

# **Office ergonomics and seating reference document**

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## **1 Topics covered**

This reference document will cover the relevant regulations, guidelines and up to date information related to the office ergonomics and seating.

The following topics will be covered in this literature review:

- 1) Relevant guidance, standards and legislation
- 2) Statistics
- 3) Information on different seating concepts and their effectiveness
- 4) Other chairs on the market
- 5) The human body
- 6) The future of the workplace

## 2 Guidance, Regulations and Standards

### 2.1 UK and European Health and Safety<sup>1</sup>

In recent years much of Britain's health and safety law has originated in Europe. Proposals from the European Commission may be agreed by Member States, who are then responsible for making them part of their domestic law. Modern health and safety law in this country, including much of that from Europe, is based on the principle of risk assessment. Employers with five or more employees need to carry out a risk assessment and record the significant findings.

The Health and Safety Commission and its operating arm, the Executive (HSC/E), have spent over twenty years modernising the structure of the health and safety law. Where HSC/E consider action is necessary to supplement existing arrangements, their three main options are:

- **Guidance** – Are put in place to help people understand what the law says, help people comply with the law and give technical advice. Following guidance is not compulsory but if employers do follow guidance they will normally be doing enough to comply with the law.
- **Approved Codes of Practice** – Offer practical examples of good practice and provide a guide to what is 'so far as reasonably practicable'. Approved codes of practice have special legal status. This means if employers are found in court not to have followed an Approved Code of Practice they could be found at fault.
- **Regulations** – Are law, approved by parliament. These are usually made under the Health and Safety at Work Act following from proposals from the HSC.

Also relevant to designers and employers are **British and European Standards**. Standards are not law therefore adherence to standards is not compulsory but any manufacturer or employer that strives to comply with relevant standards displays recognition for the importance of end user safety, comfort and performance and displays good practice.

### 2.2 Details of Relevant Guidance, Regulations and Standards

Below is a list of guidance, regulations and standards that are relevant to the ergonomics of working in offices in the UK:

#### Guidance

- **HSG57, "Seating at work" (2002)** – Health and Safety Executive (UK) guidance on seating at work

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<sup>1</sup> [www.hse.gov.uk](http://www.hse.gov.uk)

## Regulations and legislation

- **Health and Safety at Work Act (1974)** – Basis of British Health and Safety Law
- **The Management of Health and Safety at Work Regulations (1999)**
- **Display Screen Equipment Regulations (2002)** – Regulations set by the Health and Safety Executive (UK)
- **Disability Discrimination Act (1995)**

## Standards

- BS EN ISO 9241:1999 “Ergonomic requirements for office work with visual display terminals”
- BS EN 1335-1:2000, “Office Work Chair – Part 1: Determination of dimensions”
- BS EN 1335-2:2000, “Office Work Chair – Safety Requirements”
- BS EN 1335-3:2000, “Office work chair – safety test methods”
- BS EN 1335 part 2 and 3 level S, “Strength and Stability”
- BS 5459-2:2000, “Specification for performance requirements and tests for office furniture – Office pedestal seating for use by persons weighing up to 150 kg and for use up to 24 hours a day, including type approval tests.
- BS EN 1021:1994, “Furniture: Assessment of the ignitability of upholstered furniture”

More details for some of these guidance, regulations and standards will be provided below.

### 2.2.1 HSG57, “Seating at work” (2002)

This is a guidance document provided by the Health and Safety Executive and provides fundamental seat size criteria (dimensions and adjustability). It outlines that anthropometric criteria must be taken into account when designing or selecting seating.

The main adjustability options on a chair should include:

- Seat height
- Seat depth
- Back support
- Armrests (if provided)

### 2.2.2 Health and Safety at Work Act (1974)

Forms the basis of British health and safety law. The Act sets out general duties which employers have towards employees and member of the public, and employees have to themselves and each other.

These duties are qualified in the Act by the principle of 'so far as is reasonably practicable'. In other words, an employer does not have to take measures to avoid or reduce risk if they are technically impossible or if the time, trouble or cost of the measures would be grossly disproportionate to the risk.

What the law requires here is what good management and common sense would lead employers to do anyway: that is, to look at what the risks are and take sensible measures to tackle them.

### **2.2.3 The Management of Health and Safety at Work Regulations (1999)**

These regulations make more explicit what the employers are required to do to manage health and safety under the Health and Safety at Work Act. Like the act they apply to every activity. The main requirement is for employers to conduct a risk assessment and record significant findings. Employers also need to:

- Make arrangements for implementing the health and safety measures as identified by the risk assessment
- Appoint competent people to help implement the arrangements
- Set up emergency procedures
- Provide clear information and training to employees
- Work together with employers sharing the same workplace

### **2.2.4 Display Screen Equipment Regulations (2002)**

The display screen equipment regulations state that workstation and seating must be suitable for the work undertaken and suitable for the person whom it is provided for. Employers are required to assess and reduce risk posed to all employees working with display screen equipment.

The chairs for display screen equipment must allow the worker to achieve a comfortable position. The seat and back must have height adjustment, the back must also have tilt adjustment.

### **2.2.5 Disability Discrimination Act (1995, 2005)<sup>2</sup>**

The Disability Discrimination Act (DDA) 1995 aims to end the discrimination which many disabled people face. This Act gives disabled people rights in the areas of:

- employment
- education
- access to goods, facilities and services
- buying or renting land or property

The Act also allows the government to set minimum standards so that disabled people can use public transport easily.

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<sup>2</sup> [www.direct.gov.uk](http://www.direct.gov.uk)

In April 2005 a new Disability Discrimination Act was passed by Parliament, which amends or extends existing provisions in the DDA 1995, including:

- making it unlawful for operators of transport vehicles to discriminate against disabled people
- making it easier for disabled people to rent property and for tenants to make disability-related adaptations
- making sure that private clubs with 25 or more members cannot keep disabled people out, just because they have a disability
- extending protection to cover people who have HIV, cancer and multiple sclerosis from the moment they are diagnosed
- ensuring that discrimination law covers all the activities of the public sector
- requiring public bodies to promote equality of opportunity for disabled people

Some of the new laws will come into force in December 2005, and some in December 2006. The Disability Rights Commission (DRC) website has more details.

The development of legislation to improve the rights of disabled people is an ongoing process. From 1 October 2004, Part 3 of the DDA 1995 has required businesses and other organisations to take reasonable steps to tackle physical features that act as a barrier to disabled people who want to access their services. This may mean to remove, alter or provide a reasonable means of avoiding physical features of a building which make access impossible or unreasonably difficult for disabled people. Examples include:

- putting in a ramp to replace steps
- providing larger, well defined signs for people with a visual impairment
- improving access to toilet or washing facilities

Businesses and organisations are called 'service providers' and include shops, restaurants, leisure centres and places of worship.

Disabled workers share the same general employment rights as other workers, but there are also some special provisions under the Disability Discrimination Act (DDA).

Under the DDA, it is unlawful for employers to discriminate against disabled people, for a reason related to their disability, in all aspects of employment, unless this can be justified. This includes:

- application forms
- interview arrangements
- proficiency tests
- job offers
- terms of employment
- promotion, transfer or training opportunities

- work-related benefits such as access to recreation or refreshment facilities
- dismissal or redundancy

Before October 2004, the Act only applied to employers with 15 or more staff. Employers with fewer than 15 staff are now included.

Employers have a duty to consider making 'reasonable adjustments' to ensure that disabled people are not put at a substantial disadvantage by employment arrangements or any physical feature of the workplace.

### **2.2.6 BS EN ISO 9241:1999 "Ergonomic requirements for office work with visual display terminals"**

Chairs need to comply with BS EN 1335, strength and stability before they can be compliant with this standard.

The purpose of this standard is to promote and enhance performance and comfort while minimising risks to user's safety and health. The standard also specifies ergonomic guiding principles which apply to user requirements, design, and procurement of workstation equipment for office tasks using VDT's.

With regards to furniture adjustment the standard states:

"Furniture adjustment controls should be convenient and designed so that they encourage correct use:

- They should preferably be operable from the usual working position
- They should not require undue force for actuation
- They should not require any special training or special tools before adjustments can be made
- Controls should be designed to prevent unintentional activation

The following aspects of an office work chair should fit the required population of users (i.e. through adjustability):

- Seat height – knee height plus footwear
- Seat depth – Less than thigh length
- Seat width – Should be wider than the width of the hips
- Back support – Give particular support in lumbar region
- Armrests (if provided)

The standard also details the relevant design parameters to encourage dynamic aspects of sitting:

- Seat angle
- Movement of the seat pan and back support
- Castors

- Swivel

### **2.2.7 BS EN 1335-1:2000, “Office Work Chair – Part 1: Determination of dimensions”**

This standard provides detailed dimensions of office chairs that should be adhered to for compliance. It states:

“In general, they [office work chairs] should be suitable for people between 1510mm and 1920mm in body height. People with body height outside this range may need furniture of different dimensions or a footrest. Due to the variation in population heights in different countries, there will be a variation in the percentage of the office population which the dimensions will accommodate in each country.”

With regard to dimensions of the office chair it outlines:

“The chair shall provide support to the thighs and the lumbar region with sufficient depth and height to provide all users with a sitting position suited to their activity and their height.”

The standard provides dimensions and adjustability ranges that need to be adhered to by chair manufacturers for compliance. In general an adjustable chair should have the adjustability options of the seat height, seat depth, back height and back rest inclination.

### **2.2.8 BS EN 1335 part 2 and 3 level S, “Strength and Stability”**

This standard tests for the strength and stability of the chairs. The tests are both static and dynamic and for some of the tests the chairs are required to withstand thousands of cycles to comply. This testing process can take up to a few months but chairs that comply have displayed durability and endurance and there is no accident or injury risk from the build of the chair through normal use to the end user.

## 3 Health and Compensation Statistics and Other Data

### 3.1 Occupational Health Statistics Bulletin 2004/2005<sup>3</sup>

The *Occupational Health Statistics Bulletin* sets out the latest picture on work-related ill health in Great Britain. It uses updated statistics from several sources: reports from specialist doctors in The Health and Occupation Reporting network (THOR); claims for disablement benefit under the Industrial Injuries Scheme (IIS); and death certificates for mesothelioma and other fatal occupational diseases.

- **Each year over 2 million people suffer from ill health which they think is work-related** - Overall, in 2003/04 an estimated 2.2 million people were suffering from an illness which they believed was caused or made worse by their current or past work; around 600 thousand of these first became aware of the illness in the past 12 months.
- **In 2003-04 an estimated 39 million working days were lost overall** - 30 million due to work-related ill health and 9 million due to workplace injury.
- **with over 20 thousand new cases each year severe enough to be seen by specialist doctors** - In 2004 an estimated 23 000 new cases were seen by specialist doctors in The Health and Occupation Reporting network, while just over 7000 per were assessed as qualifying for compensation under the Department for Work and Pensions' Industrial Injuries Scheme.
- **Over half of all cases of work-related illness are musculoskeletal disorders or stress** - The most common types of work-related illness were musculoskeletal disorders – in particular those affecting the back and upper limbs – and stress and other types of mental illness. Both self-reporting surveys and surveillance by specialist doctors show each of these accounting for around a third of the total incidence.

### 3.2 Cost of ill-health to industry

#### 3.2.1 Average cost per employee<sup>4</sup>

*Norwich Union Healthcare* published (in 2001) a study showing the average employee is off work sick for almost 7 days each year.

The study found the:

- **direct** costs of sickness absences are best estimated as being **£534 per employee per year**;
- **indirect** costs of sickness absences are estimated to be **twice** the direct costs, i.e. £1070 per employee per year.

<sup>3</sup> <http://www.hse.gov.uk/statistics/overall/ohsb0405.htm>

<sup>4</sup> [http://www.hse.gov.uk/costs/ill\\_health\\_costs/ill\\_health\\_costs\\_intro.asp](http://www.hse.gov.uk/costs/ill_health_costs/ill_health_costs_intro.asp)

- total cost per employee per year of sickness is approx £1600 - typically around 9% of payroll costs.

While this finding is for **general sickness absence**, not necessarily work-related illness, it still clearly shows the costs of an employee being away from work.

The Confederation Of British Industry and PPP healthcare survey '*Pulling together - 2001 absence and labour turnover survey*' also found similar results. This found on average 7.8 days are lost per employee per year. This is equivalent to 3.4% of the total working time.

Their study found the:

- **direct** costs of sickness absences to be **£434 per employee per year**;
- **indirect** costs (although harder to estimate) were typically said to be £450 per employee per year.

Both of these studies indicate that the indirect costs of absence due to ill-health are at least 1-2 times the direct costs.

### 3.2.2 Cost of Musculoskeletal disorders to employers<sup>5</sup>

Over 1.1 million people experience musculoskeletal disorders caused by work.

- SWI/03/04 (Self reported work related illness) estimated that 11.8 million days were lost in 2003/2004 through musculoskeletal disorders caused or made worse by work.
- On average each person suffering from MSD's took an estimated 19.4 days off work in that 12-month period. This equates to an annual loss of 52000 days per 100,000 workers.
- The HSE has estimated that work-related musculoskeletal disorders cost employers between £590 million and £624 million (1995/1996 prices).

### 3.2.3 Costs of back pain<sup>6</sup>

Over 1.1 million people experience musculoskeletal disorders caused by work, with an estimated 12.3 million days lost annually because of these. Back pain is a major cause of sickness absence from work. Nationally it is estimated that there are around half a million people with some form of back complaint caused by work.

A report by *Backcare, the Forum of Private Business and the TUC* suggested that back pain is a problem for almost two thirds (63%) of small businesses. They found one in five people working in small firms had back strain. The

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<sup>5</sup> [http://www.hse.gov.uk/costs/ill\\_health\\_costs/ill\\_health\\_costs\\_intro.asp](http://www.hse.gov.uk/costs/ill_health_costs/ill_health_costs_intro.asp)

<sup>6</sup> [http://www.hse.gov.uk/costs/ill\\_health\\_costs/ill\\_health\\_costs\\_intro.asp](http://www.hse.gov.uk/costs/ill_health_costs/ill_health_costs_intro.asp)

average small firm was said to be losing 22 days of work a year from back strain.

### 3.2.4 Cost of Work Related Stress<sup>7</sup>

Stress is the natural reaction people have to excessive pressures placed on them. While not an illness itself, if it is prolonged or intense, it can lead to mental and physical ill health. This can include depression, back pain or heart disease.

In Great Britain, as many as one in five people are suffering from high levels of work-related stress. That's around 5 million workers. An estimated half-million individuals report experiencing stress at a level they believe made them ill. This results in approx. 13.4 million working days lost per year.

Work-related stress can also lead to:

- an increase in sickness absence;
- a reduction in staff morale;
- poor staff performance;
- staff seeking alternative employment. Organisations then have the expense of recruiting, inducting, and training new members of staff.

Increased sickness absence can have a domino effect - one person goes sick which leads to their workload being shared among the remaining staff. They are unable to cope, which affects their health, and this leads to greater sickness absence.

### 3.2.5 Compensation costs<sup>8</sup>

The two major compensation schemes are:

- Common law compensation – Where you take a legal case against an organisation
- Industrial Injuries Benefit Scheme – Which is run by the government

According to the TUC magazine 'Hazards' the combined annual value of claims under the two major compensation schemes amount to less than £1.5 billion from 80,000 successful claims (2004).

Some of the payouts related to musculoskeletal disorders and stress published on the hazards website are:

- Fiona Conalty was awarded **£243,792** by Barclays Bank after she developed **RSI** after over two years of keyboard work at a defective workstation.

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<sup>7</sup> [http://www.hse.gov.uk/costs/ill\\_health\\_costs/ill\\_health\\_costs\\_intro.asp](http://www.hse.gov.uk/costs/ill_health_costs/ill_health_costs_intro.asp)

<sup>8</sup> [www.hazards.org/compensation](http://www.hazards.org/compensation)

- Fiona Clark, a Metropolitan Police clerk, received **£384,000** for a **back injury** sustained at work. She had not been given any manual handling training and there had been no risk assessment
- Amicus member Sam Foster has been awarded over **£140,000** in compensation from Belfast Telegraph Newspapers Ltd for **stress-related ill-health**, including a breakdown that forced him to leave work. Management ignored repeated complaints.
- Law Lords have awarded teacher Alan Barber **£72,547** in damages against his employer, Somerset County Council. He was forced to retire on medical advice following a series of depressive illnesses that his union, NUT, said stemmed from **overwork**.
- Deputy headteacher Diane Bradford, who worked at a Coventry school Our Lady of Assumption RC Primary, as received an out-of-court **£200,000 stress payout** from school's governing body. The NASUWT member retired early on health grounds.
- Former nurse Joyce Rowe who **aggravated a spine condition** while tending to a patient has been awarded a total of **£47,621** compensation. She sued Gwynedd Community Health NHS Trust after suffering serious injuries in the December 1995 incident.
- NUJ member Mark Hayes, an editor at Quantum Business Media, has been awarded **£95,000** compensation at an employment tribunal after being driven to a **breakdown by overwork and bad management**.
- The Court of Appeal has upheld a damages awarded against Newham Healthcare NHS Trust, which was ordered to pay **£420,000** to nurse Angela Knott whose career was ended by a **crippling back injury** (*Hazards* 80).
- A financial adviser for Pearl Assurance has obtained **six-figure compensation** for **work-related stress**. After routinely working 75 hours per week, the Amicus-MSF member suffered two nervous breakdowns.
- Swansea teacher and NUT member Alan Powis, 53, has agreed to an out-of-court settlement of **£230,000** from Neath Port Talbot council. He was **bullied** by his headteacher then fired, suffering a breakdown.
- Chronic arthritis sufferer Sheila Pryterch was forced to leave her Whitbread pub cleaning job when her employer stopped her flexible hours. She took legal action for **disability discrimination** and won **£9,500** in an out-of-court settlement
- UNISON member and former social worker Thelma Conway received **£140,000** compensation from Worcestershire County Council for a **stress related illness**.
- Nurse Jane Witham, who had a **mental breakdown** because of stress and overwork in the aftermath of a traumatic pregnancy, has won **£140,000** compensation from her employer, Hastings and Rother NHS Trust.
- Carmel Commons, formerly a nurse at Queen's Medical Centre, Nottingham, has been awarded **£345,000** for **back injuries** caused by the repetitive strain of moving patients.
- UNISON has won **£51,414** for Janet Melling and £60,348 for Jean Chadwick for the **stress** from work as Cumbria County Council day service officers.

- Somerset teacher Alan Barber was awarded **£100,000** after a brusque, autocratic and bullying head caused him to retire, suffering from **depression**. Somerset County Council was ordered to pay damages plus costs
- An unnamed IPMS member was awarded a **six-figure sum** in compensation for the **stress** he suffered working for the UK Atomic Energy Authority at Dounreay.

#### Other RSI claims<sup>9</sup>

Most cases are settled out of court and there have been some well publicised large awards, for example, to PTC members Kathleen Tovey and Kathleen Harris, both typists at the Inland Revenue, who were awarded £82,000 and £79,000 respectively, or to Kath Watson, giro processing machine operator and CPSA member at the Benefits Agency, who was awarded £38,000 on the eve of the court hearing. UNISON won an out of court settlement of £60,000 for a council chainsaw worker. USDAW achieved two settlements of over £30,000 for check-out operators in the north-east of England and MSF won £72,000 for an industrial radiographer in Scotland.

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<sup>9</sup> <http://www.lhc.org.uk/members/pubs/books/rsi/ch09.htm>

## 4 Ergonomics, Risk of DSE Work and the Human Body

### 4.1 What is Ergonomics?

Known also as human factors in the US. The word 'ergonomics' is derived from the Greek words 'ergon' (work) and 'nomos' (laws). Ergonomics is the science associated with maximising human comfort, safety and performance by designing tasks, tools and equipment and the environment. The objects or environments humans interact with should adapt to the humans using them rather than the other way around. Ergonomics is a holistic approach and can be applied to anything the people interact with.

The definition of ergonomics given by the HSE:

“The science ensuring a good fit between people and the tasks they do, the tools and the equipment they use & the environment they work in. Human abilities, attributes & their physical size vary immensely & the application of ergonomics allows these differences in the workplace (HSE) “

The sciences on which ergonomics is based include:

- Anthropometry (science of body measurements including body size, shape, strength and working capacity)
- Anatomy
- Physiology
- Biomechanics
- Psychology

### 4.2 History of Ergonomics<sup>10</sup>

Ergonomics developed into a recognised field in the Second World War. This was the first time technology and human sciences were applied in a coordinated manner. Physiologists, psychologists, anthropologists, medical doctors, work scientists and engineers together addressed problems arising from the operation of complex medical equipment. This multidisciplinary approach proved to be very successful and the cooperation was pursued after the war. The first ever ergonomics society was formed in the UK in 1949 which is when the term 'ergonomics' was adopted. In 1961 the International Ergonomics Association (IEA) was formed which represents societies which are active in 40 countries or regions, with a total membership in excess of 15,000 people.

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<sup>10</sup> Ergonomics For Beginners, Dul and Weerdmeester (2001)

### 4.3 Why is ergonomics important? <sup>11</sup>

Ergonomics can contribute to the solution of a large number of problems related to safety, health, comfort and efficiency. Many work and every-day situations are hazardous to health, this includes musculoskeletal problems and psychological problems such as stress which account for millions of days off work and in severe cases permanent disability. These conditions can be partly due to the poor design of equipment, systems and tasks. The early application of ergonomics can help prevent these problems.

With equipment design in particular it is important that designers consider the great variability in the sizes, shapes and capabilities of the population so that products are suitable and usable by the greatest number of people. This can only be done with the application of anthropometric data and ergonomics.

### 4.4 Risks of DSE work

The three main dangers of DSE work are:

- Musculoskeletal disorders (e.g. back, neck, wrist and shoulder ache, pain or discomfort.) – physical wear and tear of the body
- Eye strain and headaches
- Fatigue and stress – Psychological affects of modern day work

The main causes of these risks are:

- Poor workstation set up
- Poor posture
- Repetitive movements
- Intensive work
- Workload
- Infrequent breaks
- Environment

Commonly reported MSD's include:

- Tenosynovitis - reportable occupational disease - RIDDOR
- Tendonitis - reportable occupational disease - RIDDOR
- De Quervains syndrome
- Osteoarthritis
- Carpal tunnel syndrome
- Tennis elbow

### 4.5 The human body

#### 4.5.1 The musculoskeletal system

Musculo-skeletal system comprises of joints, ligaments, muscles and tendons.

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<sup>11</sup> Ergonomics For Beginners, Dul and Weerdmeester (2001)

- Joint – or an articulation, is where two bones meet. Most joints in the body are synovial joints which are versatile lubricated joints (e.g. the Knee)
- Ligament - A sheet or band of tough, fibrous tissue connecting bones or cartilages at a joint or supporting an organ
- Muscles - A tissue composed of fibres capable of contracting to effect bodily movement. Muscles are made of filaments that can stretch or contract returning to their original shape.
- Tendons – are fibrous cords of connective tissue that link muscles to bones. Some tendons (e.g. hand and feet) are enclosed in self-lubricating sheaths to protect against friction as they move against the bone.

Aches, pains and discomfort should therefore not be ignored.

#### **4.5.2 Musculoskeletal disorders**

Musculoskeletal disorders refers to physical symptoms affecting the musculoskeletal system. The bones, muscles, tendons and ligaments that produce the body's movements are subjected to constant wear and tear. In general the musculoskeletal system is more likely to be affected by injury than by disease. As described in the previous section MSD's are the cause for the greatest number of days off work and cost the economy millions.

There are many other terms that MSD's associated with DSE use are known by:

- RSI (Repetitive Strain Injury) – Not always repetitive and doesn't always result in strain, doesn't only occur in the wrists.
- CTD (Cumulative Trauma Disorder) – Used in the US describes the cause and symptoms
- WRULD (Work related upper limb disorder) – HSE term, employers have a duty that any disorders are not exacerbated through work
- OOS (Occupational Overuse Syndrome) – Canadian term, describes the nature of work that results in disorders.

Musculoskeletal disorders is a good term that covers disorders affecting both upper and lower limbs.

### **4.5.3 Tendons of the Hand**

Finger movement is largely controlled by muscles in the forearm that are connected to the fingers by tendons. These tendons pass through a restricted space in the wrist known as the carpal tunnel. Any damage to tendons from overuse causes swelling and leads to pressure on the nerves that also pass through the carpal tunnel which could lead to carpal tunnel syndrome. The wrists should therefore be kept in a neutral position

#### **Pictures of the tendons in the hand**

### **4.5.4 The spine**

#### **The anatomy**

The bony column of the spine, also known as the vertebral column helps to keep the body erect. It also protects the spinal cord, which sends and receives nerve impulses to and from the rest of the body through the spinal nerves. It is made of 33 ring like bones known as vertebrae. The last 9 vertebrae are fused together forming the sacrum and coccyx (tailbone). There are 7 cervical vertebrae (neck region), 12 thoracic vertebrae (mid-back region) and 5 lumbar vertebrae (lower back). The spine consists of three natural curves, concave in the neck region (lordosis), convex in the mid back region (kyphosis) and concave in the lower back region (lordosis). Together they make an 'S' shaped spine.

#### **Picture of the Spine**

When in this 'S' shape the spine is at its strongest and is the most resilient, it acts like a suspension spring to protect the head. The pressure from the weight of the head and upper body is evenly distributed through the discs, hips, legs and into the ground.

The spine is constructed strongly to hold the head and body upright, but is also flexible enough to allow the upper body to bend and twist. Strong ligaments and muscles around the spine stabilize the vertebrae and help to control movement.

#### **The discs**

Sandwiched between each of the separate vertebrae are intervertebral discs. These discs act like shock absorbers and are made of layers of tough cartilage (annulus) with a soft jelly like centre (nucleus pulposus). The mushy nucleus of the disc serves as the main shock absorber, it is high in water

content and acts a bit like a waterbed mattress. The discs are also ligaments holding the vertebrae together and can withstand enormous forces.

### **Disorders of the discs**

The discs in the spine go through a normal degenerative process with time. As we get older our discs slowly lose height, this puts strain on the joints and ligaments that support the spine (e.g. the facet joints between the vertebrae). This process can be speeded up by abuse and misuse through sudden movements such as twisting, repetitive movements and also adopting poor postures over sustained periods of time.

### **Picture of degenerative disc**

A prolapsed disc, also referred to as a slipped disc, occurs when the outer layers of the disc are damaged and the soft centre protrudes out and puts pressure on the spinal cord or the nerves. This can be through wear and tear or uneven excessive pressures put on the disc (e.g. when the spine adopts a 'C' shape while sitting rather than an 'S' shape.). Disc prolapses are more common with people who sit for prolonged periods without a break. These usually occur in the lower region of the spine or in the neck causing severe pain. The pain can radiate to other parts of the body depending on which nerves are compressed (e.g. when the sciatic nerve is compressed the pain radiates to hips and down the legs).

### **Picture of prolapsed disc**

## **4.5.5 Movement and Posture**

Posture and Movement play a central role in ergonomics. In everyday life postures and movement are imposed by the equipment, we use and the tasks we conduct and the environments we are in. The body's muscles ligaments and joints are involved in adopting a posture, carrying out a movement and applying a force. Poor posture can therefore lead to mechanical stress on the muscles, joints, ligaments and tendons, resulting in musculoskeletal complaints. Some general guidelines for posture and movement are:

- Keep joints in a neutral position – as muscles and ligaments least stretched in these positions
- Keep work close to the body – if work is too far the arms will be outstretched putting stress on the shoulders, neck and back
- Avoid bending forward – The further forward you bend the harder it is for the muscles and ligaments to maintain balance
- Avoid twisted trunks – A twisted trunk puts strain on the back
- Avoid sudden movements – these produce peak stresses and can cause acute pain and lead to injury
- Alternate postures and movements – no single posture or movement should be maintained for long periods of time as these could cause injuries.
- More frequent breaks rather than a single long one – shorter frequent breaks allow body structures to rest and recover.

- Alternate sitting with standing and walking

## **Evolution**

The spine and human body had developed over thousands of years based round the fact that we spent most of our time walking, hunting for food. When standing up, or walking, our spine maintains the natural curves and an 'S' shape. In this shape the spine is at its most resilient and the pressures from the weight of the head and upper body are equally distributed through the disc, hip, legs to the ground.

## **Sitting at work**

### **Picture of C shape spine while sitting**

The 20<sup>th</sup> and 21<sup>st</sup> century have brought with them a more sedentary lifestyle compared to the past. The human body has not evolved to sit. In our lifestyles we sit for most of the day and most of this takes place at work in front of our workstations. Unsupported sitting and slouching loses the natural curves of the spine and puts the spine into more of a 'C' shape, the three natural curves are lost. When in this shape the discs are compressed at the front and start bulging at the back. The pressures from the weight of the body and head are unevenly distributed through the discs. This damaged the outer layer of the disc and the discs are more likely to prolapse. Adopting a 'C' shaped spine can also affect digestion as it puts pressure on the stomach and bowels.

Why do we slouch? Because slouching feels comfortable and the muscles in the back do not have to work as hard. It has also been ingrained in us to adopt a slouching posture from a very young age. When we're toddlers we are put into prams that are flat, we go to school and none of the furniture fits so we slouch to reach the backrests, we aren't told how to sit and what posture to adopt. By the time we start work we are already on the brink of suffering from back problems if aren't already. Slouching becomes natural and maintaining an 'S' shape becomes hard work.

Another issue with working in modern day offices is that we are very still. The body capitalized on movement and the spine is designed to function correctly when moving. The discs in the spine don't have a blood supply they get there nutrients from movement, when the spine is moving the discs compress and expand this allows the discs to draw in nutrients (they act like bellows) to help rebuild torn cartilage. In a static posture the degenerative process is accelerated, other problems with adopting a static posture are:

- Muscle fatigue
- Build up of lactic acids
- Less oxygen going to the brain
- Poor blood circulation

## 4.6 The office work chair

The chair is one of several factors determining whether the working posture is correct. The regulations state that the seat height and back rest height must be adjustable in relation to the floor. This is achievable without and independent backrest adjustment. However without and independent backrest adjustment it is not always possible to get good lumbar support for 90 –95% of the users.

It seems to be a well known fact that people do not adjust their chairs often (Herman Miller 1989, Zhang and Helender 1994, Kleeman and Pruiner 1980, Leuder 1983 and 1995 etc.). From active ergonomics data it is also apparent that people keep their chairs in a 'locked' position (this does not allow the backrest to recline). These are worrying statistics. As ergonomists we know that a well designed chair is one that is adjustable, but an adjustable chair is only effective when adjusted properly.

From an ergonomics perspective a chair needs to have enough adjustments that the users can tailor the chair to their body size, shape and preference. Ease of adjustment and intuitive controls are arguably equally important if these controls are to be used often and correctly.

### 4.6.1 Setting up the office chair

Every chair a user sits on needs to be adjusted so that it is suitable and helps them maintain a good posture. Users should explore their chairs and its controls so that they are comfortable with adjusting their chairs. Setting a chair up only takes a few minutes and if it not set up correctly it can have severe consequences as many people spend over and above 8 hours a day sitting at their workstations. The chair should be set up in the following way and order.

- Seat height – adjust so that the trunk to thigh angle is 90 degrees or a bit plus. This will help maintain the three curves in the spine and prevent the pelvis from rolling back
- Seat depth – adjust so that with your bum at the back of the seat you have the space of 3 fingers from the edge of the seat to the back of your knees. This will stop the back of the knees getting constricted as prominent blood vessels and nerves pass from this region to the lower legs.
- Backrest height – Adjust so that the lumbar support in the backrest fits the small of your back. This will help maintain the 'S' shape of the spine and prevent the curve in the lower back from flattening.
- Armrests – Adjust so that with your shoulder and elbows relaxed the armrests touch the underside of your forearms when at 90 degrees with your upper arms.
- Recline lock – Keep unlocked for most of the time as this will help get healthy movement, posture change and nutrients to the discs. You can keep the chair locked for short periods if you require.

- Tension – set according to your body weight. A good guide is that you should be able to float freely with your feet of the ground.

Users of office chairs need to remember that not the best ergonomic chair cannot replace getting up and walking. Shorter frequent breaks are better than a single long one.