboard should be perpendicular to the forearms to keep neutral wrists
Can mobile computer be adjusted within 20 seconds?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	Complex adjustment processes may cause users to avoid adjustment
Can mobile computer be locked in a safe position while driving?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	Driver safety may be at risk in the event of an airbag deployment

RISK FACTORS	RESULTS	ACTION REQUIRED?	RECOMMENDED ACTION
Rest and Work Environment			
Does driver exit vehicle at least once per hour?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	Static postures can lead to fatigue, discomfort, and injury
Can mobile work be performed in a standard office environment?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	Variations in work posture are the best way to prevent discomfort
Ingress / Egress			
Does driver change positions or take breaks to stretch and stand at least every hour to get blood circulation flowing?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	
Furniture / Accessories			
Can the user comfortably reach all the equipment and papers they need to use?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	Rearrange equipment, papers etc to bring frequently used things within easy reach. A document holder may be needed, positioned to minimize uncomfortable head and eye movements.
Are surfaces free from glare and reflection?	☐ Yes ☐ No ☐ N/A	☐ Yes ☐ No ☐ N/A	Consider mats or blotters to reduce reflections and glare.

Other Comments and Remarks	
Are surfaces free from glare and reflection?	☐ Yes ☐ No, please provide details:
Have the user experienced any discomfort or other symptoms which may be attributed to working with vehicle?	☐ Yes ☐ No

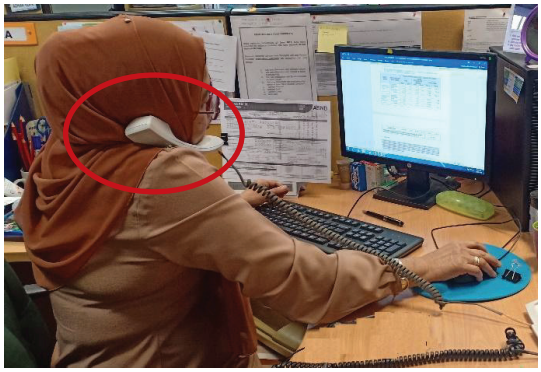
APPENDIX 2

CASE 1 – ERGONOMICS SOLUTION ON CALL CENTER

Ergonomics Issue : Awkward position while seating at workstation during receiving frequent phone calls from customers by bending neck to grip the phone handle.

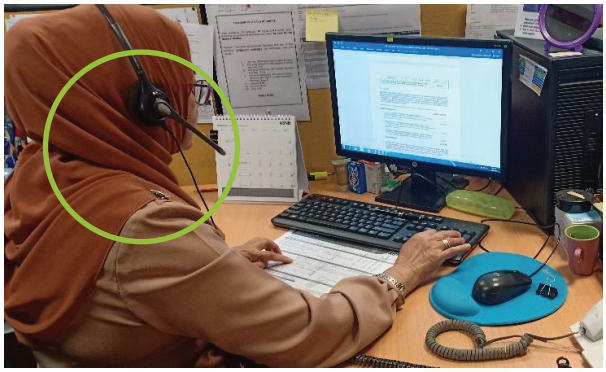
Improvement Measure : Using a headphone to provide a hands-free solution.

Description : An employee who works in a Customer Service Call Centre is having frequent calls from customers and at the same time has to work in front of computers.



BEFORE

The employee grips the phone handle with her neck and shoulder while typing information on the computer. This causes neck pain because one side of the neck muscle is stretched for a longer period of time.



AFTER

The employee uses the headphone which includes mouthpiece and can maintain neutral seating position and can focus her mind to the computer without worrying on the calling device from dropping.

Potential benefits from the improvement:

1. Reduce stress to the neck muscle.
2. Eliminate the awkward posture of the employee.
3. Free both hands so that more productive work can be done.

Remarks:

01 Recommends that a minute break by standing after 30 minutes of seating.

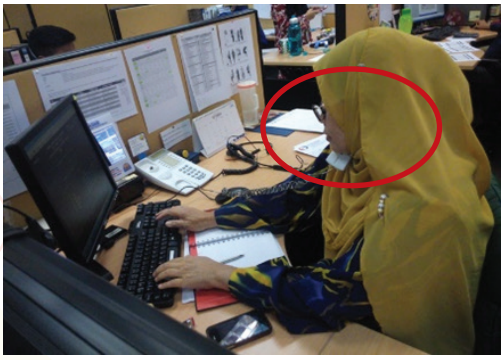
02 For work involving document reading, it is suggested that document holders be used.

CASE 2 – ERGONOMICS SOLUTION ON CALL CENTER

Ergonomics Issue : Awkward position while seating at workstation during receiving frequent phone calls from customers by bending neck to grip the phone handle.

Improvement Measure : Providing a hands free solution using the headphone.

Description : An employee who works in a Customer Service Call Centre is having frequent calls from customers and at the same time has to work in front of computers.



BEFORE

The employee uses her neck and shoulder to grip the telephone handle while using computer to type information. This causes pain to the neck as one side is of the neck muscle is stretched for.

AFTER

The employee uses the headphone which includes mouthpiece and can maintain neutral seating position and can focus her mind to the computer without worrying on the calling device from dropping.

Potential benefits from the improvement:

1. Reduce stress to the neck muscle.
2. Eliminate the awkward posture of the employee.
3. Free both hands so that more productive work can be done.

Remarks:

01 Recommends that a minute break by standing after 30 minutes of seating

02 For work involving document reading, it is suggested that document holders be used

CASE 3– ERGONOMICS SOLUTION ON CALL CENTER

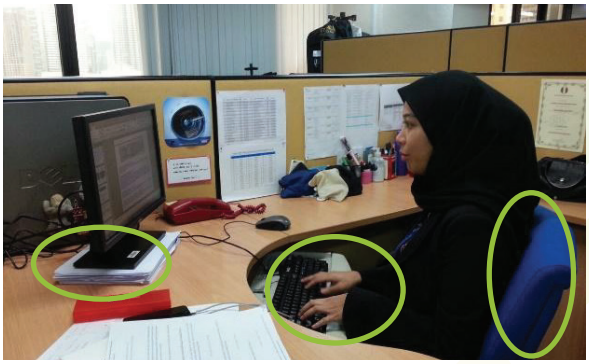
Ergonomics Issue : Improper position while sitting at workstation during typing using the computer.

Improvement Measure : To adjust Display Screen Equipment position and sitting position.

Description : Employee who is typing, frequently slouching and not using chair back rest.

BEFORE

The employee rests her elbow on the desk. As a result, her shoulder is shrugged, which can cause strain. Additionally, because the keyboard is positioned slightly further away, she is forced to slouch and not using the chair back support.



AFTER

The keyboard tray is used, and the monitor screen is raised to eye level. The employee can sit in a relaxed position as a result of this arrangement.

Potential benefits from the improvement:

1. Relieve upper and lower back pain caused by a lack of lumbar support.

2. The hand is at a 90-degree angle, and the shoulder is relaxed. This preventing shoulder and neck pain.

Remarks:

01 It is recommended that a compact keyboard be used so that there is enough space in the keyboard tray for a mouse.

02 Recommends keeping reference materials near the monitor to make it easier to refer to them.

CASE 4 – ERGONOMICS SOLUTION ON THE DISPLAY SCREEN EQUIPMENT

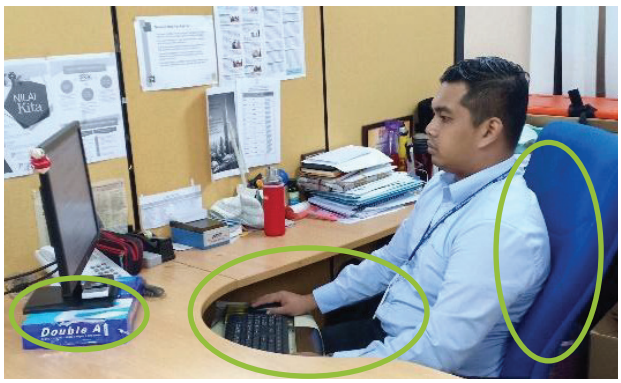
Ergonomics Issue : Improper position while sitting at workstation during typing using the computer.

Improvement Measure : To adjust Display Screen Equipment position and sitting position.

Description : An employee who works in front of computer does a lot of typing and mousing. Working conditions for employee forward leaning with no back support.

BEFORE

The employees use a keyboard and mouse that are placed on the work desk. The keyboard's positioning causes the employee to slouch forward, preventing him from properly using the back rest. His shoulders are slightly raised and his monitor is situated below eye level.



AFTER

The keyboard and mouse are placed on keyboard tray installed underneath work desk. The monitor is placed a little higher by paper rim. This arrangement allows the employee to sit back and fully use the back rest, reduce the pressure to the wrist, shoulders in relaxed position.

Potential benefits from the improvement:

1. Reduce risk of back pain.
2. Reduce risk of neck bending.
3. Reduce risk of pain at wrist join.

Remarks:

01 Allow legs to drop more naturally and widen the stance.

02 Enlarge font if monitor is far away.

03 Recommends that hand stretching exercise and focus eyes at distant objects.

04 Further improvement is by putting the monitor at 1 arm stretching distance

CASE 5– ERGONOMICS SOLUTION ON THE DISPLAY SCREEN EQUIPMENT

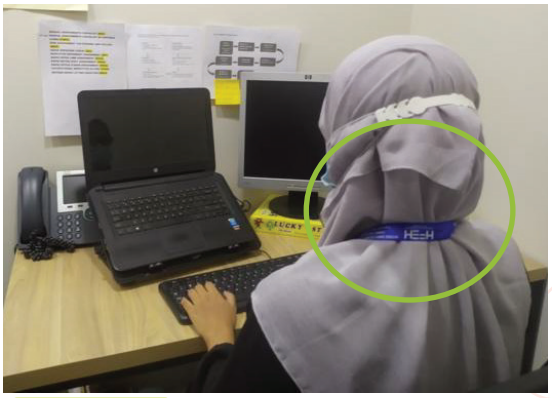
Ergonomics Issue : Awkward position of the employee while using dual computer screen (desktop and laptop computer).

Improvement Measure : To reduce the awkward posture and improve the sitting position.

Description : An employee working with dual screen with possible awkward posture.

BEFORE

Both monitors are used an equal amount of time. However, the second monitor screen was placed on the right side, tendency for the person to repetitively turn on the right causing neck muscle strain.



AFTER

The monitors were set next to each other. The point at which the monitors meet is directly in front of the user. The monitor was angled slightly outward in a "V" shape.

Potential benefits from the improvement:

1. Reduce stress to the neck.
2. Eliminate the awkward posture of the employee

Remarks:

01 Center the keyboard in front of you with mouse on the same level.

02 If necessary, use a negative tilt keyboard tray with a mouse clip platform or downward tiltable platform adjacent to keyboard.

03 Recommends that a minute break by standing after 30 minutes of seating.

CASE 6– ERGONOMICS SOLUTION FOR WORK USING MICROSCOPE

Ergonomics Issue : There is no adequate clearance under the bench surface to allow the employee to sit close to the microscope without restriction.

Improvement Measure : Reposition the microscope to workbench that have space for knee clearance so that the employee can get close to the microscope without leaning forward.

Description : Employee who performs visual inspections with a microscope.

BEFORE

The employee seated in awkward posture without enough space / room for legs.

AFTER

The microscope is repositioned to other workbench with room for legs.

Potential benefits from the improvement:

1. Eliminate the awkward posture of the employee and provide enough space for the legs under table.

Remarks:

01 A height-adjustable chair needs to use with adequate back support.

CASE 7 – ERGONOMICS SOLUTION TO LOGISTIC STOREKEEPER

Ergonomics Issue : Awkward position (squatting) at workstation during daily shipment final check.

Improvement Measure : Provide a small stool for employee to use as they move around and inspect the shipment.

Description : A logistic storekeeper must double-check the packaging data of all boxes before transferring them for shipment.

BEFORE

Since there is no other option, the employee squats and moves around in a bending position.

AFTER

Provide appropriate stool with wheel to move around.

Potential benefits from the improvement:

1. Eliminate the awkward posture of the employee.

Remarks:

01 To ensure less than 30 minutes of seating.

02 To explore possibility of engineering control such as the use of bar code scanner.

03 To relocate the boxes in higher shelves.

04 Move closer to item to avoid over-reaching posture (arm-stretched out to the front).

CASE 8 – ERGONOMICS SOLUTION TO INSPECTION WORK

Ergonomics Issue : Employees work in non-adjustable chairs and sit on hard surfaces.

Improvement Measure : Provide an adjustable chair with a cushion on the seat surfaces.

Description : An employee inspected the product and sat in the chair for a long time with minimal movement.

BEFORE

The employee has no way of adjusting the chair height, and they are seated on hard surfaces.

AFTER

Provide appropriate chair with adjustable features and cushioned seat.

Potential benefits from the improvement:

1. Eliminate the awkward posture and contact stress resulted from seating on hard surfaces.

Remarks:

01 Take frequent short breaks (microbreaks) every 30 minutes.

02 Review the workstation comprehensively to take into consideration of other possible / potential existing ergonomics risk factors unaddressed.

CASE 9 – ERGONOMICS SOLUTION FOR CAR DRIVER

Ergonomics Issue : Driver leaning forward.

Improvement Measure : Adjustment on the seating position.

Description : A driver on a long-distance trip in a vehicle.

BEFORE

The driver is bending forward with no back support and the steering wheel is too high.

AFTER

Position the steering wheel so that the elbows are close to the body and the shoulders are relaxed. Maintain a good driving posture by relaxing the muscles and keeping head upright.

Potential benefits from the improvement:

1. Eliminate the awkward posture of the employee.

Remarks:

01 When stopped at traffic lights or stuck in a jam, try to relieve tension by exercising your muscles. For example, raising and lowering your shoulders, pushing your shoulders backwards into the seat and back again or tilting your neck to each side.

CASE 10 – ERGONOMICS SOLUTION FOR CAR DRIVER

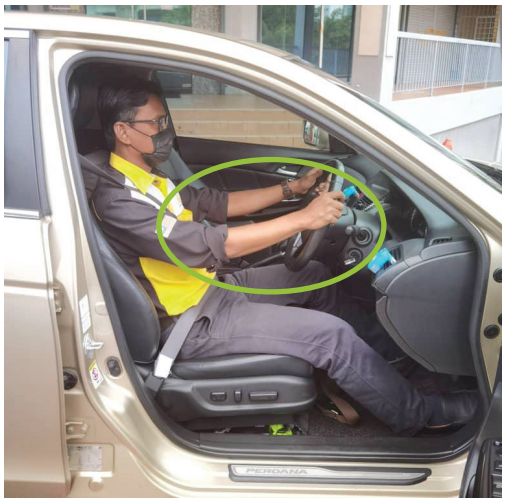
Ergonomics Issue : Awkward hand posture while driving.

Improvement Measure : Adjustment on the seating position.

Description : A driver on a long-distance trip in a vehicle.

BEFORE

The driver with awkward hand posture and not enough legs clearance.



AFTER

The hands at the 9 and 3 o'clock position while maintain a good driving posture by relaxing the muscles and keeping head upright. The seat bottom also positions horizontally whenever possible. (10° - 20° recline).

Potential benefits from the improvement:

1. Eliminate the awkward posture of the driver.

Remarks:

01 When stopped at traffic lights or stuck in a jam, try to relieve tension by exercising your muscles. For example, raising and lowering your shoulders, pushing your shoulders backwards into the seat and back again or tilting your neck to each side.

MINISTRY OF HUMAN RESOURCES
DEPARTMENT OF OCCUPATIONAL SAFETY AND HEALTH

DEPARTMENT OF OCCUPATIONAL SAFETY AND HEALTH
MINISTRY OF HUMAN RESOURCES MALAYSIA

Level 1,3,4 & 5, Setia Perkasa 4,
Setia Perkasa Complex,
Federal Government Administrative Centre,
62530 Federal Territory of Putrajaya

Tel : 03 - 8886 5343
Fax : 03 - 8889 2443
Email : projkkp@mohr.gov.my

GUIDELINES ON OCCUPATIONAL SAFETY AND HEALTH FOR SEATING AT WORK 2024

e ISBN 978-629-99979-1-7

JABATAN KESELAMATAN DAN KESIHATAN PEKERJAAN
(online)