Review of literature

A review of literature is an account of what has been published on a topic by accredited scholars and researchers. A thesis should contain a chapter about what others have done in the similar area. Gathering literature was undertaken to be familiar with the subject matter concerned with the subject matter concerned with the present problem, which proved helpful in planning and execution of the study presented in this chapter. Few sub topics related to the present study are presented in this chapter under following heads:

2.1 History, definition, objectives and use of ergonomics and industrial ergonomics.

2.2 Posture

2.3 Ways to overcome side effects of poor posture
   a) Importance Of Stretching
   b) Manual Material Handling

2.4 Shift work, hazards and important considerations.

2.5 Work Design Hazards, causes, and work design assessment.
   a) Musculoskeletal Injury
   b) Assessing Work Design Hazards
   c) Controlling Work Design Hazards
   d) Ergonomics In The Workplace
   e) The Design Of Work
   f) Work Environment Design
   g) Physical Hazards At Workplace

2.6 Conclusion
2.1 History

The foundations of the science of ergonomics appear to have been laid within the context of the culture of Ancient Greece. A good deal of evidence indicates that Hellenic civilization in the 5th century BCE used ergonomic principles in the design of their tools, jobs, and workplaces.

The term ergonomics is derived from the Greek words *ergon* [work] and *nomos* [natural laws] and first entered the modern lexicon when Wojciech Jastrzbowski used the word in his 1857 article *Rysergonomjiczylinauki o pracy, opartej naprawdachpoczerpnitych z NaukiPrzyrody* (The Outline of Ergonomics, i.e. Science of Work, Based on the Truths Taken from the Natural Science).

Later in the 19th century Frederick Winslow Taylor pioneered the "Scientific Management" method, which proposed a way to find the optimum method for carrying out a given task. Taylor found that he could, for example, triple the amount of coal that workers were shovelling by incrementally reducing the size and weight of coal shovels until the fastest shovelling rate was reached. Frank and Lillian Gilbreth expanded Taylor's methods in the early 1900s to develop "Time and Motion Studies". They aimed to improve efficiency by eliminating unnecessary steps and actions. By applying this approach, the Gilbreths reduced the number of motions in bricklaying from 18 to 4.5, allowing bricklayers to increase their productivity from 120 to 350 bricks per hour.

World War II marked the development of new and complex machines and weaponry, and these made new demands on operators' cognition. The decision-making, attention, situational awareness and hand-eye coordination of the machine's operator became key in the success or failure of a task. It was observed that fully functional aircraft, flown by the best-trained pilots, still crashed. In 1943, Alphonse Chapanis, a lieutenant in the U.S. Army, showed that this so-called "pilot error" could be greatly reduced when more logical and differentiable controls replaced confusing designs in airplane cockpits.

In the decades since the war, ergonomics has continued to flourish and diversify. The Space Age created new human factors issues such as weightlessness and extreme g-forces. How far could environments in space be tolerated, and what effects would
they have on the mind and body? The dawn of the Information Age has resulted in the new ergonomics field of human-computer interaction (HCI). Likewise, the growing demand for and competition among consumer goods and electronics has resulted in more companies including human factors in product design.

At home, work, or play new problems and questions must be resolved constantly. People come in all different shapes and sizes, and with different capabilities and limitations in strength, speed, judgment, and skills. All of these factors need to be considered in the design function. To solve design problems, physiology and psychology must be included with an engineering approach.

**Ergonomics defined**

Ergonomics (Greek ergon (work) + nomos (law)) focuses on study of the work performance with an emphasis on worker safety and productivity. Although several definitions have been proposed, one of the best was provided by Chapanis, (1991) who used the terms ergonomics and human factors interchangeably: “Human factors (ergonomics) is a body of knowledge about human abilities, human limitations, and other human characteristics that are relevant to design. Human factors engineering (ergonomics implementation) is the application of human factors information to the design of tools, machines, systems, tasks, jobs, and environment for safe, comfortable, and effective human use.”

According to the International Ergonomics Association (www.iea.cc), ergonomics is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and other methods to design in order to optimize human well-being and overall system performance. Ergonomists contribute to the design and evaluation of tasks, jobs, products, environments, and systems in order to make them compatible with the needs, abilities, and limitations of people.

Considerable debate on the definitions of ergonomics and human factors has persisted. The controversy has been especially fervent regarding the differentiation of the terms. Fraser (2006), Proponents of differentiation argue that the term human factors was first used in psychology and refers primarily to the interface of humans with technology, whereas ergonomics originated in human physiology and
biomechanics and therefore refers primarily to physically demanding work the
differentiation is capricious at best, and both the classic newer human factors and
ergonomics texts encourage use of two terms interchangeably.

It is true that originally ergonomics was not as widely used in the United States and
Canada as in other parts of the world. In the United States the terms human factors
engineering, human engineering, engineering psychology and human factors have all
been used, although the current term of choice is human factors. As noted by
Chapanis, “whether we call ourselves hyman factors engineers or ergonomists is
mostly an accident of where we happen to live and where we were trained,”
ergonomics is the more recognized term among the general public, even in the United
States.

Ergonomics focuses on humans and their interactions with the environment. It
involves interactions with tools, equipment, consumer products, work methods, jobs,
instruction books, facilities and organizations. Kantowitz and Sorkin (1989) noted that
“the first commandment of human factors is ‘Honour Thy User’.”“Ergonomists design
environments and products according to the physical (visual, auditory, tactile,
strength, anthropometric), cognitive (learning, information proceeding, retention), and
psychosocial (cultural influences, behaviour, background) characteristics of humans.
Accordingly, ergonomics is not solely confined to the workplace. Products and
environments should match the abilities, needs, and perceptions of the people who use
them. In self-care, ergonomically designed toothbrushes and spigots are found. These
spigots conform to user’s expectations (e.g. water should emerge when the spigot is
turned counter clockwise, and cold water should be controlled by the spigot on the
user’s right). Bicycles and snow skis are designed with riders and skiers of differing
abilities in mind and are designed differently for men and women. Numerous
examples of proper and improper designs can be found throughout homes and offices.
Pruitt and Adlin (2006) The concept of making the devices and systems” user
friendly” extends beyond the workplace”. To attain the goal of designing user friendly
devices and systems. Ergonomists conduct scientific investigations to identify the
limitations, capabilities, and responses of humans in a variety of climates and
circumstances. This information is used to produce designs that match human
characteristics.
Ergonomics can be considered a design philosophy that focuses on supplying a product that ensures safety, ease of use, comfort, and efficiency. However, many distinguished human factors practitioners and ergonomists contend that ergonomics is a unitary.

The general objectives of ergonomics that help employers and organizations and industries are:

1. Reduction of occupational injuries and illnesses.
2. Decrease in the disability costs for workers.
3. Increase in productivity.
4. Improvement in the quality of work.
5. Reduction in the absenteeism.
6. Application of existing rules.
7. Decrease in the loss of raw material.

Casey (2006), For the lay person, ergonomics is most noted when absent. This is because the focus is to optimize the relationship between the environment and the person. When an appropriate ergonomic design is in use, the user should be unaware of environmental design deficiencies and should be able to concentrate on the task at hand. For example, in a well-designed office workstation, a worker should not have to hold his or her neck in an awkward posture to use a visual display terminal and should not experience neck and shoulder discomfort. According to Osborne (1982), good ergonomic design in the workplace offers a means to “victory over the oppressive forces that continue to make work less productive, less pleasant, less comfortable, and less safe”.

In the past, industry focused on product outcome, and the needs of workers took second place. Humanistic and economic concerns and litigation, however, have convinced industry that consideration of the worker is good business. Chaney and Teel (1967) The use of sound ergonomic principles has generated many examples of increased worker productivity and safety. One older example demonstrated that less training is required if worker’s abilities are considered in the design of equipment. In this example, the detection efficiency of machine parts inspectors was evaluated after
either a 4-hour training program or the use of a set of visual aids and displays that assisted with the detection of defects. A 32 percent increase in detected defects was found with the training, a 42 percent increase was found with the use of appropriate visual aids, and a 71 percent increase was found when training and visual aids were combined”. Although training was useful, a properly designed environment was needed for superior results.

In terms of the case study mentioned, asking to have ergonomic consultation for all of their facilities and services is a huge endeavour! Ergonomists could start by evaluating the following:

- Safety practices, procedures, and records, including deaths, injuries, and near-miss occurrences in terms of patient safety.
- Injuries, illnesses, turnover, and workers compensation cases among the employees.
- The health care practitioner’s perceptions regarding the products they use and environments they work in to determine if the designs are as complementary to their work as they should be.
- Costs and revenues to see where they might have the most impact on a redesign effort.
- Information flow throughout the facilities including client care, team interactions, and data management.

Any of these initial approaches would be within the purview of ergonomics as they seek to design products and places to improve efficiency, effectiveness, and safety. However, it is doubtful that most therapists would be comfortable handling any of these approaches based solely on their entry-level education. With advanced education in the area of work, perhaps they would be most comfortable handling the second approach, especially if the target subset of injuries involved musculoskeletal overuse injuries.

The industrial ergonomics is not so new field of knowledge that is involved in the production field and is relatively new in many developing countries again due to the little knowledge of ergonomics and its implementation, but industrial ergonomics has been developed and applied in some large corporate in different developed countries of the world and has been becoming successful to meet its goals. Also, knowledge of
industrial ergonomics is being spread all over the world through conferences on ergonomics, meetings, and ergonomics courses that are in high demand nowadays. Use of industrial ergonomics has not only benefited employees or workers but has also benefited several organizations, especially industries which required manual labor in the world.

These pictures will help answer some of the questions on ergonomics and stimulate interest in ergonomics. Applying health work solutions and ergonomics can help prevent many occupational injuries from happening in the future because prevention is the best cure.

In any industrial work workers’ posture is of prime importance to ensure good health at work. It is imperative to discuss posture, proper posture and effect of poor posture to justify the section.

2.2 Posture

Posture is a static state – “A position of the body” or “an attitude”; “the way one move and carry oneself”.

Frost, (1944), described a good posture as “Posture which avoids strain and develops good body carriage while working.” The correct posture for work is one, which requires the expenditure of smallest amount of energy. A good posture is one in which the head, neck, chest and the abdomen are one upon another so that the weight is carried mainly by the body frame work and minimum of effort and strain is placed on muscles and ligaments.

![Plate 1: Standing Postures](SOURCE: www.clevelandclinic.org)
1. Proper Postures

Posture is the position in which you hold your body upright against gravity while standing sitting or lying down. Good posture involves training your body to stand, walk, sit and lie in positions where the least strain is placed on supporting muscles and ligaments during movement or weight-bearing activities.

The proper posture helps the workers to maintain an easy balance upon the support that aids in freedom of movement of the body and its parts during the work. This is important for reduction of fatigue. Use of the most comfortable body position while working eases the body and relieves strain. Proper posture………

- Keeps bones and joints in the correct alignment so that muscles are being used properly.
- Helps decrease the abnormal wearing of joint surfaces that could result in arthritis.
- Decreases the stress on the ligaments holding the joints of the spine together.
- Prevents the spine from becoming fixed in abnormal positions.
- Prevents fatigue because muscles are being used more efficiently, allowing the body to use less energy.
- Prevents strain or overuse problems.
- Prevents backache and muscular pain.
- Contributes to a good appearance.

Proper Posture Requirements

1) Good muscle flexibility.
2) Normal motion in the joints.
3) Strong postural muscles.
4) A balance of muscles on both sides of the spine.
5) Awareness of one’s posture, plus awareness of proper posture which leads to conscious correction. With much practice, the correct posture for standing, sitting and lying down will gradually replace one’s old posture.
2. Poor Postures- How Does It Happen?

Often, poor posture develops because of accidents or falls. But if people work continuously in a poor posture the muscles cannot relax properly. The sustained tension becomes habitual and may cause permanent damage to the body. The tensed muscles result in impairment of circulation, which in turn hampers nourishment and causes accumulation of waste material in the muscles and it gives rise to various types of musculo-skeletal problems.

Effects of Poor Posture (Singh, 2007)

- Areas of joints, muscles and nerves can be affected by mal-alignment. These ill effects may start out as very slight, they may remain at a very low level, but if the cause does not disappear, they will get worse and may become intolerable.

- Muscles will suffer through lack of circulations, which may manifest as discomfort, ache or pain as well as lack of performance, getting tired quickly. The body’s healing process is impeded when blood-flow is restricted.

Plate 2: Body Parts Discomfort and pain

[Source: www.combinedtherapy.net]
Pain may arise when nerves are stretched or inflamed by mal-alignment. Again, the range of symptoms may be from discomfort, through tingling pins and needles, hot or cold feeling or numbness to pain. A characteristic of nerve damage is that sometime the symptom is not in the place where the damage has taken place. For example, a nerve being damaged in lower back may cause tingling or pain around the ankle.

- Back pain and injury can be caused by excessive deformation and pressure of the discs.
- Sitting on high chairs increases pressure on the femoral vein in the back of the thigh. This can be a cause of blood clotting in the veins of the legs.
- Slouched posture makes the heart and lungs less efficient and concentration may be affected.
- Slouching at the desk increases the pressure inside the chest. This may cause the heart to work harder to pump blood through the lungs.
- The neck has the least pressure when the head is in an upright position, where it is well balanced.

It can be noted that with poor posture, the centre of gravity is projected forward and that places strain on the neck muscles, shoulders, the vertebrae of the neck and lower back, and on the stomach. As shown in Figure 7 Body Parts Discomfort and Pain levels may lead to fatigue more quickly. (Singh 2007)

**Tips for Improving Posture**

Bad posture can also develop from discomfort pain and injury by various factors such as environmental issues, individual & psychological factors, task invariability, load/forceful movement, work organization and work layout/awkward posture.
Plate 3: Discomfort, Pain and Injury by Various Factors

[Source: www.osh.dol.govt.nz]

Today posture related problems are increasing, so for improvement in posture at work place for comfort and adoption of good posture some tips are recommended as below:

1) Standing posture is better than sitting posture. Stand with one-foot forward position and with the weight on the forward foot.

2) As the muscles get tired, worker adopt slouching, slumping or other poor and faulty postures resulting into extra pressure on the neck and back. In order to maintain a relaxed yet supported posture, worker should change positions frequently. For example, if the worker is in sitting posture for a long time then after sometime he/she should take a break for two three minutes in order to stretch, stand or walk.

3) Distribute the body weight evenly to the front, back and sides of the feet while standing. While sitting in an office chair, take advantage of the features of the chair. Sit up straight and align the ears, shoulders and hips in one vertical line. Any single and prolonged posture, even a good one, will be tiring. Leaning forward with straight back can alternate with a sitting back, using the back support of the chair to ease the work of back muscles. One should be aware of and avoid
unbalanced postures such as crossing legs unevenly while sitting, leaning to one side, hunching the shoulders forward or tilting the head.

4) Supportive ergonomics “props” can help to take the strain and load off the spine. Ergonomics office chairs or chairs with an adjustable back support can be used at work. Footrests, portable lumber back support can be used while sitting in an office chair or while driving. Proper corrective eyewear, positioning computer screens properly can help in avoiding leaning or straining the neck.

5) Being aware of posture and ergonomics at work, at home and at play, is a vital step towards instilling good posture and ergonomics techniques. This includes making conscious connections between episodes of back pain and specific situations where poor posture or ergonomics may be the root cause of the pain.

6) Regular exercise such as walking, swimming or bicycling will help the body stay aerobically conditioned, while specific strengthening exercises will help the muscles surrounding the back to stay strong. These benefits of exercise promote good posture. It further helps to condition the muscles and prevent injury.

7) Avoid regularly wearing high heeled foot-wears, which can affect the body’s centre of the gravity and changing the alignment of the entire body, negatively affecting the back support and posture. When standing for a long period of time, placing a rubber mat on the floor can further improve comfort.

8) It is important to maintain good posture even while moving to avoid injury. Back injuries are especially common while twisting and/or lifting and often occur because of awkward movement and control of the upper body weight alone.

9) One should create ergonomic physical environments and workspaces, such as for sitting in an office chair at a computer. It does require a little attention to personalize the workspaces but it will be beneficial for the worker in the long run.

10) It is important to maintain an overall relaxed posture to avoid restricting movements by clenching muscles and adopting an unnatural, stiff posture.
Posture and Movement

Bones, muscles, joints, ligaments and tendons enable movement, maintain postures and enable force to be exerted. Poor posture can lead to problems with muscles, joints and connective tissue. Repetitive movements can cause problems too. There are a few basic posture and movement tips to follow:

- Keep joints in a neutral position wherever possible, especially when lifting. When maintaining a posture, it is best if joints are in a neutral position.

- Work close to the body, to avoid stretching too much during tasks. If you are lifting something, keep it close to your body.

- Twisting the back strains it, so avoid twisting and bending at the same time.

- Alternate postures and movements, (that means changing posture, and doing different movements frequently.)

- Limit the duration of any continuous muscular effort.

- Frequent short breaks are better than one long one, and use as little energy to do a task.

- Alternate sitting with standing, walking and other exercise.

- Give your eyes a break – often! The 20/20/20 rule-of-thumb is helpful – every 20 minutes look for 20 seconds at something at least 20 metres away (or at infinity). This is especially important with computer work or reading.

(www.tcd.ie/disability/docs/Ergonomic%20scope.doc)

Factors That Can Lead To Injuries In An Office Job

Basic office activities involve sitting in front of a work table. Still, no matter how harmless these activities may seem, they do set the stage for injuries that can develop over time. While these activities are not particularly hazardous for a worker who does them only occasionally, the situation becomes more critical for those who have no choice but to sit in front of a work station and work for long periods every working day.
It is very important to know that musculoskeletal injuries (MSIs), and specifically, repetitive motion injuries (RMIs) rarely originate from one event or a particular factor. As a rule they develop over time from a variety of factors. Some factors are strictly work-related and beyond the workers’ control. On the other hand, the workers themselves can have some control on other factors, such as their individual work practices. Other things like body build, age, gender, some medical conditions, and types of personality, attitudes and life style can also contribute to RMIs. No matter that such factors may be beyond any control, becoming aware of them is nevertheless important.

Work-related factors that present the greatest risk for MSIs involve:

- fixed and constrained postures that are frequently awkward, uncomfortable and maintained for too long a time,
- repetitious and forceful hand movements,
- a high pace of work.

**How does a fixed body posture affect your body?**

Because the human body was designed to move, it cannot tolerate immobility for long. Merely sitting for long times can be unhealthy and damaging to the musculoskeletal system. Holding the upper body still in an upright position requires a lot of muscular effort and contributes to what is called a static load. That is the invisible but constant battle against gravity and fatigue, and injury is the price.

Both holding one's head at the optimum distance from the screen and document holder and maintaining one's arms in the proper typing position increase the static load on the whole upper body, and on the neck and shoulders in particular. The reduced blood supply that follows not only accelerates fatigue, but also leaves the musculoskeletal system susceptible to RMIs. To make matters worse, the furniture in most offices does not fit the worker either because it is not adjustable or, where it is adjustable, workers are not properly instructed on how to adjust it.

**Where does poor work posture originate?**

Poor posture can be a result of:

- Non-adjustable or otherwise unsuitable workstations;
• The layout of the workstation is inadequate or is not suitable for its user;

• Lack of knowledge and experience on how to set up an adjustable workstation properly according to the worker's needs (considering both body build and job tasks);

• Poor working habits that remain uncorrected;

• Unsuitable job design that requires a worker to sit uninterrupted for longer than an hour at a time; and

• Lack of proper training, resulting in a lack of awareness.

**How can repetitious and monotonous movements affect your body?**

Holding the upper body still allows the upper limbs to engage in such fine hand movements used in typing and operating a mouse (categorized as dynamic load). These are common examples of repetitious and monotonous movements. Repeated hundreds or thousands of times, hour after hour, day after day, year after year, these movements strain and gradually cause "wear and tear" on the muscles and tendons in the forearms, wrists and fingers. People who do repetitive work with their bodies in fixed and static positions are even more susceptible to getting RMIs.

Discomfort, numbness and tingling are the danger signs. If these signals are ignored, pain, chronic problems and long-term disability are likely to follow.

**How the high pace of work - "working in the fast lane"- affects your body?**

Like repetitive and unvarying movements, a high work pace is quite a common reality in the most offices, even if it happens only occasionally. Regardless, whether it is arises from periodic overload or from uneven distribution of work; a regular high speed of work contributes to the development of MSIs very strongly.

The pace of work determines how much time working muscles have for rest and recovery between movements. The faster the pace, the shorter and less productive the recovery times become. This, in turn, increases the risk for RMIs.

A person may be able to set his or her work pace and adapt to the stresses that result. However, more harmful to one's health are external factors that increase the work pace and which are beyond the person's control, such as:

• having tight or frequently changing deadlines;
knowing your performance is being monitored by some electronic system; or

- Being overloaded with work.

The result is that the worker is denied any control over the timing and the speed of work, creating the feeling of "always being in a hurry." This haste and resulting stress while working, causes the body muscles to tense up which, in turns, significantly accelerates the risk for developing RMIs.

**Do personal factors contribute to musculoskeletal problems?**

There are certain factors inherent in work tasks that can increase our risk for the onset of musculoskeletal injuries (MSI), such as fixed and constrained postures that are frequently awkward, uncomfortable and maintained for too long a time, repetitious and forceful hand movements, and a high pace of work.

Other factors of a strictly personal nature also contribute to our risk for MSI. These include our state of health or fitness, our addictions, our lifestyle, our posture, and our work habits. These are the focus of this document.

**State of health**

Although the evidence is not conclusive, there is general agreement among researchers that individuals with medical conditions are more likely to have musculoskeletal injuries. Examples of these conditions include hyper-mobile joints, arthritis, diabetes or thyroid disease.

**Fitness**

Poor physical fitness, and the obesity that frequently results from it, also makes us more susceptible to musculoskeletal injuries. For example, poor fitness, particularly when combined with a body weight above the "ideal," is a prime cause of weariness and fatigue which are commonly recognized to be factors that can contribute to the onset of MSI. So, although there is no direct relation between poor fitness (and possible overweight), and muscular discomfort and eventual injury, we can regard a lack of fitness as a strong risk factor for injury, and any feeling of fatigue as a warning signal.
Casual Addictions

Contrary to popular belief, smoking, and the consumption of caffeine or any other comfort food (chocolate, for example), that we commonly practice as temporary stress relievers can actually increase our chances for musculoskeletal injury in the long run.

We may not have control over all of these conditions. However, if we understand the significance of these various factors, it may help us recognize how they are related to the risks in our job activities. Taking this information into account may eventually help us stay injury-free.

Do individual work habits affect your health?

The body positions held while typing and individual typing styles are so significant in the cause of repetitive motion injuries (RMIs) that their impact cannot be overemphasized. Some experts consider that they outweigh any other factors.

How do poor sitting habits undermine your health?

Slouching while sitting with the back slumped against the backrest of the chair compresses the spine and can lead to low back pain. It also puts the head in an imbalanced position, contributing to neck and shoulder problems. Additionally, a slouchy, sitting position encourages the worker to rest the wrists on the edge of the desk in the dorsiflex position (i.e., hands bent upwards or backwards at the wrist).

This is one of the most important MUST NOT DOs in RMI prevention.

How do typing styles contribute to causing musculoskeletal injuries?

There are many poor typing techniques, even among trained and highly skilled typists. Pounding the keys harder than necessary can cause tingling in the fingertips and pain in the finger joints. Pressing the keys rather than lightly touching those strains the tendons of the fingers, hands and forearms. Pecking at the keys instead of touching them lightly usually requires one to lift the remaining fingers and thumb. Over time, these repetitive movements can lead to forearm tendonitis and de Quervain's disease.

Any typing posture with arms unnecessarily away from the body puts a lot of strain on shoulders and neck makes typing more strenuous (forceful) than need to be. Examples are typing with arms extended forwards or to the sides or with shrugged shoulders.
In addition to the repetitive nature of typing, the **force** used is another risk factor contributing to the occurrence of RMIs: the greater the **effort**, the higher the risk for RMIs.

**What is meant by "working space"?**

When planning the amount of "space" needed for people to do their work, most planners remember to include all of the tools, equipment, and furniture needed to complete a job. Office jobs entail a great variety of physical and mental activities. Often, the core activities of any office job take place at the desk or at the workstation.

![Poor workstation forcing raised shoulder work](image)

**Plate 4 (a):** Poor workstation forcing raised shoulder work

**Plate 4 (b):** Adjustable workstation promoting better posture

In addition to the physical dimensions of the workspace, other features should also be considered in any design, reorganization or relocation. Some questions to ask are:

- Does the workspace provide acoustical privacy (for example, can people talk in privacy, according to the level of confidentiality required; do noises and conversations interfere with their concentration; do noises or conversations make it difficult to hear or understand speech if much of their work involves using the telephone?)
• Are the walls permanent (i.e., fixed) or is the workspace in an open office environment?
• Does the workspace provide visual privacy?
• Can an employee personalize his or her individual workspace?
• Is there access to natural light or only artificial lighting?
• Is the workplace layout designed to facilitate interpersonal contact?

**How much space do we need?**

There is no one clear-cut answer to what seems like a simple question, for the answer has to deal with many aspects implied by the question. Major aspects include:

**Nature of work.** If most of the work day is spent on field assignments, meetings, site visits and consultations, a smaller office space may be quite satisfactory. However, for office workers who perform their job at their workstation most of the time, a small space may create discomfort due to feelings of confinement. Some job functions that, for example, include frequent meetings in their office space or require the use of multiple sources of material for consultation, research, writing, etc. may be assigned more work space than.

**Cultural aspects** influence our perception of sufficient space. For North Americans including Canadians, as well as northern Europeans "adequate" personal space is an important factor. For people from other cultures often associated with dense population, much less space could be considered "adequate", or in other words, enough. This can be a significant issue in a multi-cultural society such as Canada.

**A corporate climate.** Our perception of a designated personal space is a matter of comparison. Employees generally accept the fact that those at higher levels in management positions may have larger offices. However, regardless of how large an individual's space actually is - if it is not as big as what our peers have - then, it is too small.

**Individual perception.** The amount of space available can have profound psychological meaning. It is natural for people to strive to occupy more space, for "more" space may signify importance, respect and more authority or power. In the workplace the amount of our personal space is often linked with our status within the organization.
Anthropometry (body dimensions). Actual office space requirements depend on the size and shape of employees simply because an office has to accommodate them, enable them to move safely and unhindered in the workspace, and allow them to complete their jobs. A more spacious office would be always welcome (to allow for easier movement, accommodating visitors, and storage), but the table below provides some minimum requirements:

**Table: 3 Minimum space requirements for individual**

<table>
<thead>
<tr>
<th>Application</th>
<th>Minimum Requirement Ranges*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two people can meet in an office with a table or desk between them - such as a supervisor and an employee</td>
<td>60-72&quot; x 90-126&quot;</td>
</tr>
<tr>
<td>A worker has a primary desk, and a secondary surface such as a credenza</td>
<td>60-72&quot; x 60-84&quot;</td>
</tr>
<tr>
<td>Executive office: 3-4 people can meet around a desk</td>
<td>105-130&quot; x 96-123&quot;</td>
</tr>
<tr>
<td>A basic workstation - such as call centre</td>
<td>45-52&quot; x 60-72&quot;</td>
</tr>
</tbody>
</table>

* All sizes are from Panero, Julius and Zelnik, Martin. Human Dimension & Interior Space, New York : Whitney Library of Design, 1979. (Although this is an old reference, no recent information was found that would change these recommended values.)

**Guidelines on how much space each person needs.**

The allocation of the amount of working space for offices, and for workplaces in general, is too complex to expect specific, objective standards that would apply to all kinds of work situations. This is why existing standards and guidelines similar to the ones mentioned above which are based on typical or average body dimensions (see Table 1) specify only the minimum requirements. An example of this kind can be the Canadian federal Treasury Board's minimum space standard which suggests 2.5 m x 3.0 m (8' x 10') for a personal office. These minimum dimensions are average values per person, which means that some offices can be larger than the average and others.
smaller. These dimensions also include areas that are allocated to common areas (e.g., corridors, washrooms) and "unoccupied" areas taken up by walls and pillars. This means that the actual working space area will be smaller than the "recommended" dimensions.

The Recommended Allocation Guidelines by Public Works and Government Services of Canada derived from Treasury Board document recommend a comparable amount of space: 8.3 m$^2$ (89.3 ft$^2$) for office workers.

The National Building Code of Canada provides a more generous yet very general guideline of 9.3 m$^2$ (about 100 ft$^2$) per person.

In any case the standards and guides mentioned above and any others should be considered merely as guidelines, rather than absolute standards.

Till now a peep was made into ergonomics basics and causes of poor posture and its consequences but one should also know the ways to overcome the ill effects caused to the body with continuous wrong posture and no application of ergonomics principles.

Now have a glance at ways to overcome side effects of poor posture.

2.3 Ways to overcome side effects of poor posture.

a) Importance of stretching

No matter how well a workstation is designed, problems may arise if attention is not paid to the way the work is done. Working at a computer often involves very few changes in body position. This lack of movement can lead to muscle pain and strain.

What can be done to minimize this strain?

It is recommended that a person break for 5-10 minutes for every hour spent at a workstation.

- Vary the work tasks. Break up keyboarding tasks work by doing other job duties or tasks that involve moving around or changing body position. Try to stand up and move around.

- Look away from the screen occasionally and focus your eyes on an object far away.

- Take regular rest breaks to ease muscle aches, eye strain and stress.
- Relax your muscles, stretch and change position.

**Stretches for the hands and forearms that can be done at the workstation.**

**Figure: 1 Stretches for the hands and forearms**

1. a) Start with your hand open.

![Figure 1(a)](image1)

b) Make a fist. Keep your thumb straight, not tucked under your fingers.

![Figure 1(b)](image2)

c) Slide your finger tips up your palm so the tips of your fingers are near the base of your fingers and you should feel a stretch. Do not force your fingers with your other hand if something is painful.

![Figure 1(c)](image3)
2. With your hand open and facing down, gently bend wrist from side to side, as far as possible. Hold for 3 to 5 seconds. Repeat 3 times.

![Figure 1(d)](image)

**Figure: 1(d)**

3. Start by stretching your arm and hand out and slowly rotate the wrist down until you feel a stretch. Hold for 3 to 5 seconds. Next, rotate the palm up until you feel a stretch. Repeat 3 times.

![Figure 1(e)](image)

**Figure: 1(e)**

4. Grasp your hand and hold your fingers with the other hand. Slowly bend your wrist down until you fell a stretch. Hold for 3 to 5 seconds. Relax. Repeat 3 times. Then slowly bend your wrist up until you feel the stretch. Hold and relax as above.

![Figure 1(f)](image)

**Figure: 1(f)**
5. Sitting with your elbows on the table and palms together, slowly lower wrists to the table until you feel a stretch (your elbows will move outward a bit). Be sure to keep your palms together throughout the stretch. Hold 5 to 7 seconds. Relax. Repeat 3 times.

![Image](image1)

**Figure: 1(g)**

**Stretches for the neck and shoulders.**

1. **Shoulder Shrug:** The purpose of the shoulder shrug is to relieve early symptoms of tightness or tension in the shoulder and neck area.
   - Raise the top of your shoulders towards your ears until you feel slight tension in your neck and shoulders. Hold this feeling of tension for 3 to 5 seconds. Then relax your shoulders downward into their normal position. Do this 2 or 3 times.

![Image](image2)

**Figure: 2 Shoulder shrug**

2. **Head Glide:** The head glide helps to stretch your chest, neck and shoulder muscles.
   - Sit or stand upright. Without lifting your chin, glide your head straight back. You are now doing this exercise right if it gives you the feeling of a double chin. Hold for 20 counts and repeat 5 to 10 times.
3. **Neck Relaxer**: This exercise helps to relax the neck.

   - Drop your head slowly to the left, trying to touch your left ear to your left shoulder. Repeat on the right side. Slowly drop your chin to your chest, turn your head all the way to the left, then turn all the way to the right.

4. **Shoulder Roll**: This exercise will help relax the shoulder muscles.

   - Slowly roll your shoulders backward five times in a circular motion. Next, roll your shoulders forwards.
Stretches for the back, side and legs.

1. Back / Side Stretch:

   - Interlace your fingers and lift your arms over your head, keeping the elbows straight. Press arms as far back as you can. To stretch your sides, slowly lean to the left and then to the right.

   ![Figure 6 Back/side stretch](image)

2. Middle / Upper Back Stretch:

   - Hold your right arm with your left hand just above the elbow. Gently push your elbow toward your left shoulder. Hold stretch for 5 seconds. Repeat with your left arm.

   ![Figure 7 Middle / Upper Back Stretch](image)

3. Back Curl (will also stretch your legs):

   - Grasp your shin. Lift the leg off the floor. Bend forward (curling your back), and reach your nose to your knee. Repeat with the other leg.
4. Ankle Flex and Stretch:

- Hold one foot off the floor with your leg straight. Alternately flex your ankle (point your toes up) and extend (point your toes down). Repeat with the other leg.

5. Leg Lift:

- Sit forward on the chair so that your back is not touching the chair's back. Place feet flat on the floor. With a straight leg, lift one foot a few inches off the floor. Hold momentarily, and return your foot to the floor. Repeat with the other leg.

What is a "good" sitting body position?

There is no one or single body position that is recommended for sitting. Every worker can sit comfortably by adjusting the angles of their hips, knees, ankles and elbows. The following are general recommendations. Occasional changes beyond given ranges are acceptable and sometimes beneficial.

- Keep the joints such as hips, knees and ankles open slightly (more than 90°).
- Keep knee joints at or below the hip joints.
- Keep ankle joints in front of the knees.
- Keep a gap the width of three fingers between the back of the knee joint and the front edge of the chair.
- Keep feet flat on the floor or on a foot rest.

Plate 5: Showing Good body positions

- Keep the upper body within 30° of an upright position.
- Keep the lumbar support of the back rest in your lumbar region (around the waistband).
Always keep the head aligned with the spine.

Keep upper arms between vertical and 20° forward.

Keep elbows at an angle between 90° and 120°.

Keep forearms between horizontal and 20° up.

Support the forearms.

Keep the wrists straight and aligned with the forearms.

Place the working object so that it can be seen at viewing angle of 10° to 30° below the line of sight.
• Keep shoulders low and relaxed.
• Keep elbows tucked in.
• Tuck chin in and do not bend forward when looking down and forward.
• Change positions frequently but remain within recommended ranges.
• Alternate crossed legs.
• Avoid bending to the side.
• Avoid bending forward.
• Do not slouch.
• Do not sit for more than 50 minutes at a time.
An example of a workstation for sitting/standing

Continuous standing or sitting while working is a common source of discomfort and fatigue. Frequent changes of body positions, including alternating between sitting and standing, helps to avoid fatigue.

- Adjust the workstation to the proper height. Refer to the document Working in a Standing Position for more information.
- Use a swivel chair with an adjustable seat height.
- Adjust the chair seat height to 25-35 cm (about 10 - 14 in.) below the work surface.
- Use a footrest with a height of 40-50 cm (about 16 - 20 in.).

Plate: 6 Workstation for sitting/standing

An example of a semi-circular workstation

- Arrange work in a semi-circle.
- Use a swivel chair to reduce body twisting, to allow easy movements, and to reduce side-to-side motions.
- Use sloping work tables whenever possible to reduce bending, and to encourage an upright position while sitting or standing.
Examples of a chair for sitting/standing workstations?

Whenever possible, a worker should be able to work sitting or standing at will.

- Ensure that the seat has a minimum width of 40 cm (about 16 in.).
- Choose back rests that are contoured vertically and horizontally.
- Use a seat covering of non-slip, breathable fabric.
- Select seat padding that is about 2-3 cm (1 in.) thick.

Plate: 8 Chair for sitting/standing workstations

- Provide a chair that can fold up and be stored out of the way where space is limited.
- Ensure that chairs have a back support.
• Provide a chair for resting purposes even when work can only be done standing.

Plate: 8 (b)

b) Manual Material Handling

Manual material handling refers to any tasks involving lifting, carrying, pushing or pulling objects. Muscle overuse or overexertion injuries can occur when the task is performed without pre-conditioning the muscles and joints or when the demands exceed the body’s physical capabilities. Muscle overuse and overexertion injuries can range from swelling and soreness to torn muscle, tendons or ligaments.

1. Lifting/Lowering
   a) General Safe Lifting Technique

2. Pushing/Pulling and Carrying
   1) Lifting/Lowering

   Have you ever wondered what a safe weight to lift or carry is? Well, there isn’t a simple answer and there is no single, safe “limit”. The risk of injury from lifting (or lowering) depends on a number of factors that need to be considered including:

   • Size, shape and weight of the package
   • Male vs. Female population
   • Hand placement (i.e. how far away from your body are your hands?)
   • Position of the load (below knees, waist height, above shoulders)
   • Do you twist your body during the lift?
- Shape and weight of the load
- Number of lifts performed (frequency)

a. General Safe Lifting Technique

Using safe lifting techniques is important for reducing the risk of injury when lifting (or lowering) items. Remember, let your legs do the work, not your back. Also, be sure to avoid awkward postures such as reaching too far and twisting your back. General lifting and lowering technique involves:

- Sizing up the load
- Standing close to load, with feet apart (shoulder width)
- Squatting down – bend at hips and knees
- Arching lower back inward and keep back straight
- Keeping the load close to body
- Turning your feet when changing direction
- Placing load down - squat (bend at knees, keep lower back arched inward)

2) Pushing/Pulling and Carrying

Using safe techniques is also important for reducing the risk of injury when pushing, pulling or carrying items. Remember, it’s generally easier, and safer, to push than to pull. Pushing uses your body weight to move the load and this position allows you to see where you’re headed. Also, avoid carrying heavy objects too far. Consider using a cart, dolly or other wheeled or mechanical device.
instead. The forces required, and the risk of injury, to push, pull or carry a load depends on a number of factors that need to be considered including:

- Male vs. Female
- Hand placement
- Distance involved

Plate: 10 Pushing load

- Number of lifts performed (frequency)
- Floor surface
- Size, shape and weight of the package
- Condition of floor, wheels

Related studies on posture

Deros, et., al., (2010) studied on “Work Posture and Back Pain Evaluation in a Malaysian Food Manufacturing Company” A cross-sectional study was conducted among workers at a processed food manufacturer in Malaysia. The main objective of the study was to determine the prevalence of back pain among workers who perform manual material handling. In addition, the study also investigated the effectiveness of the interventions provided by the employer to reduce the risk of back pain. Approach: A total of 60 workers had participated in the study. Socio-demographic
information and back pain symptoms were obtained using Standardized Nordic Questionnaire (SNQ) for analysis of musculoskeletal Symptoms. WinOWAS software was used to identify the respondent’s working posture. Results: Study results showed that lifting posture contributed the highest percentage of upper extremities back pain (45%) and lower extremities back pain (80%). There was a significant relationship at level p≤0.05 for posture working repeatedly and lifting weight above head level. The interventions provided by the employer showed 82% of the respondents gave a positive feedback for training provided. As for personal protective equipment and mechanical aid, both showed positive results at 84.61 and 100% respectively. Chi-square analysis results showed, respondents’ age has significant effect on standing posture for 10 min (p<0.01) for pain at the upper back. On the other hand for gender factor, correlation with; standing for 10 min, hold on load, reaching load, putting loads above head level, turning load and static standing, has significant effect on upper back pain at p<0.05. Genderalso showed significant correlation with; doing repetitive task, reaching load and putting loads above head height, which contributed significantly to lower back pain at p<0.05. Conclusion: The study suggested that all manual handling activities should be replaced with mechanical aids to reduce prevalence of back pain.

Kumar (1990) has shown that mechanical load is a risk factor for low back pain. He used a two dimensional, static mathematical model of spinal loading to estimate the shear and compression forces at the lumbosacral and thoracolumbar joints. These forces were found to be higher in workers with self-reported pain than in workers without pain.

Gangopadhyay, et., al., (2012) carried out a study on “An ergonomic study on posture-related discomfort among preadolescent agricultural workers of west Bengal, India”. In India, particularly in West Bengal, preadolescents are primarily associated with agricultural work in rural areas. Owing to poor socio-economic conditions, they are compelled to carry out a considerable number of manual, rigorous tasks in agricultural fields. The main aim of this study was to investigate postures adopted by preadolescent agricultural workers during individual agricultural activities and to analyze the causes of discomfort related to those postures. Fifty male and 50 female preadolescent agricultural workers were randomly selected and a detailed posture analysis was performed with the Ovako Working Posture Analysis System (OWAS).
It was observed that those workers worked continuously in awkward postures during certain agricultural activities. Consequently they suffered from discomfort in different parts of their body. Even though they were very young, they were likely to suffer from serious musculoskeletal disorders in the future.

A study was carried out by Nag, et., al, (2012) on “Risk factors and musculoskeletal disorders among women workers performing fish processing”. The study examined the prevalence of musculoskeletal pain and discomfort (MSD) among workers engaged in fish processing activities and identified the occupational, environmental, and psychosocial factors contributing to the MSDs. An ergonomics checklist and questionnaire on general health and psycho-social issues were administered to women workers (N=450). The relative risk for MSDs due to demographic factors, stress symptoms, and task variables were estimated. Nearly 71% of the women (age 23.0 ± 6.4 years) reported MSDs, chiefly in upper back (54%), lower back (33%), knee (35%), and shoulders (27%). Workers engaged in mixed task (OR 13.8; CI 8.7-22.0), ring cutting (OR 18.3; CI 11.8-24.7), having job experience <3 years (OR1.9; CI1.3-2.9), being married (OR 1.5; CI 1.1-2.2), BMI18-25 (OR 1.7; CI 1.1-2.8) had increased risk of MSDs in the upper back. The severity of pain was high among the workers with elevated co-morbidity (pain in two or more regions). One third of the workers perceived the work environment to be cause of their MSDs. Multivariate analysis using binary logistic regression model indicated that highly specialized job (OR 13.0; CI 4.7-14.2), high physical activity (OR 11.7; CI 4.6-12.7), improperly designed tools (OR 8.1; CI 3.5-9.5), poor training (OR 7.0; CI 3.3-7.5), and poor job satisfaction (OR 1.5; CI 1.1-4.8) significantly increased the risk of MSDs. Almost all the psychosocial and work stress factors were associated with lower back MSD.

A cold and humid environment, awkward standing work posture for long hours, high physical activities, poor task clarity, and high mental overload are important risk factors for the development of MSDs.

Bruno Garza, et., al. (2012) “Observed differences in upper extremity forces, muscle efforts, postures, velocities and accelerations across computer activities in a field study of office workers”. This study, a part of the Predicting Occupational
biomechanics in Office workers (PROOF) study, investigated whether there are differences in field-measured forces, muscle efforts, postures, velocities and accelerations across computer activities. These parameters were measured continuously for 120 office workers performing their own work for two hours each. There were differences in nearly all forces, muscle efforts, postures, velocities and accelerations across keyboard, mouse and idle activities. Keyboard activities showed a 50% increase in the median right trapezius muscle effort when compared to mouse activities. Median shoulder rotation changed from 25 degrees internal rotation during keyboard use to 15 degrees external rotation during mouse use. Only keyboard use was associated with median ulnar deviations greater than 5 degrees. Idle activities led to the greatest variability observed in all muscle efforts and postures measured. In future studies, measurements of computer activities could be used to provide information on the physical exposures experienced during computer use. Practitioner Summary: Computer users may develop musculoskeletal disorders due to their force, muscle effort, posture and wrist velocity and acceleration exposures during computer use. We report that many physical exposures are different across computer activities. This information may be used to estimate physical exposures based on patterns of computer activities over time.

Toomings, et al., (2011), discussed about Variation between seated and standing/walking postures among male and female call centre operators. The dose and time-pattern of sitting has been suggested in public health research to be an important determinant of risk for developing a number of diseases, including cardiovascular disorders and diabetes. The aim of the present study was to assess the time-pattern of seated and standing/walking postures amongst male and female call centre operators, on the basis of whole-shift posture recordings, analysed and described by a number of novel variables describing posture variation. Seated vs. standing/walking was recorded using dichotomous inclinometers throughout an entire work shift for 43 male and 97 female call centre operators at 16 call centres. Data were analysed using an extensive set of variables describing occurrence of and switches between seated and standing/walking, posture similarity across the day, and compliance with standard recommendations for computer work. The majority of the operators, both male and female, spent more than 80% of the shift in a seated posture with an average of 10.4 switches/hour between seated and standing/walking or vice versa. Females spent, on
average, 11% of the day in periods of sustained sitting longer than 1 hour; males 4.6% (p = 0.013). Only 38% and 11% of the operators complied with standard recommendations of getting an uninterrupted break from seated posture of at least 5 or 10 minutes, respectively, within each hour of work. Two thirds of all investigated variables showed coefficients of variation between subjects above 0.5. Since work tasks and contractual break schedules were observed to be essentially similar across operators and across days, this indicates that sedentary behaviours differed substantially between individuals.

The extensive occurrence of uninterrupted seated work indicates that efforts should be made at call centres - and probably in other settings in the office sector - to introduce more physical variation in terms of standing/walking periods during the work day. We suggest the metrics used in this study for quantifying variation in sedentary behaviour to be of interest even for other dichotomous exposures relevant to occupational and public health, for instance physical activity/inactivity.

Kanteshwari, et., al., (2012), studied a Correlation of awareness and practice of working postures with prevalence of musculoskeletal disorders among dental professionals. Over the last 20 years, a great many innovations have been introduced that are designed to reduce laborious activities; however, an unexpected consequence of these developments is a trend toward a sedentary lifestyle and prolonged static postures that are accompanied by musculoskeletal disorders (MSDs). MSDs have become a major issue of concern because the afflictions can be severe enough to disable professional careers. Although clinical dentistry is a field with immense potential for MSDs, only a few studies have investigated this issue. The present study was carried out addressing prevalence and awareness level of MSDs among 500 dental professionals from Central India. Also, the interrelationship between practices of working postures with occurrence of pain in different body parts were assessed using a structured questionnaire format. The results were statistically significant, and indicated that the prevalence of MSDs is high and that there is a dire need to enhance awareness regarding correct working postures. This study encompassed all factors that can be addressed as causes for MSDs among dentists.

Horton, et., al., (2011), studied on “Clinical working postures of bachelor of oral health students”.
Objective: To observe and describe the clinical working postures of final-year Bachelor of Oral Health (BOH) students.

Design: Pilot observational study.

Setting: The University of Otago Faculty of Dentistry and School of Physiotherapy.

Methods: Eight final-year BOH students voluntarily participated in this study, where postural data were collected using a digital video camera during a standard clinical treatment session. The postural data were analysed using 3D Match biomechanical software.

Results: Final-year BOH students who work in the seated position are exposed to neck flexion of greater than 35 degrees, together with trunk flexion greater than 20 degrees and bilateral elbow flexion greater than 90 degrees.

Conclusions: The findings of this study agree with the findings of previous postural studies of dental professionals. Dental hygiene students, together with their clinical supervisors, need to be aware of the importance of good working posture early in their careers, and pay particular attention to the degree of neck flexion.

2.4 Shiftwork, hazards and important considerations.

Definition of "rotational shiftwork"

The term "rotational shiftwork" covers a wide variety of work schedules and implies that shifts rotate or change according to a set schedule. These shifts can be either continuous, running 24 hours per day, 7 days per week, or semi-continuous, running 2 or 3 shifts per day with or without weekends. Workers take turns working on all shifts that are part of a particular system.

The definition of rotational shiftwork in this document does not include fixed shifts like straight nights, straight afternoons or straight days and, generally, fixed shifts are not discussed here. However, workers on fixed night shifts and workers on rotational shiftwork schedules have much in common due to the constantly changing schedules, night work and potential disruption to family and social lives.

The length of a shift can vary between 8 and 12 hours.
Effects of shiftwork

Shiftwork is a reality for about 25 percent of the North American working population. Interest in the effects of shiftwork on people has developed because many experts have blamed rotating shifts for the "human error" connected with nuclear power plant incidents, air crashes, and other catastrophic accidents.

Alternating day, night and afternoon shifts are common in

- industrial work
- customs & immigration
- mines
- hospitals
- protective services -- police, fire, ambulance
- hospitality -- hotels, food service
- health care
- transportation services -- trucking, airlines

Shiftwork is also common in workplaces where technical processes cannot be interrupted without affecting the product and/or where expensive equipment is used more profitably when in constant operation. The overall prevalence of shift work is similar for women and men. However, there are gender differences in shift work patterns by sector of employment. Many more women than men work in the health care sector, while many more men than women work in manufacturing.

Many workers find that shiftwork disrupts their family and personal life and leads to health problems including chronic fatigue and gastrointestinal disorders. On the other hand, some workers prefer shiftwork because it usually allows for more free time.

A shiftworker, particularly one who works nights, must function on a schedule that is not "natural". Constantly changing schedules can:

- upset one's circadian rhythm (24-hour body cycle),
- cause sleep deprivation and disorders of the gastrointestinal and cardiovascular systems,
- make existing disorders worse, and
- disrupt family and social life.


Effects on circadian rhythms

Many human physical functions follow a daily rhythm or a 24-hour cycle. These cycles are called circadian rhythms. The word circadian comes from the Latin "circa dies" which means "about a day." Sleeping, waking, digestion, secretion of adrenalin, body temperature, blood pressure, pulse and many other important aspects of body functions and human behaviour are regulated by this 24-hour cycle. These rhythmical processes are coordinated to allow for high activity during the day and low activity at night.

Normally, the body uses cues from its processes and from the environment such as clock time, social activities, the light/dark cycle, and meal times to keep the various rhythms on track. For example, body temperature is highest during the afternoon and early evening (6:00 p.m.) and lowest in the early morning (4:00 a.m. or just before sunrise). However, if the person is working at night, the body temperature does not have as much variation during a 24-hour period as it would normally. The temperature rhythm and other body rhythms get out of sync: these rhythms also get out of phase with the person's activity pattern. This disorientation can lead to feelings of fatigue and disorientation. "Jet lag" is a term often used to describe these feelings.

Some rhythms adapt in two to three days while others change only after longer periods. People adapt to new schedules at different rates as do the different rhythms. Total reversal of circadian rhythms may never occur because on days off most people go back to a "normal" day schedule. Frequent changes in schedule and disruption to circadian rhythms can lead to chronic fatigue and other health problems.

What are the changes in sleep patterns?

Disruption of both the quality and quantity of the normal sleep is inevitable in shiftwork particularly where night work is involved. The daytime sleep is seldom as deep or as refreshing as sleep at night. The problem is greater if there is not a quiet, dark, comfortable place to sleep. Even when disturbances are removed, a worker who
returns home in the morning may still find sleep impossible or less refreshing. This difficulty occurs because the circadian rhythms are no longer synchronized. Being constantly tired is a typical complaint of shift workers.

**What are the gastrointestinal disorders associated with shift work?**

Gastrointestinal and digestive problems such as indigestion, heartburn, stomachache and loss of appetite are more common among rotating shift workers and night workers than among day workers. It is less clear if more serious conditions such as peptic ulcers are more common in shift workers. The irregular work, sleep and eating schedules are not helpful for the proper care of ulcers.

Given the irregularity in type and timing of meals, it is not surprising that the night worker is more likely to have a poorer diet. At night, the loss of appetite often leads to increased snacking on "junk" food rather than eating a full, well-balanced meal. Feelings of fatigue may encourage the consumption of beverages with caffeine (coffee, cola) to help the worker stay awake.

**What are the cardiovascular disorders associated with shift workers?**

Shiftwork is not absolutely associated with cardiovascular disease. However, heart rate and blood pressure have been shown to follow a circadian rhythm. Life-style can directly affect an individual's health. Therefore, it is very important that a shift worker follows exercise programs to maintain an adequate level of fitness. It is also very important not to smoke, to have good dietary habits and to participate in leisure activities.

A study of Swedish men with a history of heart attack showed they were significantly more likely to have been shift workers than those men without a history of heart attack. Another study showed that the modification of shift rotation schedules by changing the direction of rotation of shifts to a forward direction (for example, days -> afternoons -> nights) can significantly decrease the levels of several coronary risk factors, e.g., triglycerides, glucose, and urinary excretion of catecholamine's (chemicals like adrenalin that occur naturally in the body).
Are there concerns about pregnancy?

Working irregular shifts have been associated in some studies with preterm birth, and low birth weight. No conclusions can be made based on the studies available, and more studies are being conducted.

Can shift work aggravate existing conditions?

Workers who require prescription drugs to control certain disorders should be aware that disruption of the circadian rhythm can interfere with the medical treatment of some diseases. Check with your family physician if you take medication while working shifts. Your pharmacist may also be able to give you some additional information. If you get all your prescription drugs from the same pharmacy, the pharmacists can also advise you if one drug is likely to interact with another one you may be taking.

What are the effects on family and social life?

Compared with people who work straight days, shift workers report more interference to their family lives, especially the time available to spend with spouses and children. This fact is very important since the amount and quality of social interaction is related to physical and mental health. Individuals who cannot establish regular routines in their daily activities have difficulties planning for family responsibilities and coping with physical and mental fatigue as effectively as non-shift workers. Participation in clubs, sports and other organized activities is very difficult since they are usually geared to the normal day schedule. The lack of regular social contact can lead to feelings of loneliness and isolation. In addition, quality child care facilities aimed at meeting the needs of shift workers is almost nonexistent.

What are the safety concerns associated with working shifts?

The Institute for Work and Health (IWH) reports that there is strong evidence that night, evening, rotating and irregular shifts is associated with in increased risk of occupational injury. This risk is associated with worker fatigue, and less supervision and co-worker support during non-daytime shifts.

One study reported that night shift had the most incidents, followed by afternoon shifts (least incidents in the morning shift). The risk of an incident was 20 percent more during the first to second hour of a night shift, as well as a small raise between 3
and 4 am. More incidents are reported on the 4th successive night shift than the first night shift.

**What are some strategies for improvement?**

The best solution to the problems of shiftwork would be to eliminate it but this is not often a practical possibility. Shiftwork is likely to continue to be a reality for a large percentage of Canadian workers.

There are two basic levels where improvements can be made:

- The organizational level - primarily through the design of shift schedules, education and better facilities.
- The individual level - helping workers to get better sleep, a healthier diet, and the reduction of stress.

**What are some organizational approaches?**

There are several approaches the organization can take to help reduce the effects of shiftwork. There are also several important considerations for organizations.

Shift Schedule Design: Optimizing the design of the shift schedule is the most effective way of reducing the health and safety problems. Satisfaction with a particular shift system is the result of a complicated balancing act that is the best compromise for personal, psychological, social and medical concerns.

- **Length of the rotation period** (the number of days on any one shift before switching to the next shift). The optimum length of the rotation period has been disputed.
  - The most common system has a rotation period of one week, with five to seven consecutive night shifts. However, since it generally takes at least seven days for adjustment of the circadian rhythms, it is argued that just as adjustment starts to occur, it is time to rotate to the next shift. Some schedule designers feel that a longer shift rotation should be arranged so that the worker spends from two weeks to one month on the same shift that would allow circadian rhythms to adjust. A problem occurs when the worker reverts to a "normal" day/night schedule on days off, thus, possibly cancelling any adaptation. Also, longer periods of social isolation may result.
o Others suggest a rapid shift rotation where different shifts are worked every two to three days. This system may reduce disruption to body rhythms because the readjustment of circadian rhythms is minimized. It also provides time for some social interaction each week.

o In the end individual differences and preferences, play the most important role.

- **Direction of rotation of shifts.** It is recommended that shifts rotate forward from day to afternoon to night because circadian rhythms adjust better when moving ahead than back.

- **Start and Finish Times.** Early morning shifts are associated with shorter sleep and greater fatigue. It is advisable to avoid shift start times as early as 5 or 6 a.m. The social customs and desires of the specific work force should be considered as well as the availability of public transportation. The safety on the streets, in terms of crime and violence, is another consideration.

- **Length of rest between shifts.** It is recommended that a rest period of at least 24 hours occurs after each set of night shifts. The more consecutive nights worked, the more rest time should be allowed before the next rotation occurs.

- **Alternative forms of organizing work schedules.** For example, extended work days of ten or twelve hours have been used. It has the advantage of fewer consecutive night shifts and longer blocks of time off. However, the additional fatigue from long work hours may also have adverse effects. The physical and mental load of the task should be considered when selecting the length of a work shift. Exposure to chemical or physical agents should also be considered when selecting a shift system as well as ergonomic hazards.

**Additional Considerations**

- Provide time off at "socially advantageous" times like weekends whenever possible.

- Start a special shift system if production demands result in extended periods of overtime work.
Inform shift workers of their work schedules well ahead of time so they and their families and friends can plan activities. Allow as much flexibility as possible for shift changes. Keep schedules as simple and predictable as possible.

**Facilities:**

The provision of certain facilities can help the shift worker cope better.

- Give attention to the work environment. For example, good lighting and ventilation are important on all shifts. Do not widely separate workstations so that workers at night can remain in contact with one another.

- Provide rest facilities where possible. Whenever a person must remain at work after a night shift to attend a meeting or a training session, providing rest facilities is advisable. When a night worker is "on call" and must remain in the building, it is advantageous for this person to be well rested rather than tired and bored.

- Provide healthy cafeteria services so a balanced diet can be maintained. The nutritional needs differ between day shifts and other shifts because of circadian rhythms. Provide educational and awareness materials on the benefits of eating a balanced meal.

- Consider offering facilities for social activities with the needs of the shift worker in mind. Recreational opportunities are often minimal for workers on "non-day/night" shifts.

- Consider access to quality day-care for shift workers' children. Some strain on all family members would be alleviated.

**Education:**

Educate employees on the potential health and safety effects of rotational shiftwork and what can be done to stop these effects. In particular, education in stress recognition and reduction techniques is helpful.

**What can the individual do to cope with shift work?**

People who work shifts face many problems that others do not recognize. The difficulties stem from the change in eating, sleeping, and working patterns. The following guidelines can help people cope better.
Guidelines for Diet and Eating Patterns

- Maintain regular eating patterns as much as possible. Balanced, varied meals are very important. Keep family meal times the same even though the work routine constantly changes. Family meals may need to be altered in content to suit the shift worker.

- Time meals carefully. Afternoon workers should have the main meal in the middle of the day instead of the middle of the work shift. Night workers should eat lightly throughout the shift and have a moderate breakfast. This way they should not get too hungry while sleeping during the day and digestive discomfort should be minimal.

- Pay careful attention to the type of food eaten. Drink lots of water and eat the usual balance of vegetables, fruit, lean meat, poultry, fish, dairy products, grains and bread. Eat crackers, nuts and fruit instead of pop and candy bars during work breaks. Reduce the intake of salt, caffeine, and alcohol. Avoid greasy foods, particularly at night.

- Avoid excessive use of antacids, tranquilizers and sleeping pills. It is healthier to watch what and when you eat, and use relaxation techniques to aid sleep.

- Relax during meals and allow time for digestion.

Sleep

- Sleep on a set schedule to help establish a routine and to make sleep during the day easier. Some people may prefer to get a full period of rest just before the next work shift (as it is with "normal day" work). Try different patterns of work and sleep to see which is best for you.

- Make sure that family and friends are aware of and considerate of the worker's sleep hours and needs. Ensure that the shift worker has a comfortable, dark, quiet place to sleep during the day. Air conditioning, a telephone answering machine, and good blinds on windows are recommended.

- Make time for quiet relaxation before bed to help get better sleep. Learn how to relax using muscle relaxation, breathing techniques and so on. Use mental imagery to block out unpleasant thoughts. If you still do not fall asleep after an
hour, read a book or listen to quiet music on the radio for a while. If sleep still
does not come, reschedule sleeping hours for later in the day. Limit commitments
later in the day to allow for napping.

**Other Important Considerations**

- Pay attention to general physical fitness and good health habits.
- Find out about and understand the potential health and safety effects of shift work.
- Learn how to recognize and reduce stress through physical fitness, relaxation
  techniques and so on.
- Take leisure seriously.

(http://www.ccohs.ca/oshanswers/ergonomics/shiftwrk.html)

**Related Studies**

Simo S. (2010) carried out a study on “Shift work and extended working hours as risk
factors for occupational injury”, The aim of this review is to examine the effect of
shift work and extended working hours on occupational injuries. A calculation based
on four studies shows that the risk of occupational injury during afternoon shifts was
6% lower than that during morning shifts. The same kind of calculation show that the
risk of occupational injury during night shifts was 15% lower than during morning
shifts. A review of eight studies showed that the risk of occupational injury was 41 %
higher for 10 hour working days compare to eight hour working days. On the other
hand, working 12 hour days increased the risk of occupational injury by 14 % .when
working more than 12 hours per day, 3 studies showed a 98 % increase in
involvement in occupational injury. The results of this study showed that shift work
considerably increased the risk of occupational injury in the USA, but not  in the other
countries. Extended working hours was related to elevated risk of occupational injury.
Thus shift work and long work hours did not suit for all employees.

Brouha and Ball (1948) have demonstrated a marked improvement in cardiovascular
stress in the second half of the shift on group of industrial workers attending to
furnaces, by proper adjustment of work-rest periods.

Panchal M. and Shaikh M., (2009), carried out a study on “ shift work and health
behavior” introducing shift work clearly depends on productivity and safety being
maintained at an acceptable level. However the evidence reviewed in this paper clearly indicates that both productivity and safety may be compromised at night. More specifically, safety declines over successive night shifts, with increasing hours and between successive rest breaks. The only known way to minimize these problems is to improve shift systems with respect to these factors. However, these factors need to be considered in combination with one another since, for example, a long night shift that includes frequent rest breaks might well prove safer than a shorter night shift with less frequent breaks. These literature gives an idea about health effect of shift work on shift workers and precaution to be taken to prevent it.

Drury et al. (2006), carried out a study on “Vicarious perception of postural discomfort and exertion” Perceived exertion and discomforts have been used extensively in ergonomics practice. Job incumbents typically rate their exertion on scales such as Borg’s rated perceived effort (RPE) and their discomfort on scales such as Corlett and Bishop's body part discomfort scales (BPD). This study asks whether exertion and discomfort can be perceived by an external observer, i.e. is vicarious perception possible? Four participants (targets) performed 20 postural holding tasks selected from Ovako Working Posture Analysing System postures and gave RPE and BPD scores for each posture. Video clips of each target in each posture were shown to four expert ergonomists and 23 novices, who also gave RPE and BPD scores. Correlations between targets and observers scores were high, with significance exceeding $p = 0.01$. Observers were generally conservative, rating easy postures too high and difficult postures too low. All observers rated female targets higher than male targets. Female observers rated all targets higher than male observers. Vicarious perception of discomfort and exertion was possible, but there was not a one-to-one correspondence to ratings given by those experiencing the posture.

Peter, et. al., (2006), carried out study on “Lumbopelvic kinematics and trunk Muscle Activity During sitting on stable and unstable surfaces” with the objectives: To compare lumbopelvic kinematics and muscle activation patterns while sitting on stable and unstable surfaces. Unstable surfaces are commonly used during the rehabilitation of certain low back pain disorders. The benefits postulated are increased muscle activity and facilitation of sustainable midrange positions via neuromuscular control. The use of unstable sitting devices in the workplace is controversial, as the
postulated increase in muscle activity is thought to lead to a muscle fatigue/pain response. Present study included 26 healthy adults (14 male, 12 female). Fastrak 3-dimensional motion analysis detected lumbar curvature, pelvic tilt, and postural sway during sitting on a stable and unstable surface over 5-minute periods. Surface electromyography was used.

Major findings showed that spinal postures were similar for sitting on a stable and unstable surface. Significant increases in postural sway were detected (P = .013) in 3 dimensions of movement during sitting on an unstable surface. Gender differences were noted. No EMG amplitude or variance differences were detected between seating conditions. Conclusions: Preliminary data show that sitting on unstable surfaces induces greater spinal motion, but does not significantly alter the lumbosacral posture or the amount of activity in the superficial trunk muscles under investigation.

Vergara, et al. (1991) studied “Relationship between comfort and back posture and mobility in sitting-posture”. The objective of this work was to analyse the causes of lumbar discomfort while sitting on a chair, by analysing the relationship of lumbar curvature, pelvic inclination and their mobility with discomfort. An experiment has been performed with healthy subjects, in which comfort, postural and mobility parameters have been measured. Their relationship has been analyzed with multivariate analysis. Factorial analysis has been used to represent all the correlated variables measured. Logistic regression and discriminant analyses have been used to classify discomfort/absence of discomfort. The results show that great changes of posture are a good indicator of discomfort, and that lordotic postures with forward leaned pelvis and low mobility are the principal causes of the increase of discomfort.

Salminen (2010), studied on “shift work and extended working hours as risk factors for occupational injury” with the aim to examine the effect of shift work and extended working hours on occupational injuries. A calculation based on four studies shows that the risk of occupational injury during afternoon shifts was 6% lower than that during morning shifts. The same kind of calculation showed that the risk of occupational injury during night shifts was 15% lower than during morning shifts. A review of eight studies showed that the risk of occupational injury was 41% higher for 10-hour working days compared to 8-hour working days. On the other hand, working 12-hour days increased the risk of occupational injury by 14%. When working more
than 12 hours per day, three studies showed a 98% increase in involvement in occupational injury. The results of this study showed that shift work considerably increased the risk of occupational injury in the USA, but not in the other countries. Extended working hours was related to elevated risk of occupational injury. Thus shift work and long work hours did not suit for all employees.

2.5 Work design hazards, causes, work design assessment.

The design and organization of work can potentially cause harm to the body by placing stresses and strains on the musculoskeletal system. The elements of work design include the design of the work station, tools and equipment, the physical environment and general work organization.

When these elements are not designed properly, they can overload and damage the muscles, tendons, ligaments and associated nerves and blood vessels of the musculoskeletal system.

Work design affects those who work in a wide variety of occupations and workplaces. In addition to industrial workplaces, these include offices, health and other human care facilities, construction sites, warehouses and service establishments.

a) Musculoskeletal Injuries

The musculoskeletal system has two main parts. One part is the skeleton with its 206 bones. The other is the system of skeletal muscles attached to the bones. They give the body its ability to move. The musculoskeletal system also includes the tendons that connect the muscles to the bones, cartilage that covers the ends of the bones which form joints, and ligaments that bind the joints together and connect the bones. Tendons, cartilage and ligaments are known as connective tissues.

Blood vessels and nerve systems provide the musculoskeletal system with oxygen and communication with the brain.
Work design hazards can create a situation that may cause injuries to parts of the musculoskeletal system. These injuries are known collectively by a number of titles. Some examples are *musculoskeletal injury* (MSI), *repetitive strain injury* (RSI) and *cumulative trauma disorder* (CTD). MSI is the term used in this document.

**Incidence of Musculoskeletal Injuries**

Injuries of the musculoskeletal system (MSI) make up an increasing proportion of workplace health problems. The explanation lies in the design of many jobs, both new and old, that require repetitive motions and strain on the part of the worker. One example is the supermarket cashier who must repeatedly perform lifting, pulling, twisting and bending motions while at the same time operating a cash register and weigh scale.

**Health Effects**

Hazards caused by poor work design have received increasing attention as the incidence of reporting musculoskeletal injuries has increased. Many musculoskeletal conditions have been recognized for a long time. Bursitis of the knee is a painful, work-related condition that was once called *housemaid’s knee*. Many other musculoskeletal injuries are identified by occupations they are associated with, rather than by their medical names. Thus we have *postman’s shoulder*, *carpet layer’s knee* and *telephone operator’s elbow*.

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**Musculoskeletal System**

**Connective Tissues**

- **Tendon**: a fibrous tissue that connects muscle to bone. Tendons are inelastic and strong and vary in length and thickness.
- **Cartilage**: a tough, fibrous tissue that protects and connects bones. Cartilage has no nerves or blood supply.
- **Ligament**: a resilient and flexible fibrous tissue that binds joints together and connects bones and cartilage. The ligament allows joints to move while preventing their dislocation.
Musculoskeletal Injuries of the Arms and Legs

The most common musculoskeletal injuries of the arms and legs are described here using their medical names.

**Bursitis**

A *bursa* is a sac filled with fluid that lubricates joints like the knee, elbow and shoulder. It also protects other parts of the musculoskeletal system like the connections between tendons and bones and tendons and ligaments.

Bursitis is the condition that develops when the bursa swells and inflames. Carpet layers are susceptible to bursitis of the knee. Supermarket cashiers who work with stationary scanners are susceptible to bursitis of the elbow. Bursitis in the shoulder can be traced to tasks that involve exertion while the arms are lifted to shoulder height or above. The symptoms of bursitis are pain and limited mobility of the affected joint.

**Epicondylitis**

Epicondylitis is inflammation of the muscles and other connective tissues around the elbow joint. A cause of this condition is frequent rotation or twisting of the forearm, and exertion with a bent wrist. It is a problem common to workers who use hand tools, such as carpenters, electricians and pipefitters and is frequently called *tennis elbow*. Frequent picking up and carrying of heavy objects is another cause. The condition causes pain and swelling at the elbow.

**Carpal Tunnel Syndrome**

The *carpal tunnel* is a tunnel formed by the bones of the wrist covered by a fibrous sheath. It encloses the tendons that connect the arm muscles to the finger bones. It also surrounds the *median nerve* that controls most of the fingers. The term *syndrome* means a group of symptoms associated with an illness.
Carpal tunnel syndrome can occur when the tendons in the carpal tunnel become inflamed and swollen from overuse. They put pressure on the median nerve, causing carpal tunnel syndrome. The symptoms of this problem are tingling and numbness, most pronounced in the index and middle fingers and most often experienced at night. As the condition worsens, it causes burning and constant pain. The hand becomes clumsy and weak so that tools or other objects are hard to hold. Non-work related conditions that may contribute to carpal tunnel syndrome are diabetes, hypothyroidism and pregnancy.

Carpal tunnel syndrome is most frequently seen in data entry workers, cashiers and meat cutters. All these jobs involve rapid and repeated motions of the fingers and hand. In many cases these motions are accompanied by exertion while the wrist is bent or by other types of body strain.

**Ganglion Cyst**

A ganglion cyst is a closed, fluid-filled sac which develops in a tendon sheath or the capsules around joints. This disorder is most often found in the wrist. Ganglion cysts are often not painful and may be caused by repetitive or forceful motion or a constrained position.

**Tendinitis**

Tendinitis is an inflammation of the tendon arising from small tears or wounds in the tissue. Because tendons have almost no blood supply they heal very slowly. When use of the tendon continues, it may become inflamed.

Tendinitis is most common in the tendons of the hand, wrist, shoulder and forearm, but the foot and ankle may also be affected. The affected area becomes red and swollen and it is painful and tender. Hairdressers, sewing machine operators and painters are among the workers frequently affected because they often work with their arms in unnatural postures for prolonged periods.

**Tenosynovitis**

Over-activity of the tendons from repeated motions and exertion, as well as awkward postures, causes inflammation of the protective sheath that surrounds them. The tendon sheath produces excess lubricating fluid which causes it to swell. A sudden
increase in exertion may bring this condition on quickly, in which case it is described as acut\textit{e tenosynovitis}.

Tenosynovitis commonly occurs in the fingers and wrists. The hand becomes painful and swollen and difficult to use. It is most frequently seen in workers such as sheet metal workers who use cutting shears and data processors. It can also lead to carpal tunnel syndrome because it puts pressure on the median nerve.

\textbf{Trigger Finger}

Trigger finger is a non-medical name for chronic tenosynovitis. It results when the tenosynovitis is not treated and repeated movements and exertion of the fingers, thumb or wrist continue. The tendon sheath reacts by growing thicker, restricting the movement of the tendons or stopping it altogether. The index finger is the one most often affected, especially where a vibrating tool must be operated by finger pressure against a trigger or other control that is narrow or has sharp edges.

The symptom is an inability to move the finger, sometimes accompanied by pain and swelling. Trigger finger is most frequently experienced by miners and assembly-line workers who use trigger-activated tools.

\textbf{Sprains and Strains}

A sprain results from over-stretching of the ligament around a joint causing the ligament to tear. It causes pain, swelling and discoloration. Twisted ankles and wrists are examples.

A strain is an injury to a muscle caused by over-stretching. Some fibres of the muscle are torn by the overuse, causing pain and swelling. Those in jobs that require bending, twisting and lifting are at risk.

\textbf{White Finger Disease}

Known as \textit{vibration-induced white finger disease}, this condition is caused by the impact of vibrating tools on the fingers. Continual use of such tools as jack-hammers, rock drills and chain-saws causes the small blood vessels in the fingers to go into spasm. Given enough rest, they will recover their normal shape. But continuing exposure to vibration makes recovery difficult and may cause permanent damage to the blood vessels and nerves.
Victims of white finger disease experience tingling and numbness of the fingers. These signs are accompanied by swelling and stiffness of the knuckles and then whitening of the surrounding skin. Fingers become clumsy and difficult to use. The condition results from constriction of the blood vessels.

White finger develops more rapidly when vibrating tools are used in cold temperatures. Over years of this kind of work, the person’s fingers become more and more sensitive to cold temperatures. Those most frequently affected include workers in forestry, mines and construction.
Musculoskeletal Injuries of the Back

The spine encloses and protects the spinal cord. Its bones and their associated muscles allow the body to bend and twist. The spine and its muscles together are often referred to as the back. The back is susceptible to injury from work that involves harmful postures and practices.

Back injuries are a major cause of lost time from work. In some cases, this condition will prove to be chronic or continuing. It is often difficult to link back pain to a particular back injury or defect.

Degenerative Disc Disease

With increasing age, the discs which separate the vertebrae of the back gradually dry out and flatten. This brings the vertebrae closer together and reduces the space available for nerves and other tissues. Sometimes the space becomes so small that nerves are irritated, causing pain.

Degenerative disc disease is part of the aging process, but it can be accelerated by postures which put pressure on the discs. Jobs that involve long periods of sitting carry this risk. Examples are drivers and some office workers.

Herniated Disc

This condition arises from tiny rips or ruptures in the wall of the disc. These ruptures may allow some or all of the gel-like fluid in the disc to bulge. This reduces the ability of the disc to act as a cushion between the vertebrae and thus places pressure on the spinal nerves. The result may be pain in the back and legs.

Back Injury Risk Factors

- Weight of the object being lifted or handled
- Distance of a lifted load from the spine
- Bending or twisting of the spine while lifting or handling
- Distance over which a load is carried
- Awkward shape or size of the load
- Frequency of lifting or other load handling activities
- Obstacles which interfere with a lifting or carrying activity
- Strength of the person
- Absence of convenient handholds on the load
- Deconditioned muscles
Pinched Nerve

Pinched nerve can happen when a spinal nerve is caught between the vertebrae or when a bulging herniated disc puts pressure on the nerve. The symptoms of a pinched nerve may include pain, tingling and numbness in the leg. Weakness of the leg may also be a sign of a pinched nerve. The pain felt in the leg is known as referred pain. The pain actually originates in the back but is referred or passed on to the leg.

The pinching of a spinal nerve can arise from degenerative disc disease or from a herniated disc.

Sprains and Strains

As with the ankles and wrists, sprains and strains of the back occur when the ligaments or muscles of the back are over-stressed. Lifting and handling activities can lead to sprains or strains of the back, particularly when heavy exertion is required and awkward postures are assumed.

Common Causes of Musculoskeletal Injury

Certain hazards or factors in work design increase the risk of musculoskeletal injury. These include posture, exertion, repetition, vibration, work organization and work environment.

Posture

The posture of a person’s body at work can cause or contribute to a musculoskeletal injury. Workers who must stoop, bend, crouch or squat to do a job risk musculoskeletal injury. Construction work often involves awkward postures.

Other occupations that involve awkward postures include nurses, ambulance attendants and child care workers. But even postures that are apparently comfortable can be risky if they are held too long. Sitting and standing tasks, like desk jobs in banks or offices or at checkout counters, can cause back, neck and shoulder problems and pooling of the blood in legs if proper controls are missing.

Exertion

Exertion, or force, is the amount of work a muscle must do to perform an action. Whether it’s holding a heavy object or pushing against a lever to operate a tool, exertion is involved. Exertion is also needed to hold the body in a particular posture.
Muscles do static work even when the body is not seen to move. Holding a particular body posture like standing or sitting involves static work. Static work involves the risk of decreased blood flow and waste product build-up. The opposite of static work is dynamic work where the muscles alternately contract and relax to exert force and make the body move. Dynamic work is generally easier and healthier unless it requires abnormal exertion.

Forceful exertion overloads the tendons and ligaments associated with muscle movement. Injuries to this connective tissue can occur regardless of the individual’s muscle strength, or the weight involved. For example, a forceful grip may be needed to lift an article that is slippery or difficult to grasp because it has an awkward shape. Shippers and receivers in warehouses, garbage collectors and health care workers may suffer back or other musculoskeletal injuries from manual lifting and from improper lifting.

Localized pressure and impact force are other factors in forceful exertion. The operator of a heavy staple gun exerts strong hand or finger pressure and may risk a trigger finger injury.

**Repetition**

Repeated movements affect the muscles, joints and connective tissues over time. When the same muscles are used again and again without rest, they begin to ache. This aching is the outward sign of muscle and/or connective tissue distress. Constant contraction or pull on the muscle decreases the flow of blood and with it the supply of nutrients. It also prevents waste products from being removed. Muscles begin to tire and cramp and other nearby muscles, not designed for the work, try to take over. This leads to further tiredness and cramping. The muscles are less able to stabilize the joints and the system becomes more prone to strain and sprain injuries.

In assessing the risk connected with repetitive work, four factors should be considered:

- **frequency**: how often the repetitive motion must be done;
- **speed**: how fast the motion is performed;
- **duration**: the period over which the repetitive work continues without rest;
• **Position:** the posture that the worker must assume.

Some kinds of jobs involve a lot of repetition. Data entry operators may have to do repetitive keying, sometimes with a bent wrist. Poultry processing and assembly line work are other examples. Without proper work design, persons in these and similar occupations may be at risk of an occupational injury.

**Physical Condition**

Muscles that are de-conditioned due to illness, injury, inactivity or aging are more vulnerable to musculoskeletal injury.

**Vibration**

Vibration can affect the entire musculoskeletal system or certain parts of it. Vibration might be called externally induced repetition.

The musculoskeletal injury most often linked to vibration is white finger. Vibration from hand tools like chain-saws and jackhammers impacts on the blood vessels and sensory nerves that serve the fingers, hand and arm. This deprives the muscles of blood and affects the transmission of nerve impulses. It allows waste matter to accumulate in the muscle tissues. Vibration can also affect the legs, because some workers do their jobs on vibrating surfaces and because vibration can be communicated from one part of the skeleton to another. Whole body vibration can be a special risk for drivers of vehicles.

**Work Organization**

The organization of work includes such factors as how, when and where a job is done, how quickly it is carried out, and the systems of compensation and supervision used. Poor work organization can contribute to musculoskeletal injury because workloads may be badly distributed and individuals may be required to work under excessive pressure. Certain types of incentive systems are believed to contribute to the numbers or severity of accidents in some industries. The lack of adequate training is another work organization factor that can contribute to musculoskeletal injuries.
Work Environment

A number of environmental factors in the workplace can also contribute to musculoskeletal injury. These include temperature, vibration and lighting. Working in extreme temperatures can put the body under heat or cold stress, as discussed in Chapter 10. And as discussed above, vibration may harm parts of the musculoskeletal system. Glare and the lack of direct lighting can force workers to adopt awkward postures in order to see their work. This can lead to eye, neck and shoulder strain.

Interaction of Factors

Repetition, exertion, posture and vibration can operate independently to cause musculoskeletal injury. But they may also operate in combination with each other or with other environmental factors.

Badly designed work may involve frequent and prolonged repetitive movements combined with exertion from lifting or pressure on tools or using improper lifting procedures. These factors may be further combined with awkward or uncomfortable postures and vibration. In addition, some or all of these combined factors may be at work in an environment of abnormal heat or cold or be aggravated by the effects of bad lighting. Some jobs in construction, forestry and mining may combine all of these risk factors.

b) Assessing Work Design Hazards

Assessing work design hazards requires observation of individual job functions and work processes. When jobs are analyzed this way, factors like repetition, exertion, posture and vibration can be measured. Environmental influences like temperature and lighting can also be taken into account.

To be effective, the assessment should be based on a thorough inspection which includes a careful job hazard analysis and interviews with workers and supervisors.

c) Controlling Work Design Hazards

The control of work design hazards is based on a science called ergonomics. Ergonomics studies the relationship between work and the human body. The aim of ergonomics is to fit the work to the worker. Effective ergonomic design provides work stations, tools and equipment which are comfortable and efficient for the worker.
to use. It also creates a work environment that is healthy, and it reorganizes the work process to control or eliminate hazards.

**The Human Body**

To fit the work to the worker, the capabilities and limitations of the human body have to be considered. Ergonomics borrows from a number of other fields of study for this purpose.

*Anthropometry*, a division of anatomy, provides data about body size and measurements like height, reach and hand size. This information is used to help design work stations, tools and equipment which are better suited to the human anatomy.

*Physiology* is the study of body functions. It helps in evaluating the physical demands of a job. This data helps designers find ways to minimize muscle fatigue, blood pooling and pressure on joints as well as friction on tendons and their protective sheaths.

*Biomechanics* studies the application of force or exertion in work activities like lifting, pushing and pulling. Designers use this knowledge to find ways of getting the work done while minimizing the amount of exertion or stress on the musculoskeletal system.

*Psychology* is the study of human behaviour. Knowledge of psychology can help ensure that equipment controls and displays are not misleading or confusing. It can also influence the design of the general work environment or surroundings.([http://www.accel-team.com/ergonomics/main_01.html](http://www.accel-team.com/ergonomics/main_01.html))
d) **Ergonomics in the Workplace**

![Ergonomically design workplace](http://en.wikipedia.org/wiki/Ergonomics)

**Plate: 11 Ergonomically design workplace**

Fundamentals for the Flexible Workplace Variability and compatibility with desk components, that flex from individual work activities to team settings. Workstations provide supportive ergonomics for task-intensive environments.

Outside of the discipline itself, the term 'ergonomics' is generally used to refer to physical ergonomics as it relates to the workplace (as in for example ergonomic chairs and keyboards). Ergonomics in the workplace has to do largely with the safety of employees, both long and short-term. Ergonomics can help reduce costs by improving safety. This would decrease the money paid out in workers compensation. For example, over five million workers sustain overextension injuries per year. Through ergonomics, workplaces can be designed so that workers do not have to overextend themselves and the manufacturing industry could save billions in workers compensation.

Workplaces may either take the reactive or proactive approach when applying ergonomics practices. Reactive ergonomics is when something needs to be fixed, and corrective action is taken. Proactive ergonomics is the process of seeking areas that could be improved and fixing the issues before they become a large problem. Problems may be fixed through equipment design or task design. Equipment design changes the actual, physical devices used by people. Task design changes what people do with the equipment. Environmental design changes the environment in which people work, but not the physical equipment they use. (http://en.wikipedia.org/wiki/Ergonomics)
e) The Design of Work

The design of work to fit the worker involves the application of common sense and sound engineering principles. The workers who do the jobs and the supervisors who organize and oversee the process know a lot about the design problems of a particular job. They should be consulted for ideas and information that can help in the redesign of work.

Work or job design examines the separate elements that make up the job. The objective is control or elimination of those work factors that cause or contribute to musculoskeletal injuries and other injurious health effects.

Work Station Design

Work stations are the particular places where people work. A work station might be on an assembly line in an auto plant or at a desk in an office. Good design of a work station will eliminate risk factors that might cause musculoskeletal injuries. It is also likely to increase efficiency and productivity.

Since workers come in different sizes and shapes, it’s important that the work station be able to accommodate these differences. A good guide to the principles of work station design is the modern automobile. Auto makers must design the driver’s seat and controls so that any driver can sit in comfort and conveniently operate the controls while maintaining a good view of the road ahead. The design of the driver’s station thus allows the driver to react quickly and safely to changes in road or traffic conditions.

Work station design requires application of the same principles. These can be summarized as designing for extremes and designing for adjustments within the extremes.

Designing for extremes, rather than averages, is a principle observed in many aspects of life. If the doorways in homes and workplaces were designed to fit the average person, those taller are than average would regularly bump their heads. Work stations should be constructed to accommodate extremes of height, reach, and leg length and body shape.

Designing for adjustments allows individuals to adjust elements of the work station across a range between the extremes so that their body features are accommodated
comfortably. Ergonomically designed computer work stations, for instance, have adjustable seats and arm-

rests, tiltable keyboards and movable monitor screens so that any user can adjust the work station for comfort and efficiency.

**Reach and Arm Comfort**

In general, work stations should be designed to permit workers to easily reach any object or control involved in the work, whether it is hand or foot operated. Hand controls are easiest to operate when they are placed between shoulder and waist level. It should not be necessary for the person to work with elbows or arms raised or to hold the arms away from the body or above shoulder height. Armrests may help those who must do delicate assembly work.

Ergonomists have devised guidelines for the placement and height of work surfaces which are most comfortable and efficient. For instance, for fine assembly work done by a standing worker, the work table or work surface should be about 5 to 10 centimeters above the elbow height of the worker. Different distances apply to assembly of medium and heavy components. This means that the position of the worker or of the work surface, or both, should be adjustable to allow for the correct distance for the kind of job being done.

**Chairs**

Every work station should be equipped with a chair or stool, where possible and practicable, even if most of the work is done in a standing position. Chairs give workers a chance to change body positions and reduce fatigue by getting their weight off their feet. In some jobs, like that of the supermarket cashier, the opportunity to sit and stand at intervals while continuing work can greatly ease strain on the legs, arms and back. Adjustable sit/stand stools are best for this purpose.

Attached or separate footrests allow changes in posture and the easing of pressure on the feet. When the chair is not adjustable, footrests can provide support for people with short legs which might otherwise dangle above the floor.
Standing Surfaces

The floor or other surface on which the worker stands at the work station can be equipped with a shock-absorbing pad to minimize pressure on the feet or to reduce the effects of machine vibration which is transmitted through the floor.

Instrument Displays

The instrument displays at work stations should be at or below the eye level of the worker. This means that seat height should be adjustable and that displays should be readable without the person having to bend or stretch.

Space

Work areas should not be cramped or crowded. People need sufficient room so that they can vary their body postures to relieve strain on particular muscles.

f) Work Environment Design

A properly designed workplace takes environmental factors into account. The environment includes temperature and humidity, lighting, air quality and vibration.

Temperature and Humidity

The workplace atmosphere should be designed to maintain comfortable levels of temperature and humidity. For instance, cold is a well-known contributor to vibration-induced white finger disease. In addition, excessive dryness or dampness, cold or heat produces discomfort. Discomfort tends to impair a person’s concentration and accuracy, and this in turn can reduce attention to safe work practices. It also reduces the individual’s work efficiency.

Some workplaces require abnormal conditions of temperature or humidity. For example, the molding of clay to make bathroom fixtures requires a humid atmosphere. Design features in such cases may include air-conditioned control rooms for operators.

Outdoor work can involve extremes of both temperature and humidity depending on the season. Protective clothing and indoor rest breaks may be necessary in such cases.
Ventilation

The circulation of fresh, clean air in the indoor workplace helps to ensure healthy working conditions. Stale air may cause discomfort. The placement of walls and room dividers should not restrict the flow of fresh air. Ventilation should circulate the air in the workplace without blowing it directly on those who work there.

Lighting

Lighting levels should be appropriate to the job. Every worker should have a clear view of the work. No one should be forced to bend and peer to make up for poor lighting. Intricate assembly requires more light than more general work. Special adjustable task lamps may be required to light some work, like technical drawing or woodworking.

Glare from computer screens can be adjusted by lighting and/or by the use of non-glare displays or by the installation of shields. In addition, proper positioning of computer work stations can reduce glare and reflection from windows and other reflecting surfaces.

Vibration

Vibration in the workplace environment can increase strain as muscles try to compensate. Where the vibration is caused by machinery, the source machines can be equipped with shock absorbing mounts. Shock absorbent floor coverings at work stations and shock absorbent footwear and gloves are less effective alternatives. (http://www.accel-team.com/ergonomics/main_01.html)

g) Physical Hazards At Workplace

1) Heat

Heat can be more than uncomfortable. It can be dangerous and even deadly. Summer weather is a common cause of heat problems. Workers are also exposed to heat in boiler rooms, laundry facilities, confined spaces, and during welding or brazing. Too much heat can cause a number of health problems.
Health effects

Being exposed to heat can cause:

- **Heat rash** is also known as prickly heat.

- **Heat cramps** are painful muscle spasms. The cramps usually are felt in the arms, legs and stomach area. They usually occur after sweating heavily and not drinking enough liquids.

- **Heat exhaustion** symptoms include tiredness, dizziness, clammy skin, heavy sweating, loss of appetite, nausea and pain in the stomach area. These symptoms are brought on when the body loses too much fluid (dehydration) during hard physical labour.

- **Heat Stroke**

  - The body can no longer cool itself. The person’s skin becomes hot and red or blotchy, and their body temperature is as high as 105 degrees or more. Heat stroke can cause a person to lose consciousness and go into a coma.

**HEAT STROKE CAN KILL.** Heat stroke is a condition that needs immediate medical attention.

*Other effects* of exposure include heart disease. Workers also become less alert and are more likely to injure themselves or others.

**Measuring heat hazards**

Knowing the temperature is only part of figuring out if it is too hot. The effects of heat increase when it is humid or when there is no breeze. A Wet Bulb Globe Temperature device gives a reading based on heat, humidity and wind speed, and provides a more accurate measure of the effects of heat on the body.

**Controlling heat hazards**

**Engineering controls**

*Ventilation and air conditioning:* Air conditioning can eliminate heat hazards in buildings and vehicles. Areas with machines such as ovens, dryers and other equipment that cause heat need exhaust systems to remove the extra heat that is produced.
Work practices (administrative controls)

The following changes can protect workers from heat:

- **Scheduling:** Do the hottest work during early morning, evening or night hours, or on cooler days.
- **Job rotation:** Divide heavy and hot work among more workers.
- **Breaks:** Take breaks preferably in an air-conditioned area or at least a shady place.
- **Drink fluids:** Replace the fluids that are lost through sweating. **AVOID DRINKS THAT CONTAIN CAFFEINE AND ALCOHOL!** Caffeine and alcohol make you lose more fluids.
- **Get used to heat gradually:** Workers need a chance to get used to heat (acclimatization). At first, work in hot environments should be limited to short periods. The amount of time that workers spend in the heat should be increased gradually.

Personal protective equipment

Light-colored clothing should be worn. Cooling vests provide some protection for jobs like highway repair and working on boilers and in steam tunnels.

Laws

There are no OSHA standards that limit the amount of heat exposure to workers. (The state of Minnesota has a heat standard for indoors.) OSHA can, however, rule that an employer has violated its “general duty” to provide a safe workplace if heat is excessive.

2) Cold

Health effects

- **Frostbite:** As the body tries to prevent heat loss, less blood reaches the surface. Hands and feet become numb and the skin freezes. Severe frostbite may require amputating the affected parts.

  **WARNING!!!** Do not rub frost-bitten areas. Warm the area by soaking or running under cool or lukewarm water.
• **Hypothermia**: This is a condition that results from being in cold weather or submerged in cold water. The body can no longer create heat, causing dizziness, fatigue, and can lead to unconsciousness and death.

• **Trench foot**: Long periods of exposure to wet and cold conditions can cause severe nerve and muscle damage in the feet.

• **Eye injuries**: Workers can become snow-blind and the cold can cause the cornea to freeze.

**Controlling cold hazards**

The following steps can protect workers from the cold.

• Give workers frequent rest periods in a warm area.

• Provide clothing designed to keep cold and wind out and allow heat and perspiration to escape. The body loses heat quickly when clothes are wet.

• Workers should wear layers of vented clothing, and insulated gloves and footwear.

• Where possible, build barriers around the worksite to block the wind.

• Supply workers with warm beverages that do not contain caffeine or alcohol.

• Keep vehicles in good running order. Workers can be exposed to extreme cold for long periods if they get stranded in vehicles that break down.

3) **Noise**

Too much noise can damage hearing. Continuous or periodic noise can be harmful.

**Health effects**

• **Temporary hearing loss**: This may last for minutes, hours or days. Normal hearing does return.

• **Permanent hearing loss**: This usually develops gradually from being exposed to high levels of noise over a long period of time.

• **Other effects**: Noise can cause fatigue, nervousness and increased blood pressure, which can lead to problems such as heart disease.
Finding noise hazards

You do not need fancy equipment to know if you are exposed to noisy conditions. Your hearing may be affected if:

- it is too noisy to hear your co-workers at arms-length;
- you have to turn the volume up on the TV or radio;
- you get a ringing in your ears after working in noisy areas; and/or
- family, friends and co-workers notice that you have more trouble hearing them.

Measuring sound

The level of sound is measured in units called decibels. The abbreviation for decibels is dB. On the decibel scale, each time the number of decibels goes up by three, the level of the noise is doubled. In other words, 93 decibels is a noise that is twice as loud as a sound that is 90 decibels. Examples of common noises and their decibel levels are shown in the chart below.

<table>
<thead>
<tr>
<th>Sound</th>
<th>Decibel Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whisper at 5 feet</td>
<td>25</td>
</tr>
<tr>
<td>Quiet office</td>
<td>40</td>
</tr>
<tr>
<td>Conversation</td>
<td>60</td>
</tr>
<tr>
<td>Printing press</td>
<td>80</td>
</tr>
<tr>
<td>Heavy city street traffic</td>
<td>90</td>
</tr>
<tr>
<td>Jackhammer</td>
<td>102-111</td>
</tr>
<tr>
<td>Gunshot</td>
<td>140</td>
</tr>
</tbody>
</table>
Controlling noise hazards

Substitution

Use equipment that makes less noise.

Engineering controls

Noisy machinery can be enclosed, isolated or rigged with equipment to muffle sound. Acoustical building materials and carpeting absorb sound indoors.

Work practices (administrative controls)

- Rotate jobs to reduce the amount of time workers are exposed to noise.
- Move workers away from noise.
- Keep equipment lubricated and in good working order.

Personal protective equipment

Plate :12 Ear Plugs

There are different types of hearing protection that workers can wear. See Figure 1. Ear plugs are worn in the ear and must fit the worker’s ear. They should only be worn in healthy ears. Foam plugs should be soft and springy. They must be compressed so they can expand after inserting in the ear.

The other common type of hearing protection are earmuffs that are worn outside the ear.
Earmuffs require a good seal to be effective.

**WARNING!!!** Ear plugs or muffs make it difficult to hear warnings from co-workers, alarms or other warning signals. You should be able to hear alarms when wearing protection.

**Laws (OSHA standard - 29 CFR 1910.95)**

The OSHA noise standard limits the amount of exposure to noise to 90 decibels averaged over an 8-hour day. This means the louder the noise, the less time workers can be exposed. The chart below shows the amount of time that workers can be exposed to different decibel levels of noise.

**Table: 5 OSHA Noise Limits**

<table>
<thead>
<tr>
<th>Hours Per Day of Exposure</th>
<th>Decibels (dB) Allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>90</td>
</tr>
<tr>
<td>6</td>
<td>92</td>
</tr>
<tr>
<td>4</td>
<td>95</td>
</tr>
<tr>
<td>3</td>
<td>97</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>1 1/2</td>
<td>102</td>
</tr>
<tr>
<td>1</td>
<td>105</td>
</tr>
<tr>
<td>1/2</td>
<td>110</td>
</tr>
<tr>
<td>1/4 or less</td>
<td>115</td>
</tr>
</tbody>
</table>

**WARNING!!!** Legal does not always mean safe!!! Hearing damage can begin at levels as low as 80 dB over an 8-hour day. Just as with chemical exposure limits, you can suffer from harm even when your employer is obeying the law.

All work areas that might be over 85 dB must be measured for noise. If noise levels are above 90 dB, the employer must take steps to bring down noise levels. The employer must try to reduce noise below 90 dB before relying on ear plugs or other personal equipment.

If exposure to noise averages above 85 dB for a shift, the employer must have a hearing conservation program. This includes providing employees with hearing tests and hearing protection.
4) Ionizing Radiation

Radiation is physical energy that moves in a wave-like motion. X-rays, the light we can see from the sun or a light bulb, microwaves, and radio waves are all forms of radiation. Figure 2 shows the wavelike motion of radiation. The distance from the top of one wave to the top of the next wave is the wavelength. The frequency is the number of waves that pass each second, or cycles. Frequency, or the number of cycles, is measured in units called Hertz (Hz). One Hz is equal to one cycle per second.

Common types of radiation are shown in Figure 2. The differences can be compared to the display on a radio. The frequencies of different types of radiation are shown from highest to lowest. As shown in Figure 2, radiation is divided into two kinds, ionizing and non-ionizing.

Ionizing radiation

Ionizing radiation is strong enough to change the structure of atoms. X-rays are the best-known type of ionizing radiation.
Health effects of ionizing radiation

Exposure to ionizing radiation can be serious or even deadly. The type of effect depends on the strength of the radiation, the length of exposure, and the part of the body exposed. The main health effects include:

- **cancer** of the skin, breast, lung, digestive organs, blood (leukemia) and other sites;
- **infertility** due to changes in the genes and chromosomes in men or women;
- **birth defects**; and
- **radiation sickness**, a short-term effect that includes loss of appetite and nausea.

Finding sources of ionizing radiation at work

Workers should be informed about all equipment that use X-rays and other forms of ionizing radiation. In addition to training, workers should be aware of radiation hazards through:

- **labeling and warning signs**;
- **monitors** that measure the amount of radiation being emitted by equipment; and/or
- **radiation badges** worn by workers to measure each employee’s exposure.

Worker exposure to ionizing radiation (X-ray, alpha and beta particles) is measured in units called Rems. “Rem” stands for “Roentgen Equivalent Man.”

### Table: 6 Ionizing Radiation in the Workplace

<table>
<thead>
<tr>
<th>Type of Radiation</th>
<th>Source of Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-ray</td>
<td>X-ray machines in medical and dental settings; XRF lead-based paint detectors; machines to check welds</td>
</tr>
<tr>
<td>Beta and Alpha</td>
<td>medical implants; nuclear reactors</td>
</tr>
</tbody>
</table>

Preventing exposure to ionizing radiation

**Engineering controls**

- Properly shield and maintain equipment that uses radiation.
- Isolate radioactive equipment in restricted access areas.
• Install switches to turn on equipment from another room.

**Work practices**

• Move workers as far away from radiation sources as possible. The strength and, therefore, the danger of radiation decreases as workers move away from radiation.

• Workers should not hold patients during X-rays. Use film holders. If a child needs to be held, a family member should do it.

• Identify patients with radioactive implants.

• Wear badges to measure exposure to radiation.

*Pregnant Workers Should Not Be Exposed To Radiation. They Should Be Transferred To Other Jobs Without Loss Of Pay, Seniority Or Other Rights Or Benefits!!*

**Personal protective equipment**

Wear aprons and gloves that shield radiation.

**Radiation standards**

OSHA’s Standard for ionizing radiation is 29 CFR 1910.1096.

**5) Non-Ionizing Radiation**

**Non-ionizing radiation**

Non-ionizing radiation is not as strong as ionizing radiation. However, non-ionizing radiation can have serious health effects.

**Preventing exposure to non-ionizing radiation**

• Properly shield and maintain equipment that gives off non-ionizing radiation.

• Move workers away from sources of radiation.

• Wear glasses with UVR filter lenses.

• Cover skin or use sunscreen when working outdoors.
Very low frequency (VLF), extremely low frequency (ELF), and electric and magnetic fields (EMFs)

Very low frequency and extremely low frequency electromagnetic fields are also forms of non-ionizing radiation. Power lines, electrical wiring and electrical equipment such as computers produce these types of EMFs.

Researchers have been studying many different occupations and types of electric equipment to see what the risks might be. For example, studies have been done to see if those who work around power lines have increased rates of leukemia, brain or other cancers. There has also been concern that working all day with computers may cause miscarriages or birth defects. The evidence at this time does not show that radiation from video display terminals causes reproductive problems. Unfortunately, questions about the health effects of EMFs have not been fully answered. More research is needed on the health risks of EMFs.

<table>
<thead>
<tr>
<th>Type of Radiation</th>
<th>Sources of Exposure</th>
<th>Health Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultraviolet Radiation (UVR) (low intensity)</td>
<td>sunlight and artificial light from fluorescent and incandescent bulbs</td>
<td>sunburn, skin cancer, cataracts</td>
</tr>
<tr>
<td>Ultraviolet Radiation (UVR) (high intensity)</td>
<td>welding</td>
<td>damage to eye (&quot;welder's flash&quot;)</td>
</tr>
<tr>
<td>Infrared Radiation (IRR)</td>
<td>foundries</td>
<td>cataracts</td>
</tr>
<tr>
<td>Microwave/radio</td>
<td>microwave equipment and telecommunication equipment immune disorders</td>
<td>immune disorders cataracts, can interfere with pacemakers and other medical devices</td>
</tr>
<tr>
<td>Laser</td>
<td>laser equipment</td>
<td>damage to eyes and skin</td>
</tr>
</tbody>
</table>

Protecting workers from EMFs

Workers should not be treated like guinea pigs. Efforts should be made to reduce exposure to EMFs until more research answers questions about health risks. A policy of “prudent avoidance” means avoiding exposure to EMFs because the risks are unknown. Exposure to EMFs can be reduced by:
• shielding and grounding electrical equipment; and/or
• moving people away from equipment and sources of EMF. For example, the source of EMFs in a VDT is the flyback transformer located in the back of the monitor. The radiation is strongest in the back and side of the monitor. Computer operators should be at least four feet away from the back or sides of other workers’ machines.

6) Electricity (Internal Links)

Electricity can kill. The danger can strike in the form of lightning, contact with power lines or current from equipment that uses electricity.

Electricity travels in circuits. An electric shock occurs when a person becomes part of the electric circuit that the electricity is moving through. The seriousness of the shock a person receives depends on the amount of current (amperes), the path of the current through the body and how long the exposure lasts.

**WARNING!!!** Low voltage does **NOT** imply low hazard!

A health and safety program should include work practices to prevent shocks and electrocution. Safety measures include:

• having only qualified workers install and maintain electrical systems;
• using proper electrical outlets instead of overloading extension cords;
• not allowing electrical cords to come into contact with water;
• using ground fault circuit interrupters (GFCI) where electrical equipment and cords may come into contact with water. The GFCI cuts the circuit before the electricity reaches the worker.
• properly grounding electrical equipment;
• keeping a safe distance from overhead power lines;
• locating underground utility wires before digging; and
• finding shelter during rainstorms when there is lightning and thunder.
Related Studies on design of workplace and work environment:

A study on “Occupational Health Problems of Dyeing and Printing Workers” carried out by Parimalam et.al. [2008], In India around 38.1 million people are involved in the textile industry, which is a dye dominant industry. Dyeing and Printing is an age old process and forms an integral part of every textile industry giving employment to millions of people. The study was taken up in Madurai district which is situated in the southern Tamil Nadu. One hundred and forty two workers employed in 23 small scales dyeing and printing units participated in the study. An interview schedule was prepared in English but was communicated to them in their local dialect [Tamil]. The mean age of fabric dyers and printers was 42 years (±10.7). Majority of the workers [93 percent] were male and rest [7 percent] were female. Majority [91 percent] of the workers were engaged to work from 8 to 10 hours per day during regular days. Shoulder pain was experienced by almost every worker who was involved in dyeing activities. Upper and lower arm severe discomfort was reported by 48 percent and 47 percent workers respectively. Severe neck discomfort was also reported complaint by workers who were engaged as dyeing workers. Other problems reported by diabetes, blood pressure and asthma.

Lohsoonthorn, (2001), "From August 1999 to June 2000, a cross-sectional analytic study was conducted in health check up clients to compare body mass index (BMI) and health risks data derived by measuring height, weight, and blood pressure, recording physical and laboratory outcome, and interviewing health characteristics". Data were analyzed for the relationships between BMI and lipids, and fasting blood sugar, and serum glutamate-pyruvate transaminase, and hemoglobin, and hypertension and other health risks and test for association by Chi-square test. The results showed that 1350 health checkup clients were 25.8 per cent overweight and 7.3 per cent were obese. There was a gradient relationship of abnormal cholesterol levels (>300 mg%) and levels of BMI. The abnormal triglyceride levels (>300 mg%) were higher in obesity than normal BMI (9.1% vs 1.6%). Hyperglycemia in
obesity was higher than that of normal BMI (30.3% vs 11.6%). The percentage of two-fold abnormal SGPT levels (>76 units/L) in obesity (9.1%) was higher than that of normal BMI (2.8%). The percentage of anemia in underweight (28.3%) was higher than that of normal BMI (24.3%). Normal blood pressure in normal BMI (94.2%) was higher than that of obesity (69.7%).

Baruah [2008], studied the knowledge of physiological responses resulting from the unnatural body postures at work. Physiological workload is of great practical value to provide comfort and promote health and well-being of the workers in any occupational categories. The handloom industry of Assam is highly labour intensive and engages 90 percent women workers. Many of the activities performed by women workers engaged in the handloom industry demand a high degree of physical effort leading to fatigue, reducing their productivity. In study efforts were made to collect the ergonomic data on physiological parameters in terms of total cardiac cost of work [TCCW] and energy expenditure [EE] of the workers doing various activities. The angle of deviation from posture was also studied. Bad working postures and resulted in the occurrence of low back pain which was quite high [85 percent]. Further analyses of data revealed that 60.83 percent workers faced acute incidence of musculoskeletal problems where as 16.67 percent reported the musculoskeletal syndromes perceived as very acute which only 22.50 percent workers reported negligible.

Ara & Gangopadhyay [2008], a study was conducted to identify the work related health problems of workers engaged in footwear industries of Kolkata. A detailed modified Nordic Questionnaire on discomfort feeling was performed on 50 male workers of footwear industries, from the questionnaire study it was revealed that most of the workers were suffering from discomfort feeling 98 percent, 90 percent of the workers said they didn’t have any previous history of diseases. Accidental fundamentals of the questionnaire it was observed that most of the workers had met with accident [88 percent] during work, activity being cutting [76 percent], parts affected hand [50 percent] and finger [38 percent], the type of accident was cut [76 percent]. They said their work required them to sit [100 percent] and stoop [100 percent] for a prolong period of time. 96 percent felt discomfort during work. 82
percent of workers said that their hand were maximum involved on the specific operation. The physiological and environmental parameters also were playing a contributing for their suffering.

Muzammil, et.al, [2008], carried out study aimed at establishing the effect of noise and illumination on workers of different age groups performing an assembly task in a lock manufacturing industry. Experiments were carried out in a simulated industrial environment. The independent variables used for investigation were equivalent noise levels [at 3 levels: 80,90 and 100 dB (A)], illumination level [ at 3 levels: 400, 600 and 800 Lux.] and [at 3 levels: 18-22, 23-27,28-32 years. The subjects were asked to perform the task for a period of 40 minutes. The number of assembled units produced was taken as a measure of performance. The results showed that the main effect of equivalent noise level, illumination level and age were having a statistical significant effect in the kind of task undertaken in study. Further, the interactive effect of levels of equivalent noise and illumination was also observed to be significant.

Singhal, et.al, (2004), Environmental noise is a known stress which induces alteration of various physiological responses in individuals exposed to it. Present study was undertaken to assess the effects of industrial noise on hearing and cardiac vascular system of lock factory workers 114 subjects working in different section of lock factory i.e. power press, lathe machine, grinder unit and hand press unit were under taken. The data was analysed using STUDENT t-TEST, the result indicate that there is a increase in systolic BP, Diastolic BP, mean BP, in some section of lock factory and also hearing loss was present maximum number of cases in power press unit.

Verma, (1970), compared four different types of seats having suspensions of solid rubber, double leaf spring, single leaf spring and parallelogram linkage supported on helical coil spring and shock absorber. He observed that the seat with helical coil spring and shock absorber was having minimum value of transmissibility in these case was 1.21 and it occurred at frequency of 1.9 Hz.

Vibration studies were carried out at TNAU, Coimbatore (TNAU 2002), on tractors and power tillers. The whole body vibration and hand arm vibration transmitted to the operator ranged 1.36-3.77 m/s² and 0.54-3.48 m/s², respectively on the tractor. The hand transmitted vibration ranged 3.66-5.26 m/s² on walking type power tillers. The
whole body vibration measured on the tested power tillers with seat observed from 0.63-1.21 m/s².

Mehta, et.al, (2000), quantified ride vibration of low horse power tractor implemented systems. They observed that the acceleration levels increased as forward speed of travel increased most of the operating conditions. It was concluded that the exposure time for the tractor operator should not exceed 2.5 h during ploughing and harrowing operations. Increasing exposure time may cause severe discomfort, pain and injury.

Sharma and Shyam, (1993), reported that noise level of 31 percent of the new tractors tested at Central Farm Machinery Training and Testing institute [CFMTTI], Budni met the BIS requirement at operator’s ear level. The noise levels measured on the different makes of tractors ranged between 90-100 dB(A), which were above the safe limit for 8 h work exposure [Gupta, 1978].

Datar (2003), carried out a study on work posture analysis and musculoskeletal problems experienced by the students of Architecture Profession. Majority of the students experienced pain when working at college. They experienced pain in all the parts of the body which was also experienced by the respondents of the present study and the results were in the line with the present study. The reason for the similarity in result may be improper dimensions of furniture and work area used for the work in both the studies.

Dogra, (1996), carried out an audiometric evaluation of 200 farm machinery operations and observed and increase in threshold of hearing at 4 kHz. He observed higher hearing loss in the workers having increased duration of exposure to noise.

Pawar, (1979), reported that noise levels in power tiller varied from 86-94 dB (A) and concluded that continued exposure for more than 5 h may cause hearing damage to the operator.

Tandon, (1991), conducted studies to determine the noise level of the brush cutter. The multi-function-brush cutter was operated at speeds ranging from 2600 to 8200 rpm and the noise levels were found to increase with speed, average values varying between 70.0 and 92.9 dB(A) respectively. At speeds exceeding 7000 rpm, the noise levels were found to be more than recommended 8 h safe exposure levels. He concluded that the noise level of approximately 2 dB (A) above the recommended
safe limit could easily be reduced by providing an enclosure around the engine or by wearing ear defenders.

Turner, et.al, (1989), carried out epidemiological studies and has found that high prevalence rates of back pain sitting posture.

Mandal, (1994), suggest that a sited person has a hip joint flexion of about 60 degree and the pelvis has a slopping axis so that the lumber region than exhibits a convexity or kyphosis.

Feldman, et.al, (1983), & Cosletl and Bishop, (1976), prolonged awkward postures of the lower body may cause pain, discomfort and injury to the legs and feet, including compression injuries to nerves. Studies of workers from a variety of Industries have shown that prolonged or repeated use of a foot pedal while standing, or prolonged kneeling and squatting contributes to elevated rates of discomfort and injury in the lower body.

Pheasant, (1991), conducted a study which revealed that injury at back by bending down to pick up a pencil Biomechanical calculations show that when the trunk is inclined forward to a horizontal position, the loading on the base of the spine is the same as the loading that results from lifting a compact 30 kg weight close to the body. So if for one reason or another the back is at all vulnerable to injury there may be no spare capacity for actually lifting an external load, over and above the weight of the body itself.

A study was conducted by Singh & Sharma, (2000), on load carrying activities and body posture adopted. It was reported that while transporting manure most of the workers adopted erect standing posture, for milling grains standing posture, while delivering vegetables erect standing, in fetching of fuel bending posture/standing posture, storing of grain squatting posture, transporting of grain erect standing posture, transporting of crops, crops residue erect standing and standing cum bending posture. Workers in food processing unit experienced lot of postural stress, the reason was that the technologies used by them were not ergonomically designed.

Lingam, (1998), stated that there is need to identify areas of women’s work which require close examination in terms of work environment, posture at work and nature of work. Women workers suffer from musculoskeletal problems due to their posture.
at work and the kind of implements they use, and the working environment in which they work.

Choobineh, et. al., (2007), studied Musculoskeletal Problems in Iranian Hand-woven Carpet Industry: Guidelines for Workstation Design Long hours of static work with awkward posture at traditionally designed looms can cause high prevalence of musculoskeletal disorders (MSDs) among carpet weavers. A comprehensive study was conducted in this industry with the objectives of determination of MSDs symptoms prevalence; identification of major factors associated with MSDs symptoms in carpet weaving occupation; and development of guidelines for weaving workstation design. In the present paper, this ergonomics study is presented.

The study consisted of two phases. In the first phase, MSDs symptoms in nine Iranian provinces were surveyed by questionnaire among 1439 randomly selected weavers. Working posture and weaving workstations were ergonomically assessed as well. The results of this phase revealed that symptoms from the musculoskeletal system occurred in high rate among weavers with the prevalence significantly higher than that of the general Iranian population (P<0.001). It was found that the majority of ergonomics shortcomings originated from ill-designed weaving workstation. Based on the findings, some general guidelines for workstation design were presented. In the second phase, considering the general guidelines, an adjustable workstation was designed and constructed. To develop quantitative guidelines for optimizing workstation set-up, in the laboratory, nine sets of experimental conditions were tested, and working posture and weavers’ perceptions were measured. The results of this lab work showed that working posture was acceptable for both the researchers and the weavers when the weaving height was adjusted 20 cm above the elbow height and a high seat with forward slope was used.

By combining the results of the two phases, guidelines for weaving workstation design were presented. In this ergonomics-oriented workstation, loom is vertical. Seat, loom and weaving heights are adjustable. There is enough leg room under the loom. The seat with 10° forward slope is adjusted 15 cm above the popliteal height of the weaver. Weaving height is set at 20 cm above the elbow height. It is believed that the recommended workstation improves working posture and results in reduced postural stress on weavers’ bodies and, consequently, reduced prevalence of MSDs symptoms.
Woods and Buckle (2005), “An Investigation into the Design and Use of Workplace Cleaning Equipment” This paper presents the findings from a 2 year investigation into the musculoskeletal health of UK cleaners and focuses on the potential association of these problems with the design and use of cleaning equipment. The five-stage study employed a participative approach using a number of different methodologies to explore the use and design of commonly used cleaning equipment. The methodologies included: questionnaire studies, workplace assessments, an ergonomics assessment of cleaning equipment, a user trial of this equipment in the laboratory and focus groups with interested parties. Based on the findings of the study, previous research work (e.g. Report from Kilpatrick and Associates PTY LTD for Miscellaneous Workers’ Union, 1991) and the use of ergonomic guidelines (e.g. Int. J. Ind. Ergonom. 10 (1992) 7), modifications were recommended for the design of buffing machines (e.g. machine height, design of triggers/grips/levers, pressure to activate controls), mopping systems (e.g. mop length, pressure required to squeeze mop, bucket stability) and vacuum machines (e.g. attachment length, grip design, provision of safety lights). A checklist was also compiled to aid in the purchase of new workplace equipment. This paper concentrates on equipment and postures adopted when in use. It is acknowledged that this represents only one aspect of the work system that influences musculoskeletal health. Inadequate work organisation, task scheduling and social support are also associated with an increased risk for musculoskeletal problems among UK cleaners (Musculoskeletal Health of Cleaners, HSE Books, Suffolk, 1999). Relevance to industry Cleaning is a basic service occupation conducted by many world-wide. Researchers, manufacturers and designers should work with user groups to improve equipment to ensure good musculoskeletal health, working posture and technique. Cleaning managers, trainers and purchasers should be aware of ergonomic guidelines for equipment selection for safe use at work.

Dieen and Jaap (1992). Carried out a study on “Evaluation of work-rest schedules with respect to the effects of postural workload in standing work. ”The influence of four work-rest schedules (60-min shift-15-min break, 45-15, 30-15, 30-30) on acute effects of physical workload in the back and legs due to standing work was investigated in 12 poultry inspectors. Subjective discomfort in the legs and back, and swelling in the distal lower leg were significantly affected, with the 60-15 schedule leading to a higher postural load as compared with the other schedules. No effect on
spinal shrinkage was found. It was concluded that the 60-15 schedule should be avoided. An optimal work-rest schedule considering visco-elastic deformation of the spine would probably involve frequent short breaks, whereas longer breaks would seem more effective considering leg swelling.

Nag, Desai and Nag. (1992) studied “Work stress of women in sewing machine operation”. The study examined the work stresses of 107 women who were engaged in sewing machine operation in small garment manufacturing units. Of the three types of sewing machines (motor-operated, full and half shuttle foot-operated), 74% of the machines were foot-operated, where throttle action of the lower limb is required to move the shuttle of the machine. The motor-operated machines were faster than the foot-operated machines. The short cycle sewing work involves repetitive action of hand and feet. The women had to maintain a constant seated position on a stool without backrest and the body inclined forward. Long-term sewing work had a cumulative load on the musculo-skeletal structures, including the vertebral column and reflected in the form of high prevalence of discomfort and pain in different body parts. About 68% of the women complained of back pain, among whom 35% reported a persistent low back pain. Common sewing work accident is piercing of the needle through the fingers, particularly the right forefingers. Unsatisfactory man-machine incompatibility, work posture and fatigue, improper coordination of eye, leg and hand are the major problems of the operators. The design mis-match of the workplace may be significantly improved by taking women’s anthropometric dimensions in modifying the workplace, i.e. the seat surface, seat height, work height, backrest, etc.

Ayoub, (1990) Ergonomic deficiencies: I. Pain at work. This was Part I of a three-part series that examined various aspects of ergonomic deficiencies at work. The paper dealt with pain at work and the association between such pain or discomfort and a poorly designed workplace or poorly structured job. Neglect of ergonomic principles brought inefficiency and pain to the workplace. An ergonomically deficient workplace may not cause immediate pain, because the human body has a great capacity for adapting to a poorly designed workplace or structured job. However, in time, the compounding effect of job and/or workplace deficiencies will surpass the
body’s coping mechanisms, causing the inevitable: physical symptoms, emotional stress, low productivity, and poor quality of work.

Yamazaki, (1992), carried out analysis of sitting comfortability of driver’s seat by contact shape. In order to evaluate sitting comfort qualitatively, a flexible and very thin sensor was developed to measure the contact shape between a seated man and the seat surface. Each tape has twenty strain gauges on it at regular intervals, and the fourteen tape sensors were arranged on the bottom and back surface of the experimental driver’s seat. The contact shapes and postures in thirty two male drivers were measured with two types of seat cushion and sitting posture: free and recommended. Sensory evaluation was made for each experimental condition. The results of the interrelation between the characteristics of the surface deformation, the parameters of body build, sitting posture and feeling of comfort shows that the comfort of each morphological fitting does not correspond to one special and single parameter from those physical factors, but is represented by a function with many parameters related to the deformation, posture and body build. By using these relations, a sensory model for the prediction of the sitting comfort was constructed.

Stuebbe, et. al., (2002), carried out a field study on the relationships between biomechanical and postural stresses, musculoskeletal injury rates, and perceived body discomfort experienced by industrial workers. A combination of archival, subjective, and observational field data collection methods were used to investigate the relationship between biomechanical and postural stresses, and the resulting physical strain experienced by industrial workers of a packaging plant. Assessment of physical strain was based on the number and incidence rate of Occupational Safety and Health Administration (OSHA)-reportable injuries that were recorded over a period of 27 months, and based on the self-reported ratings of perceived body discomfort. Both the biomechanical and postural stresses correlated with the musculoskeletal injury rate. The results illustrate the usefulness of postural and biomechanical analyses for assessing the risk of injury in industry.

Jekayinfa, et. al., (2008), carried out a study Ergonomic evaluation and energy requirements of bread-baking operations in south western Nigeria. Purpose – In Nigeria, local fabricators of agro-processing equipment have designed and manufactured various improvised versions of imported bread-baking machines
without due ergonomic considerations. Also, most of the processes of bread baking in Nigeria largely involve manual materials handling, which continues to represent a major loss source in the work place. The manual operations besides being uncomfortable are characterized by low output and unhygienic products. A study was therefore conducted in three south western states of Nigeria with the purpose of evaluating the energy requirements and man-machine relationships in bread-baking operations. The study, which lasted over one year, involved the use of three fuel sources namely, firewood, electricity and cooking gas during bread baking operations. Questionnaire and physical measurements were employed for data collection from 50 bakeries randomly selected within the study area. The data points include the environmental and body temperatures, anthropometrical data, bio data, injury data, metabolic and production measurements.

Findings – The results of the study revealed that bread-baking with wood as energy source required the highest energy (6.15?kJ/min) compared with 3.37?kJ/min and 1.52?kJ/min obtained with gas and electricity as sources of energy, respectively. The cost of energy per kg of baked bread was 7.58 with cooking gas followed by 6.05 for electricity and 5.05 for wood in that order. The average baking rate (BR) using firewood, gas and electricity as energy sources were, respectively, 11.92, 17.97 and 20.58?kg/h. Analysis of metabolic data showed moderate (not to a lethal level) increase in the subjects’ body temperatures, blood pressures and heart rates after bread-baking operations.

Originality/value – The study suggests that bread-baking operations could be categorized as a light grade work and that the use of electricity as energy source is the most appropriate in terms of bread-BR and unit energy requirement.

Patel M. and Parikh A.,(2009) carried out a study on “ergonomic assessment at the hospital” The computer operators and material handlers were facing ergonomic problem while performing the work at workplace. On carrying out the ergonomics assessment for the office work station using the self assessment checklist, it was found that eye level with the computer top level was not maintained and key board was placed too high resulting in health problems such as neck pain. Rapid Entire Body Assessment (REBA) tool was used to carry out the ergonomic assessment of the
material handlers. The REBA action level score obtained was 11, which is very high risk level and requires immediate action to be taken for correction.

Stoia, M. and Oancea S. (2008) carried out a study on “Occupational risk assessment in a bakery unit from the district of Sibiu” as quality standards in food industry focus on food safety and security, health and security at work continues not to be optimally administrated by a rigorous risk management, this industry being considered light industry. In the present paper we emphasized on the importance of occupational risk assessment in exposed workers from a significant bakery unit of Sibiu. Quantitative determination of risk factors showed high values for temperature (28.7°C) and flour dust (2.32 mg/m3) in the workplace atmosphere. The physical overstressing on locomotion consists in reiterative movements and orthostatic preponderant work, while the three shifts/day working time represents the peculiarity in this industrial sector. We conclude that these employees (bakers, pastry workers) are exposed to significant occupational risks. There is limited data in national statistics of a certain occupational or occupation related pathology in this field.

Riihimaki, et. al., (1989), studied “Low-back pain and occupation”. A cross-sectional questionnaire study of men in machine operating, dynamic physical work, and sedentary work”,

The frequency of sciatic pain, lumbago, and nonspecific low-back pain (LBP) and factors related to these symptoms were determined among men occupied in machine operating (541 longshoremen and 311 earthmover operators), dynamic physical work (696 carpenters), and sedentary work (674 municipal office workers). Sciatic pain was more common among machine operators and carpenters than among office workers, and also more frequent among machine operators than among carpenters. The occupational differences were considerably smaller with regard to lumbago and nonspecific LBP. In multivariate analysis, occupation, age, reported back accidents, and postural load showed significant independent effects on the occurrence of sciatic pain. Allowing for other risk indicators, the relative risk was 1.3 contrasting machine operators with both office workers and carpenters, but carpenters had no excess risk as compared with office workers.
2.6 Conclusion

The review of existing literature covers various topics, namely work posture, back pain in organised sectors like fish processing company, call centre operators, dental professions, dyeing and printing workers, footwear industries, lock manufacturing companies etc.

After reviewing the extensive literature it was found that although many researches has been conducted on occupational health hazards faced by workers of organised sectors, there is dearth of information on occupational health hazards faced by workers of unorganised sectors in terms of postures adopted, workplace and working environment. It was also noted that there were no studies conducted on food units in India.

Therefore a need was felt to conduct a study on an ergonomic assessment of selected activities carried out in unorganised food units to find out the postures they adopt, their working environment, their work practices and suggest remedies to increase safety at workplace.