CHAPTER CONTENTS

5

Ergonomic factors

> We have evidence that the more risk factors combined in the same job, affecting the same tissues, the greater the risk of WMSD. We have evidence the longer the duration to the exposure the greater the risk of a WMSD. We have evidence that reducing the physical and psychosocial risk factors decreases the severity, and may also decrease the incidence of WMSD.
>
> Silverstein (1995)[1]

Injuries are usually caused by physical loading of some sort – actions initiated by muscles, using bones and tendons as levers, articulated at joints. The loading can be very short and intense, cyclic, prolonged, or a combination of these. The different factors that determine the demands of the tasks involved – the posture adopted, the amount of force required, the duration of the load and the environmental factors such as temperature and humidity – are ergonomic factors. This is a limited definition of the term ergonomics, which can also cover many other aspects of the work environment such as psychosocial factors and systems management.

POSTURE

Overall body posture and individual joint posture are important determinants of injury risk. A number of work postures have been identified with an increased incidence of injury. These will be covered in greater detail in Section 3. Posture is an interface between the job we are required to do and the tools we have to complete the task. Good posture requires education as

[1] WMSD corresponds to work-related musculoskeletal disorder (WRMSD), as described in Chapter 2.

to how to complete these tasks using the tools appropriately.

Individuals often do not have a natural sense of what constitutes good posture. When asked to demonstrate a comfortable posture, a person will usually identify a familiar posture as being comfortable, even though this may have a high biomechanical loading. Some body tissues, such as articular cartilage and intervertebral discs, have minimal afferent nerve endings and provide no feedback on levels of loading or fatigue. The unfamiliar, which may have a much lower biomechanical loading, will often be rejected as good posture because it feels different and there is a low neurophysiological adaptation to this new posture. If you ask someone to assume a good posture, the posture he or she adopts will be based on cultural and learned habits rather than on an assessment of internal neuromuscular information, such as joint loading or muscle activity. People may be provided with excellent equipment but may set it up in ways that increase their joint loading based on a mistaken view of what constitutes good posture. The key point is that a person has to be appealed to on an intellectual level to understand the need for good posture, and educated in a practical environment as to what is good posture. Once these are established, the person must be prepared to trial the posture through the familiarization and adaptation period. Frequently, when setting up individuals with a slightly forward-sloping seat for sitting at desk-based or VDU tasks, the unfamiliar nature of the posture encourages them to question the validity of it. When the physiological benefits are explained, and they are encouraged to try it, they soon adapt and there is usually a very high uptake of this posture, with the consequent benefits.

What is good posture?

Good posture should involve:

- minimum joint strain or biomechanical loading
- economy of energy – minimal muscular loading
- avoidance of prolonged, repetitive or awkward movements.

The soft tissues around a joint – articular cartilage, muscles, tendons, ligaments and joint capsule – are usually in their greatest balance in the middle third of their range of motion. As this range is extended, there is increasing soft tissue stress. People in a relaxed state, such as sleeping, usually adopt joint postures in this mid-range (Fig. 5.1). If the demands of gravity are removed, the joint positions move into their own natural balance and the same phenomenon is found. However, as soon as people start assuming postures to do work these joint postures start to become compromised by the demands of the task. Even standing requires quite a high workload to maintain balance and defy gravity. In the standing posture the lower body – pelvis, hips and knees – move into extension to keep the body position close to the centre of gravity and minimize muscle tension. However, this is not a comfortable position to maintain for long and people transfer weight from one leg to another to try and introduce some flattening of their lumbar curve and some pelvis, hip and knee flexion (Fig. 5.2).

Relaxed sitting generally uses less energy than standing because there are more points of support and balance and less muscular energy is required to maintain the posture. However, performing a task while sitting can compromise this relaxation. Head and neck posture will be compromised by visual demands; upper limb postures will be compromised if the hands are used.

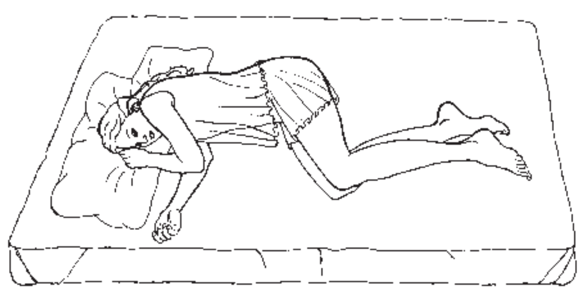

Figure 5.1 When choosing a sleeping posture most people usually place their joints in the middle third of the range of movement – the joint comfort zone.

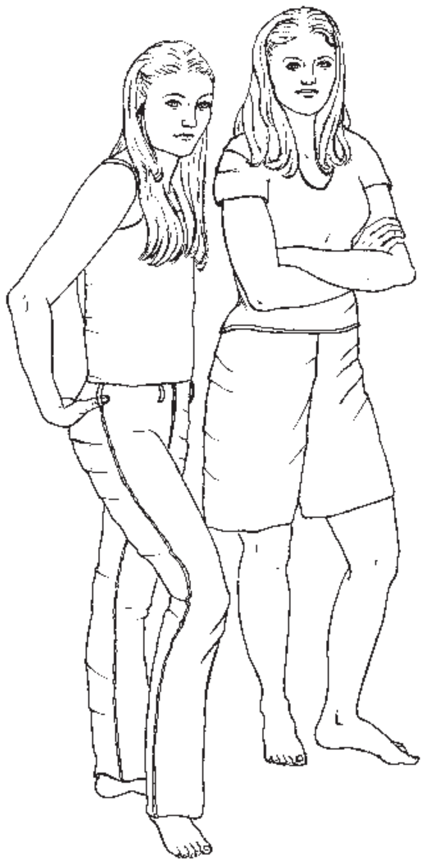

Figure 5.2 Relaxed standing posture usually involves placing one pelvis, hip and knee into flexion, and regularly alternating legs. This reduces biomechanical loading.

The further a body part is moved from the centre of gravity, the more muscle tension is required to move it to or hold it in that position, unless that part of the body is supported against gravity. To minimize muscle tension, a person must:

- keep their joints in the middle one-third of the range of movement as much as possible
- keep their limbs close to the centre of gravity as much as possible
- try and support body parts that move away from the mid-range or centre of gravity.

People tend to hunt for comfort around these parameters, usually naturally alternating the biomechanical demands on different body parts. For example, when people are standing, arms hanging by their sides have the least gravity but there is a muscular load on the upper arm and shoulder girdle. They may attempt to unload this by folding their forearms. This tends to relieve the shoulders but creates some tension in the forearms. Next they may attempt to support the limbs by putting their hands in their pockets.

It is normal and healthy to move the joints through their full range of motion. There are positive vascular, lymphatic, neurological and other homeostatic processes that benefit from movement. The difficulties start to become apparent when people do stereotyped, repetitive movements or they sustain postures that are physiologically demanding.

Sitting posture

People are increasingly spending more and more time sitting – for work, for travel and for relaxation. The more labour-saving devices perform manual tasks, the more people sit. Sitting has become the predominant daily posture for a large proportion of Western society. Sitting fundamentally changes the posture and the demands and constraints placed on the musculoskeletal system. It changes the natural spinal curve from a three-curve structure to a single curve, which profoundly alters the biomechanical forces and physiological homeostasis of the spine. A number of effects on other body systems are also caused by the sitting posture:

- circulation – reduced muscle pump effect of circulation, particularly venous return from the lower limbs
- digestion – increased abdominal pressure, can increase incidence of reflux, constipation and carcinoma
- respiration – increased thoracic cavity pressure can affect quality of breathing and oxygenation
- physical inactivity – can be regarded as a risk factor for obesity, osteoporosis and arteriosclerosis.

A person who works in a sitting position tends to move certain parts of the body to perform certain tasks, chiefly the head and neck to maintain visual contact and the upper limbs to manipulate tools. The ramifications of this will be covered in Section 3. It is possible to sit and fulfil good biomechanical requirements for task work and to maintain the joints in their natural comfort zones.

Joint comfort zones when sitting for work

The aim is to provide good spine and pelvis posture while still being able to easily access work tools and maintain good visual angles and distances:

- spine and pelvis – 110–130 degrees
- lumbar spine – retain some natural lordosis
- thoracic spine – a slight kyphosis
- head and neck – erect and close to the centre of gravity
- visual angle – 10–30 degrees below horizontal
- shoulders – relaxed in line with the trunk
- elbows – 90–100 degrees
- wrists – straight with wrists extended up to 20 degrees
  – forearms supported where possible
- knees – 60–120 degrees
- feet – flat on the floor or on footrest.

Sitting for relaxation, when the arms are not required to manipulate tools, is generally improved by more reclined postures where spinal weight is more supported. If people want to watch TV in the reclined position they may require neck/head support to maintain a comfortable posture. Aaras et al (1997) found greater neck flexion angles when viewing a VDU task while standing and greater spinal flexion when sitting. They recommended alternating between sitting and standing postures to minimize joint stress. This will be explored in further depth in Section 2.

FORCE

The forces applied to the joint structures can be an important determinant of the risk of injury. If the force exerted exceeds the tolerance of the tissues, injury results. The force is determined by a number of possible components including the load, the distance, the joint position required and the activity involved. Repetitive forces tend to reduce the tolerance of most tissues such as muscles, tendons, intervertebral discs, vertebral end plates, etc.

Figure 5.3 Joint comfort zones for task-related sitting posture while working at a computer.

The load

The load refers to the object being manipulated. The weight of the load is a significant determining factor for the risk of injury. Most occupational safety legislation sets maximum limits for recommended lifting, based on this recognized risk factor. The size, shape and position of the load will also determine how easy it is to lift or how much the posture needs to be compromised to affect the activity.

When attempting a musculoskeletal (MS) load, a person generally has an expectation of the force required and their MS system prepares for the expected loading in a reasonably efficient manner. If the load differs from expectations, for instance, if the weight of a lift has been underestimated or a step has not been noticed, this dramatically increases the MS forces generated and the risk of injury. An unstable load, and a variable load, thus represent risk factors that can dramatically modify the risk of injury. Experienced load handlers will usually carefully assess the requirements of the load and the task and try and avoid sudden peak forces, as far as possible.

Distance

The distance required to reach to the load away from the body, or against gravity, and then the manipulation of the load at that distance are dramatic modifiers of the force required to manipulate the object. Lifting a heavy object close to the body can be relatively straightforward, but place the same load at a distance from the body and it can become a very high-risk activity (Fig. 5.4). It has been estimated that a load is 12 times greater when lifted at a distance from the body than when the load is kept close to the body and the trunk remains upright.

Lifting a child close to the body may be straightforward; lifting the same child from their seat in the centre of the back seat of the car is a much more significant load. Using a well-sited computer mouse with forearm support can produce a relatively low MS load; placing the mouse at an awkward height or distance, without forearm support, dramatically modifies the degree of load on the forearm, shoulder and neck. The load on the MS tissues then includes the weight of the part of the body extended to the object plus the magnifier of the distance involved.

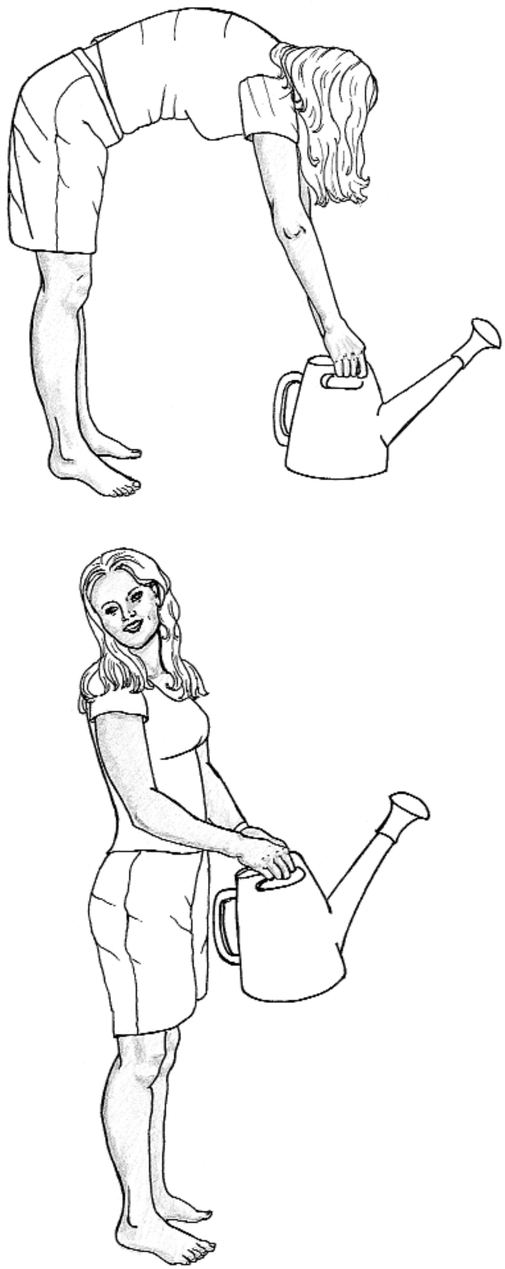

Figure 5.4 Lifting a load at a distance from the body can magnify the forces at the low back by up to 12 times. In addition to the load of the object, the weight of the trunk has to be lifted as well.

Joint position

We have established that there is a lower physiological load when the joint is in its comfort zone in the middle third of the range of movement. Among the reasons for this are:

- the biomechanical load can be distributed between the range of supporting musculature around the joint
- the musculotendinous units generally provide efficient force vectors, with less friction or pressure, when there are no significant changes of direction
- the joint architecture provides efficient distribution of loads throughout the articular surfaces

- nociceptive and mechanoreceptor afferent stimuli are minimized
- in the mid-range of joint movement there is usually more efficient homeostasis of vascular and neurological processes, which become progressively compromised as we move to joint extremes.

Moving a joint in one plane away from its comfort zone tends to localize the forces to the particular prime movers of that action, and their antagonists, which may also be involved in maintaining the joint position. These become selectively loaded. As the movement away continues, these prime movers have to work even harder to overcome the passive resistance of the other tissues. It often introduces joint angles that reduce the efficiency of the musculotendinous unit and create additional muscle tension, friction and leverage, while affecting neurological and vascular homeostasis. This can have a marked effect on the level of musculotendinous loading and the rate of fatigue. If we introduce movement in another plane, this further localizes the stress to a smaller portion of the MS structure and creates even stronger leverages.

The wrist provides a good example of this process. In the mid-range there is an efficient and strong wrist grip. However, when it is moved into flexion or extension the wrist grip reduces noticeably, despite considerable muscular effort. Thus more effort is required to perform the same task in a poorer posture. In addition, the increasing angle of the flexor and extensor wrist tendons produces considerable stress on these structures. Furthermore, the dramatic increase in pressure in the carpal tunnel inhibits the efficient physiological processes of the median nerve, and this can be an important factor in carpal tunnel syndrome (Rempel 1996).

Another important example is the movement into flexion of the lumbar spine, which dramatically increases the loading. This loading is further increased if an element of rotation is introduced that changes the symmetrical nature of the stress introducing localized peak loads, and leads to an increased odds ratio of low back pain (LBP) (Punnett et al 1991).

Joint postures near the limit of their mobility often place a load on the ligamentous structures. This ligamentous tension can often substitute for the muscle activity that would otherwise be required to hold this extreme joint posture. This is often seen in slumped spinal or neck postures. While this can be valuable in providing an opportunity for muscular recovery it can also create additional problems. The taut ligament is at risk from any sudden increase in the magnitude of load. The ligaments are also subject to a fatigue loading and exhibit a creep effect. This can produce a wedging effect of the intervertebral discs at this level, and this alteration in dynamics has been postulated to be a significant risk for disc injury (Adams & Dolan 1995, McGill 1995).

Cumulative effect

The classic study by Armstrong et al (1987) shows that risk factors are not just cumulative but that they can also magnify or multiply to a remarkable magnitude. Using videotape analysis, Armstrong and colleagues studied 652 workers at seven manufacturing plants and compared the incidence of wrist tendonitis with the characteristics of the job. They categorized the jobs as low or high force and low or high repetitiveness. They found the following risk ratios:

- low force/low repetition – risk ratio 1 – % affected 0.6
- high force/low repetition – risk ratio 6.1 – % affected 3.1
- low force/high repetition – risk ratio 3.3 – % affected 3.3
- high force/high repetition – risk ratio 29.4 – % affected 10.8.

The combination of high force and high repetition had a remarkable increase in the risk of injury.

The corollary of this is that identification and reduction of risk factors may have a remarkable benefit by reversing or reducing this multiplication factor.

The magnifier effect of different risk factors combined in the same job has been clearly demonstrated in the literature. The executive summary of the comprehensive NIOSH review (NIOSH 1997b)

Table 5.1 Evidence for causal relationship between physical work factors and MSDs

Body part *Risk factor*	**Strong evidence**	**Evidence**	**Insufficient evidence**	**Evidence of no effect**
Neck and neck/shoulder				
Repetition		✓		
Force		✓		
Posture	✓			
Vibration			✓	
Shoulder				
Posture		✓		
Force			✓	
Repetition		✓		
Vibration			✓	
Elbow				
Repetition			✓	
Force		✓		
Posture			✓	
Combination	✓			
Hand/wrist				
Carpal tunnel syndrome				
Repetition		✓		
Force		✓		
Posture			✓	
Vibration		✓		
Combination	✓			
Tendinitis				
Repetition		✓		
Force		✓		
Posture		✓		
Combination	✓			
Hand–arm vibration syndrome				
Vibration	✓			
Back				
Lifting/forceful movement	✓			
Awkward posture		✓		
Heavy physical work		✓		
Whole body vibration	✓			
Static work posture			✓	

shows a table of the causal relationship between physical work factors and musculoskeletal disorders (MSDs) (Table 5.1). It shows clearly the increasing evidence of risk when multiple ergonomic risk factors are present. Where the evidence exists for combinations of risk factors (elbow, hand/wrist tendonitis, carpal tunnel syndrome) combinations of exposures provide the strongest evidence of the association between risk factors and injury.

DURATION

The duration of work, or the duration of an exposure, is one of the key determinants of the overall injury risk. The duration determines the cumulative biomechanical force and the degree of fatigue experienced. The duration can be short and intense, leading to acute disorders, or prolonged with low or moderate intensities, leading to chronic or degenerative disorders. All functions of the human body are a cyclic relationship between work and rest and recovery. Sufficient recovery periods are indispensable if effective performance and efficiency are to be maintained, and injury avoided. Fatigue can be localized to a particular muscle group, generalized, or primarily psychological. New, unfamiliar tasks tend to be more fatiguing than accustomed tasks.

Rest breaks

There are different types of breaks that allow recovery or at least add variety to the workload.

- Variety of workload gives an opportunity for some exposed tissues to get relative rest.
- Structured breaks.
- Unstructured breaks, such as taking the opportunity to talk to a colleague or to have a drink of water.
- Pauses in workload provide an opportunity for a break in well-designed workstations. Computer work has frequent pauses provided there are comfortable and easily accessible surfaces to unload the weight of the arms and a good back support to unload the weight of the trunk. Telephone headsets maximize the opportunity to rest some body regions when taking phone calls.

If pauses are optional, or breaks are deducted from the pay schedule, there is often a reluctance to take them. It is often much easier to continue work than to stop and abandon the work process, particularly with machinery or electronic based tasks. People often become so involved with a task that they are reluctant to stop. It is important to assess what is a reasonable workload at any particular task, or a reasonable concentration span, and ensure there are sufficient breaks to accommodate these tasks. It is difficult to make generalizations for recommended periods of exposures for many tasks. There are so many variables that can be involved, such as individual factors and environmental factors, as well as the demands of the task. It is important to be flexible and allow people to work at a comfortable pace rather than a predetermined pace. For a good review of recommended work/rest and break schedules for different industries and shifts see Konz (1998a).

The first marker of fatigue is usually deterioration in work efficiency – a slowing of process time and an increase in error rates. An important marker of overexposure is the development of work-related symptoms. Where there are work-related symptoms in a workplace then, clearly, some people are being overexposed to some tasks. Hence it is also important to establish an environment that encourages the reporting of early symptoms, and early modification of the exposure.

It is vital to establish a break culture where people learn the importance of breaks to the process of productivity, and are made aware of the responsibility to ensure that they maintain a healthy balance between work and rest.

Type of exposure

Static loads and postures have been linked to increased risk of developing MS symptoms, even at low levels of loading. The pathophysiological mechanisms for this are discussed in Chapter 4. Even low static loads in optimal joint postures cannot be held for long periods of time. A number of writers have represented the injury risk from different types of physical workload as a U-shaped curve. Those with long periods of static postures have a high risk of injury; those who are moderately active with frequent postural variation have a low risk of injury; those who have high physical workloads or high frequency repetition have a high risk of injury (Fig. 5.5).

One of the major factors for the increasing incidence of injury may be that, as the industrial and electronic revolutions continue to change society, people's postures are also changing, as they adopt

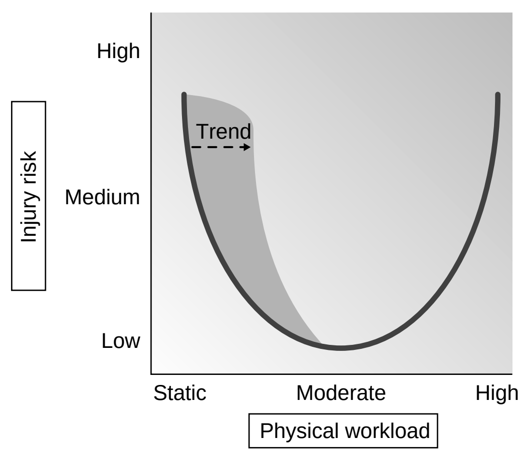

Figure 5.5 The relationship between types of workload and injury risk.

increasing static postures in all areas of life – work, transport and recreation. This has the effect of increasing the volume on the left side of the graph in Figure 5.5 and squeezing the U. As static joint postures move away from the joint comfort zone and become suboptimal, or as the MS load increases, the period available before the onset of fatigue becomes relatively less. Static loads have relatively poor physiological efficiency and the need for postural and task variation are paramount. Where these are not possible, micropauses, pauses and breaks are necessary to allow physiological recovery and to delay or diminish the onset of fatigue. Where jobs involve static activity without significant variation, the need for well-designed workstations and good management practices are essential. Breaks should be taken before the effects of fatigue become apparent. If the break is delayed until there is fatigue or performance deterioration, the recovery period is longer and often the break is not sufficient to recharge the batteries, resulting in an accelerated fatigue process, with a performance decrement and a prolonged recovery period. The fatigue process increases exponentially with time – the greater the level of fatigue the relatively longer the recovery period becomes. However, recovery from fatigue is also exponential – there is maximum benefit in the earlier phases of the recovery period. Thus, three breaks of 5 min have more benefit than one break of 15 min as: (i) recovery is better; and (ii) fatigue is not as advanced (Konz 1998b).

For static work that requires intense concentration, 30 min seems to be the ideal time to work, followed by a 5 min break. For tasks that require less concentration and a little more variety, but which are still mainly static postures, up to 1 h work followed by a 10 min break is reasonable. For tasks that have good variation without requiring prolonged, intense psychological demands, the standard morning and afternoon breaks are acceptable, although research has shown improved efficiency with more frequent breaks. For dedicated word processing tasks, longer breaks or more task variation are recommended. For general VDU tasks the consensus of the literature seems to recommend taking breaks every 30–60 min, depending on the intensity and the psychological demand of the work. Johnson et al (1997) found that there were effects of fatigue in the finger muscles (flexor digitorum superficialis) in subjects working in well-designed workplaces after 3 h typing, even when they took a break for 7.5 min per 30 minutes:

> Significant levels of muscle fatigue were measured after 3 hours of typing and persisted up to 40 minutes after typing had ceased. Similar levels of fatigue were found in both hands despite the right hand performing twice the number of repetitions as the left. Therefore it appears that muscle fatigue is dependent on typing duration and force rather than on the repetition itself. Johnson et al (1997)

Johnson et al found that heavier force keyboards produced significantly greater levels and duration of fatigue.

People with a previous history of injury, or who are not well adapted to a particular work task, will require reduced periods of exposure with increased opportunity for recovery.

For clerical tasks there is a significant exposure for prolonged static muscle tension in the cervical musculature from head and neck posture for viewing purposes; and finger and wrist flexors from gripping the writing implement. These demands can be minimized by providing an appropriate height, and angled, work surface, which significantly reduces neck flexion, joint torque and cervical musculature EMG readings (see Section 3). The hand and wrist can be aided by a good quality, low friction pen with a comfortable grip that has a good gripping surface area.

VDU tasks have a considerable capacity for prolonged static muscle tension, with the continuous nature of the tasks creating high visual demands and prolonged static tension in the upper limbs. A number of studies have identified an exposure–response relationship between keyboard work and the development of symptoms. Some authors recommend a threshold of computer work of 4 h a day, above which the risk of injury increases dramatically. The configuration of the computerized workplace is of major importance for minimizing these loads. However, even with well-designed workstations, the ability to effect pauses, micropauses and regular breaks is essential.

Active breaks

For people who have static loading or are involved in monotonous tasks, active breaks are more beneficial than passive breaks. An active break will encourage circulation, oxygenation, concentration, muscle stretching and a better balance of proprioceptive activity. A 5 min walk, or climbing a flight of stairs, will be more beneficial than sitting down and having a cup of tea. It will encourage recovery and delay fatigue. A sedentary worker should also try and have some moderately vigorous activity at the end of the working day to encourage neuromuscular relaxation and recovery, as well as improving fitness.

Cyclic loading

Cyclic loading, with its more physiologically efficient contraction/relaxation cycles, allows better fluid dynamics and more varied proprioception and tends to delay onset of the fatigue process. It also allows some time for recovery between loads. If the cyclic loading is varied over a number of different body regions there is a general process of fatigue rather than a local process. Inevitably there is an element of both local and general fatigue. Repetitive loading cycles at relatively high rates of maximum voluntary contraction (MVC) or high joint torques can lead to rapid onset of fatigue. Monotonous or repetitive work has to be planned carefully, with attention given to workstation design in order to minimize the exposure to muscle fatigue and joint stress. The ratio of work to recovery has to be carefully assessed and allowances made for individuals and changing circumstances. Generally, the longer the period of exposure, the slower the available output and the greater the risk of fatigue.

Generalized fatigue

With mixed tasks where there is no significant local exposure, prolonged workloads may lead to generalized fatigue. Symptoms of generalized fatigue may include:

- weariness, lack of enthusiasm, distaste for work
- reduced alertness, sluggish thought processes
- slow perception and decision-making
- reduced output
- depression or mood instability.

Generalized fatigue can be delayed by application of stress, or states of high arousal or motivation. However, this will delay the need for recovery rather than replace it. Continued work at these states of stress or arousal can create a state of chronic fatigue or exhaustion.

Efforts to increase output by increasing work hours or increasing work intensity can often be disappointing due to reductions in efficiency due to fatigue, and increased risk of illness or injury.

ENVIRONMENT

The environment in which work is performed can be an important determinant of the total exposure to musculoskeletal strain. Any suboptimal environmental factors can contribute to the overall exposure and accelerate accumulation of fatigue and strain. This section will briefly cover the key environmental exposures and provide guidelines for their management.

Lighting

Research has shown that in many workplaces productivity can rise, and the error rate fall, by improving the quality of lighting. Poor lighting can increase the rate of visual fatigue, general tension and can create poor posture in a bid to improve vision. Lighting levels are dependent on the visual acuity required for the task. General guidelines are:

- moderately precise – packing, carpentry, engineering – 200–300 lux
- fine work – reading, writing, book-keeping – 500–700 lux
- precision work – technical drawing, sewing, delicate electronics – 1000–2000 lux.

For VDU work 300–500 lux is recommended; for general office work a range of 500–700 lux is considered appropriate. Over-bright lighting (over 1000 lux) can lead to visual strain caused by reflections, high glare, contrast between light and shadow, etc.

General guidelines for lighting

- Lighting sources (windows and lights) should be placed parallel or overhead rather than directly in front or behind.
- Walls should be light coloured to allow an even distribution of light.
- Sharp contrasts between dark flooring or furniture and reflective table tops should be avoided.
- No light sources should be in the visual field when working.
- Light sources should never flicker. Some people seem to be sensitive to fluorescent light flicker.
- It is better to use more lamps of low power than a few of high power.

Glare and reflections are very visually fatiguing. Good placement of workstations and light sources is important. A light source from behind can cause reflected glare on a VDU screen. Light sources in front can create glare. Glare from windows can be reduced by using blinds or tinted film. Ceiling or wall lights can be shielded to reduce glare or reflection.

Noise

Noise levels are best kept to a minimum, particularly where a high degree of concentration is required. Telephone and dictaphone work demand auditory acuity and these tasks can be very stressful if there is background noise.

Temperature

Low temperatures can be a significant problem for sedentary work, where very little body heat is generated. It can lead to significantly increased levels of muscle tension. A warmer working environment is preferred for sedentary work. The recommended air temperature is 20–21°C for summer and 20–24°C for winter. Drafts can be a very irritating factor for sedentary workers, producing significantly increased tension levels especially at neck and shoulder level – they should be eliminated.

Comfort levels of temperature are subject to considerable personal variation and can be influenced by clothing, posture, fat levels, metabolic rate and personal preference.

High heat and high levels of humidity can create difficulty in controlling body heat. It can lead to increased levels of stress and lower work efficiency.

Electromagnetic radiation

Radiation remains a controversial subject. It is a specialist area and, even among specialists, it is difficult to get a consensus view as to safe levels and what, if any, health risks are associated with exposure. Most Health and Safety Regulations state that it should be 'reduced to negligible levels' (Health and Safety Executive 1992). Some general guidelines to minimize exposure levels are:

- Position monitors carefully. Most radiation comes from the rear and sides of a screen. Workers should sit at least one arm's length from the front of a screen and two from the rear or sides of a screen.
- Arrange desks carefully to avoid radiation from a co-worker's screen. Walls do not provide effective screening.
- More modern monitors generally have lower radiation levels. Liquid crystal screens (as in flat screens and lap tops) do not give off radiation.
- Turn off computers and other electrical equipment when not in use.
- Photocopiers and plain paper fax machines also give off radiation and these should be at safe distances.
- If in doubt, seek specialist advice.

SUMMARY – AVOIDING FATIGUE AND INJURY

- Good workplace design.
- Interesting and varied tasks.
- Comfortable postures with optimum neuromuscular efficiency.
- Work at comfortable pace.
- Opportunity for structured and unstructured breaks.

- Avoid prolonged hours.
- A comfortable environment.

This chapter began with a quote from Barbara Silverstein, a noted ergonomist who specializes in public health policy, regarding the presence of risk factors and the risk of WMSD. It finishes by summarizing her plan for dealing with these risk factors:

1. Employers must provide information to all employees and their supervisors regarding early symptoms and risk factors so they can participate fully in the identification, control and prevention of poorly designed jobs.
2. Employers must look at their workplaces for high-risk jobs, determine the underlying causes, and involve employees in identifying and minimising solutions.
3. Employers and end users must provide critical feedback to designers and suppliers whose end products contribute to WMSD so future designs can be improved.
4. Health care providers and their societies must work together with employees to familiarise themselves with the disorders, the risk factors and appropriate treatment, and how the workplace can participate in the treatment by keeping the employee at work and reducing exposure.
5. Business, engineering, industrial design, health sciences and educational institutions (from primary school onward) should incorporate ergonomics and the evaluation of healthy work into curriculum and practice.

Silverstein (1995)