AN INVESTIGATION

INTO THE

APPLICATION OF ERGONOMIC PRINCIPLES

TO THE USE OF

DESKTOP KEYBOARD-OPERATED

COMPUTER TECHNOLOGY

WITHIN ORGANISATIONS

A Thesis submitted for the Degree of Doctor of Philosophy

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ABSTRACT

Procedures for the ergonomic use of desktop computer technology are well documented. The design of computer workstations, positioning of the body, and ergonomic work practices have received a great deal of attention and the relevant ergonomic principles are extensively covered in books, manuals, information guides, and web sites. Despite the proliferation of material, however, there is a wide gap between theory and practice. This thesis investigates the reasons why by comparing the knowledge of practice, derived from four field studies at different times in different kinds of organisation, with the extensive literature on ergonomics that was available at the time.

The studies showed that levels of ergonomic knowledge and the priority given to ergonomic computer use were low, irrespective of location, but generally better in public-sector organisations. However, academic staff and post-graduate students reported least awareness of ergonomic principles, were least likely to have received training in ergonomics provided by their organisation, and experienced the highest proportion of physical health symptoms. Most workers did not know whether their organisation had written policies and procedures regarding the ergonomic use of computers. The majority believed ergonomic computer use was not given sufficient priority within their organisation and that they needed to spend more time in training on ergonomics. Most were satisfied with their job; the work was interesting and there was a variation of tasks. The work environments were generally supportive and the people had adequate job control, although urgencies and deadlines dominated the organisation of work. Overall, the respondents were methodical, thorough, conscientious people who demonstrated generally compliant behaviour in other health promotion areas.

It was concluded that the computer users would be more likely than not to apply ergonomic principles to their work if given appropriate information, training and encouragement. The findings highlighted the prevalence of non-ergonomic computer work and provided insights into the nature and extent of the computer-related health problems being experienced. They could have fuelled more commitment to ergonomic computer use within organisations and the development of a workplace culture that took this aspect of work safety seriously and put the proliferating information available into action.

DECLARATION

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by any other person, except where due reference has been made in the text.

I give my consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

Janet Sawyer

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For Rod

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CHAPTER 1

INTRODUCTION

This thesis investigates the application of ergonomic principles to the use of desktop computer technology. It begins with an enquiry into the knowledge of the principles of ergonomics related to computer use and the priority these principles have been given within various types of organisations via a series of inter-related field studies. Factors that could influence the application of ergonomics to computer use, such as psychosocial aspects of the work environment and an individual's personality and attitude to compliance, were also examined. In addition, the extent and nature of computer-related health problems experienced by computer users were explored. The final chapters raise wider questions about the history of ideas that drove ergonomics and empirical studies of the kind reported in the earlier chapters.

Studies I and *II* enquired into the knowledge of and priority given to ergonomic principles within organisations located in the regional city of Whyalla (Study I), and in the Adelaide metropolitan area (Study 2). *Study III* was an extension of the initial research, conducted with academic staff and post-graduate students within a university setting. *Studies IV* and *V* were carried out with the same organisations from Study I four years on. Study IV enquired further into the psychosocial work environment and aspects of mental and physical health and Study V compared the findings over the time period as a quasi-longitudinal study. *Study VI*, conducted within a large private-sector firm, extended the focus of Study IV by exploring the impact of ergonomic knowledge, personality and attitude to compliance, cultural work environment, and psychological and physical wellbeing, on the individual and within the work situation.

Chapter 1 discusses what is meant by ergonomics and the importance of ergonomics in relation to the use of computer technology. It provides an outline of the health risks commonly linked to computer use and discusses the ergonomic factors relevant to the prevention of computer-related disorders. Various elements within the work environment that may impact on the application of ergonomics and on the health of computer users are also considered.

Chapter 2 details the design of the field studies that underpin this thesis. The methodology of the sample selection and data collection, validation and administration of the questionnaires, and the statistical analysis are described for each study. The nature and purpose of each study and the specific research questions for each are also outlined. Chapters 3 to 7 present the results of the data analysis and a summary of the research findings for each study.

Chapter 8 discusses answers to the research questions for the studies. Chapter 9 deliberately shifts the focus, to discuss the internal logic of ideas that prevailed during the period covered by the field work. The original element of this thesis is its attempt to read the findings of the field work against what could have been known and practised within organisations.

Background to the Empirical Studies

Desktop computer technology has played an increasing role in the workplace for more than two decades. Computers provide many benefits to organisations as they allow the processing, storage, generation and communication of vast amounts of data quickly and accurately, resulting in increased efficiency and productivity, and may also increase employee job satisfaction by removing the monotony involved in many routine tasks. Computers, once typically found in offices, are now located in numerous other environments such as plants and factories for controlling production and processing operations, at sales and service counters, in schools and universities, and in homes. The field of e-commerce is growing rapidly, educational institutions are placing their learning programs on-line, and many people are using computers for entertainment and other purposes at home. Computers now form an integral part of a growing range of business and other activities, resulting in rising computer usage. It is important that this computer usage is maintained in an optimal way with respect to the user's health.

It has been acknowledged for some time that the use of computers can result in physiological and psychological stresses that may affect the health and productivity of employees and that work stress and musculoskeletal complaints may occur when a person's physical and psychological capabilities are overloaded (Harper 1991, p. 39; Smith et al. 1987). From a physical perspective, overload may occur when people compromise the correct use of their body because of poor workstation, equipment or job design; from a psychological perspective overload may occur when a person has too much work to do or is required to process too much information within a limited time period (Johansson 1987; Hancock and Rosenberg 1987; O'Mara 1992, 1993, p. 2[1]).

In Australia in the mid-1980s, young to middle-aged, predominantly female employees working in low-paid, low-prestige positions were commonly affected by upper limb pain that they generally attributed to rapid, repetitious use of a keyboard. By the early 1990s, computer operators had reported visual, musculoskeletal and emotional disorders after using computers continually for long periods. Typical computer user complaints were headaches, eye strain, pain in the neck and shoulders, arms, elbows, wrists and fingers, lower back or hip pain, pain down the leg, swollen ankles, and pain in the foot and/or toes (Peper et al. 1994, pp. 8-9). Improper work habits, poor workstation design and an inappropriate work environment had resulted in muscle soreness, fatigue and injury (Grandjean 1987) that cost the individual in terms of suffering, medical expenses, lost career opportunities and reduced quality of life, and organisations in terms of days lost, impaired work performance, reduced productivity and increased compensation claims.

The application of ergonomic principles can play an important role in the provision of a safe, healthy work environment for computer users. When understood and applied, ergonomics can "increase efficiency and performance; reduce fatigue; reduce negative work stress; keep skilled staff on the job; improve internal public relations; and reduce

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1 In addition to the published material, similar ideas were expressed by Mr Noel O'Mara, Senior Consultant Ergonomist, Occupational Health Division, South Australian Department for Industrial Affairs, in his presentation of the Ergonomics Systems Approach for preventing workplace accidents and injuries and document titled "Office Ergonomics The Ergonomics Systems Approach to Optimise the Design of Office Work and Environments".

liability exposure" (Pater and Button 1992, p. 55). Research also indicates that personal factors, workplace factors and ergonomic variables "have important but differing associations" with the symptoms experienced by computer users ('Latest from the experts on tenosynovitis' 1985, p. 41;[2] Johansson 1994).

However, despite the reported benefits of applying ergonomic principles to computer work, my empirical research in the 1990s revealed a lack of application of those principles, together with complaints of aches and pains from many computer users. With this background in mind, the thesis considers three research questions, concerning:

1. the knowledge among managers and computer users within organisations of ergonomic principles in relation to the use of desktop keyboard-operated computer technology,
2. the priority given to ergonomics in relation to the use of desktop keyboard-operated computer technology within organisations, and
3. the relative influence of ergonomic knowledge, personality and the work environment on the application of ergonomics and the health symptoms experienced by computer users.

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[2] Quoted from a paper on prevalence of RSI in data process operators in government departments in Melbourne presented by G. A. Ryan, J. H. Mullerworth and J. Pimble from Occupational Health and Safety Unit, Department of Social and Preventive Medicine, Monash Medical School, Alfred Hospital, in article titled 'Latest from the experts on tenosynovitis'.

The Nature of Ergonomics

'Ergonomics' comes from two Greek words, 'ergos' (work) and 'nomos' (natural laws). Murrell developed the name in 1949 after working with a team of physiologists, anatomists and engineers at Cambridge University during World War II on the design of weapon systems to suit humans (Murrell 1975). At the end of the War, the group stayed together to form the Ergonomics Research Society, which became the forerunner of similar organisations that exist in many countries today. In the United States of America, this activity is referred to as Human Factors and several thousand full-time professionals are members of the Human Factors Society. In Australia, the Ergonomics Society of Australia Inc[3] is also a strong association with approximately 650 professionals working in the areas of ergonomics, occupational health and safety, and design.

Ergonomics is the scientific study of people, their work and their environment and uses data derived from engineering, anatomical, physiological and psychological sources (Standards Association of Australia 1976, p. 6). The Standards Association document described ergonomics as "the design of work so that the best use is made of human capabilities without exceeding human limitations" (Standards Association of Australia 1976, p. 6). This description was supported by Worksafe Australia (1989a, p. 44), which stated that ergonomics:

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[3] Now known as The Human Factors and Ergonomics Society of Australia Inc this interdisciplinary organisation of professionals is concerned with the role of humans in simple and complex systems, the design of equipment and facilities for human use, and the development of environments for comfort and safety (HFESA 2004, p. i).

> aims to promote the well-being, safety and efficiency of the worker by the study of his or her capabilities and limitations in relation to the work system, machine or task and in relation to the physical, psychological and social environment in which he or she works.

A more detailed definition describes ergonomics as:

> that branch of science and technology that includes what is known and theorized about human behavioural and biological characteristics that can be validly applied to the specification, design, evaluation, operation, and maintenance of products and systems to enhance safe, effective, and satisfying use by individuals, groups and organizations (Christensen et al. 1988).

More recently the Ergonomics Society of Australia Inc (ESA) (2001, p. 2) adopted the definition of ergonomics as approved by the International Ergonomics Association, as follows:

> Ergonomics (or human factors) is the scientific discipline concerned with the understanding of the interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimise human well being and overall system performance.

This definition placed emphasis on ergonomics as a 'systems-oriented discipline'. The ESA noted that "ergonomists must have a broad understanding of the full scope of the discipline, taking into account the physical, cognitive, social, organisational, environmental and other relevant factors, and that they may work in particular 'application domains', describing three domains as:

> **Physical Ergonomics –** concerned with human anatomical, anthropometric, physiological and biomechanical characteristics as they relate to physical activity.
> **Cognitive Ergonomics –** concerned with mental processes, such as perception, memory, reasoning and motor response, as they affect interactions among humans and other elements of a system.

> **Organisational Ergonomics –** concerned with the optimisation of sociotechnical systems, including their organisational structures, policies and processes (ESA 2001, p. 2).

Historically, the development of ergonomics in Australia was closely associated with occupational health and safety due to the high incidence of musculoskeletal injuries in the workplace. Since then, the need for a holistic approach “to counter the increasing impact of rapid technological change has been emphasized” (Bullock 1999, p. 36).

Ergonomics is “an approach”, “a philosophy”, “a way of taking account of people in the way we design and organize things” (Wilson 1990, p. 3) that may be used to provide an environment in which humans can produce their work in harmony with ‘the machine’ to the betterment of work quality and quantity and the maintenance or improvement of the physical and behavioural environment. The application of ergonomics within organisations can result in improved working techniques, reduced errors and accidents, improved industrial relations, and increased efficiency. By decreasing disability and increasing work satisfaction and productivity, ergonomics contributes to a better quality of work life. The philosophy is to “alter the task to suit human capacity, rather than force the human to adapt to an inappropriate task” (Patkin 1987, pp. 2, 4).

Among the key issues related to optimal human interaction with computers were the physical layout of the computing environment, lighting levels and sound levels (Harper 1991, p. 39). In an effort to continually improve the working conditions for computer users, ergonomics researchers studied problems related to equipment, furniture and the workstation environment. However, Patkin (cited in Moore 1990, p. 45) noted that, while having a suitable environment and well-designed furniture and equipment is important, it is also important that people "know how to use it correctly and incorporate it into the total work place system". The last clause is a major focus of this thesis.

The Nature of Computer-Related Disorders[4]

The health problems associated with computer use are generally musculoskeletal or vision disorders such as Computer Vision Syndrome. Computer Vision Syndrome (CVS) is a term used to describe a variety of vision-related symptoms including eye strain, tiredness, headaches, blurred vision, double vision, dry or irritated eyes, temporary myopia (nearsightedness) and increased sensitivity to light, that may be caused or aggravated by extended computer use. Computer users should be aware of the high demands visual display units (VDUs) place on the visual system and watch for eye twitching at the end of the work period. If symptoms appear, it is advisable to rest the eyes and avoid activities such as watching television (Meilach 1983, p. 52).

In a study by Sheedy (1991) optometrists reported that prescription lenses or spectacle design changes alleviated only a portion of the vision problems experienced by computer users, the remaining symptoms being directly related to the work environment. Four

[4] The following discussion of disorders is based on knowledge current during the field work. The gap seems to be unproblematic because the field work lays out non-technical reports by workers at the time: technical understanding of some of the 'disorders' may have been lacking at the time but technical knowledge established since the field work can still be brought to bear validly on my post-factum analysis of whether ergonomic and health promotion advice at the time would have made any difference to the workers' experience.

environmental factors, namely the arrangement of the office, poor lighting, screen resolution and screen glare, were identified as having considerable impact on the incidence of vision problems.

Workplace musculoskeletal disorders (MSDs), also commonly known as repetitive strain injuries (RSIs), repetitive movement injuries (RMIs), cumulative trauma disorders (CTDs) and Occupational Overuse Syndrome (OOS), involve the tendons, muscles, nerves and supporting structures of the body (National Institute for Occupational Safety and Health (NIOSH) 1997, p. 6). MSDs are cumulative, generally developing slowly in response to prolonged, repeated activities that affect the soft tissues of the body. Usually rapid, repetitive movement, sustained, constrained or awkward postures, and/or forceful movements are involved. The pressure need not be great; even the force required to use a keyboard can be sufficient to cause problems. Prolonged repetitive movements can cause the tendons and tendon sheaths to become inflamed as the supply of fluid that lubricates the tendons is exhausted. As a result severe muscle strain in the forearm, upper arm, shoulders, neck and back can develop either alone or in combination with pain in the hands. These disorders are generally incremental and may take months or years to appear. Likewise, if the symptoms are ignored, it may take a long time for the injury to be repaired (Oxenburgh 1991, p. 58). It is noteworthy that Worksafe Australia classifies RSIs as a ‘disease’ in recognition of their long-term latency rather than as ‘injuries’, which are generally short-term in nature. When the term ‘injury’ is used in this thesis, it includes ‘disease’.

Armstrong (1992, pp. 19–20) argued that "the development and manifestation" of disorders that "may result when work requirements exceed an individual's capacity", share common elements and can be treated as a group. He used the group term 'cumulative trauma disorders' which he defined as "those disorders that are caused, precipitated, or aggravated by repeated or sustained exertions of the body." He noted that the work activity "produces a mechanical or physiologic disturbance that results in persistent symptoms". He pointed out that other terms were used to refer to disorders with these characteristics, and that**,** although "differences among these terms and concepts can be debated, the similarities outweighed the differences".

Symptoms experienced by computer users included aching, swelling, tingling, burning, numbness, and tenderness in the fingers, hand, arms and wrists, pain in the elbow, loss of strength, and loss of joint movement, difficulty in gripping objects firmly and pain in the muscles of the arms and shoulders. These symptoms "may come and go before settling in" and resulting in a disorder (Graps 1998). Initially, there may be only slight aching and tiredness, while doing the repetitive work. As the condition worsens, the symptoms may increase and continue while doing other repetitive movements or when not moving at all. If the affected area is rested, the symptoms usually gradually disappear. It is important to appreciate that housework, hobbies and spare-time activities such as knitting, crocheting, playing musical instruments and recreational sports, and using home computers may increase the problem and these activities may also need to be reduced or ceased entirely. Generally injury is preventable if action is taken immediately, and the affected areas rested. However, if the repetitive work is continued and there is inadequate rest, the symptoms may increase and more prolonged rest of the body part and/or other treatment may be required.

Repetition injuries may cause permanent damage. Unfortunately workers often ignore the symptoms. The reasons may include not wanting to complain, fear of being sacked, believing that the pain is just part of the job, that the pain will eventually go away, or that the injury is not real because it can't be seen (Public Service Association of South Australia Inc (PSA) 1990).[5] The fact that many MSDs are not readily visible has led to additional problems for computer users who are suffering a disorder. As there is usually no observable "specific accident or single incident" involved and "no bleeding, broken bone or scars to validate the complaint", others may "suspect the honesty of the complainant", adding conflict and psychological stresses to the problem and increasing the person's suffering (IMPACC USA[6] 1995).

Some 'warning signs' of RSI are clumsiness, a feeling of heaviness in the hands, difficulty in opening and closing the hands and in carrying things, difficulty in using the hands for activities such as buttoning clothing, turning the pages of a book, a doorknob or a tap, and cold hands. Frequent self-massage of the hands, reluctance to shake hands, avoidance of activities or sports that were once enjoyable, and waking up during the early

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[5] The Public Service Association of South Australia, a large union that represents employees in a wide variety of State government organisations, had prepared a comprehensive handbook titled *Office Design and Equipment* that provides detailed information on ergonomic computer use and the work environment to publicise what was known and assist members and occupational health and safety representatives to deal with unacceptable or hazardous office environments.

hours of the morning with wrist pain or numb hands may also be warning signs (Quilter 1998).

The name given to a particular type of disorder generally depends on the muscles, tendons or nerves affected (PSA 1990, p. 36). Some of the commonly documented types of workplace musculoskeletal disorders are described below. While it is acknowledged that the nature of these conditions may be medically complex, these brief descriptions are considered appropriate for this thesis.

Tenosynovitis – occurs when the repetitive activity causes inflammation and thickening of the tendon sheaths in the hand, wrist or arm. When the tendon sheath is inflamed it fails to provide the lubrication necessary for the tendon to move through it, often resulting in a painful swelling inside the wrist, finger or arm.

Tendonitis – occurs as a result of repeated tensing of a tendon, causing the tendon to become inflamed and sore. The tendons can become ‘locked’ in the tendon sheath, reducing free movement in the fingers, hands and arms.

Ganglion – is a cyst-like swelling filled with fluid that occurs near a joint or in a tendon sheath, especially on the back of the hand or wrist.

Epicondylitis/Tennis Elbow – inflammation occurs in the area where the tendons are connected to bones or muscles. Pain and swelling occur in the elbow and can also affect the forearm and shoulder. Elbow disorders occur when nerves are compressed between

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[6] IMPACC USA Inc is operated by a team of industrial physical therapists who specialise in ergonomics and work injury prevention using a total quality management approach

muscles in the forearm below the elbow as a result of the forearm being repeatedly rotated, or in relation to computer-related activity, wrist flexion and excessive forceful movements.

Ulnar Tunnel Syndrome – here the inflammation is on the inside of the elbow. It can result from resting forearms and elbows against hard surfaces such as some armrests on chairs (Graps 1998).

Peritendinitis – inflammation of the junction between muscles, tendon and surrounding tissue.

Carpal Tunnel Syndrome – is a nerve disorder that develops when the median nerve is compressed within the carpal tunnel between the forearm and the hand as a result of poor posture and applying excessive force. The squeezing of the nerve against other wrist structures may cause pain, tingling and numbness, and loss of strength in the hands and forearms. The symptoms usually start as a tingling in the first three or four fingers, particularly after the pressure is released at the end of the work period and the nerve allowed to swell. It is characterised by "disturbances of sensation in the area of the skin supplied by the median nerve, pain on sharp flexion of the wrist, oedema of the fingers, tense and shiny skin and atrophy of the thenar muscles" (Blakistons *Gould Medical Dictionary* 1972, p. 261).

Adverse Mechanical Tension/Neural Tension – occurs as a result of nerves in the arm becoming contracted or compressed due to muscle spasms in the shoulders and elsewhere. It is generally reversible with physiotherapy.

(http://impaccusa.com/impacc1.html 2004).

Thoracic Outlet Syndrome – refers to damage to the tissues of the hand and arm as a result of postures that cause the nerves and blood vessels of the neck and shoulder to be compressed or stretched. Postures with the head forward, slouching forward and dropping the shoulders, or where the shoulders are raised or pulled down and back, can cause tight neck muscles and constriction of the arteries and nerves, resulting in inadequate blood supply to the arms and hands. Thoracic outlet syndrome is often difficult to diagnose because the symptoms of pain, weakness, numbness, tingling, swelling or coldness in the arm and hand are similar to those found in other conditions, such as carpal tunnel syndrome. Symptoms generally respond well to physiotherapy and stretching and strengthening exercise programs.

It is possible for more than one type of disorder to occur at the same time, making it difficult to separate one from the other (Ireland 1992, p. 81; Worksafe Australia 1996). While some occupational overuse disorders were well defined and understood medically, the cause and development of others had not been determined when I undertook the field surveys reported in following chapters. The treatment of inflammatory overuse disorders such as trigger digit, deQuervain’s tenosynovitis, intersection syndrome and enthesopathies had been well established but compressive neuropathies, particularly non-specific complaints of pain, weakness, numbness, and tingling in the upper extremity, continued to be perplexing and controversial.

Patients with non-specific complaints of pain often do not respond to rest, anti-inflammatory drugs, physiotherapy or strengthening exercises. Surgery may relieve some symptoms, but the result is generally dissatisfaction (Higgs and Mackinnon 1995). It was found that these patients usually had jobs such as keyboard operation where shoulder and neck movement was limited. Abnormal or prolonged postures, positions or movements lead to muscle imbalance and either “increase the pressure around a nerve or stretch the nerve, causing increased tension within the nerve, which results in chronic nerve compression” (Higgs and Mackinnon 1995). Ergonomic changes at the workstation, postural changes, and the performance of specific exercises to restore muscle balance, can generally reduce the need for surgical intervention. It is, therefore, important that computer users are aware of positions and postures that put nerves at risk of compressive neuropathy and muscle groups at risk of muscle imbalance, and are also aware of ‘non-risk positions’ such as keeping the wrists neutral, forearms supinated, elbows extended, shoulders not elevated or rolled forward, the neck not flexed, and the back with an appropriate lordosis (Higgs and Mackinnon 1995).

One of the greatest risk factors leading to RSI is the restriction of circulation to muscles, tendons and nerves during repetitive use. Computer work puts a static load on the muscles of the neck, shoulders and upper arms, as they support the arms at the keyboard and hold the head in position to view the screen or documents, and dynamic load on the fingers and hands as they press the keys. During static contraction circulation is reduced, denying tissues vital nutrients and oxygen and failing to remove toxic waste such as lactic acid and carbon dioxide (Pritchard et al. 1999; Gold et al. 2004; Graps 1998). Poor posture at the neck and shoulders may also affect the arms and wrists. A study by Elvey et al. (1986), with patients diagnosed as having RSI after experiencing pain in the arms and hands and tingling or numbness in the fingers, but where no pathological condition in the arms and hands was found, demonstrated that pain could be reproduced by upper arm tension tests and other tests which affected nerve tissue in the neck. This indicated "that the cervical nerve roots or the upper and middle trunks of the brachial plexus (a major nerve centre in the neck region) was the real source of the disorder affecting the patients", and that the "head, neck and arm relationship" should be the focus during prolonged upper limb activity ('RSI – it's really a pain in the neck' n.d., p. 6).[7]

A forward head posture as a result of slouching or rounded shoulders is another major risk factor to be aware of.[8] In this posture, the weight of the head is not being carried directly over the spine, so the load of the head on the muscles of the upper back, which must work to hold the head upright, is increased, while at the same time the rounding forward of the shoulders is producing a stretch weakness in these muscles. In this position, the head must bend backward slightly to restore level vision, causing pressure to the soft tissues at the base of the skull. Further, this position of the head may cause the muscles under the chin to pull the jaw back, causing pressure in the joint where the jaw attaches to the skull and a disorder known as Temporo Mandibular Joint (TMJ) Syndrome, which can result in headaches, earache, face pain and pain in the neck, shoulders and upper back. In addition, there may be shortening of the lateral neck muscles, causing pressure on the nerves and blood vessels passing through these muscles and inadequate blood supply to the arm and

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[7] Dr Robert Elvey, physiotherapist, reporting on a clinical study carried out with Drs John Quintner and Adele Thomas, quoted in an article titled 'RSI – it's really a pain in the neck', n.d., p. 6.

hand (thoracic outlet compression). The forward head posture also moves the shoulder joint from the side of the body towards the front of the body, causing pressure on the shoulder joint tendons (IMPACC USA 1995).

Repetitive, one-sided movements such as using the mouse with the same hand, rotating the chair in the same direction when getting up or speaking to people, reaching to the same side to the printer or commonly used reference materials, and sitting in a skewed posture such as twisting to view the monitor, also increase the risk of injury (Peper and Shumay 1996). Even in 1996 it was recommended that computer operators observe their movement patterns and rearrange the workstation so that movements could alternate from one side to the other, and that they practise physical movements to counter-balance the asymmetry. Forearm, neck and shoulder tension may also occur where there is a pronounced wrist angle. Wrist flexion and ulnar deviation place strain on the tendons, nerves and blood vessels that pass through the narrow wrist area known as the carpal tunnel and can result in pain and discomfort. Ulnar deviation may also be caused by leaning forward to read the screen, thereby pushing the elbows out from the sides of the body, and by having short arms and/or a wide torso so that the hands and arms must reach around the body, forcing the elbows out and the hands to angle (Peper and Shumay 1996).

A review by NIOSH (1997, p. 2.1) of epidemiologic studies that examined work factors and their relationship to neck and neck/shoulder disorders provided evidence for a causal

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[8] My summary of the technical material necessarily relies on the kind of material that could have been available to management, workers and unions at the time of my field work. I am not giving technical

relationship between highly repetitive work and neck and neck/shoulder MSDs, and evidence for forceful exertion and the occurrence of neck MSDs, which suggested that groups with high levels of static contraction, prolonged static loads or extreme working postures involving the neck and shoulder muscles were at increased risk for neck and shoulder MSDs. Hales et al. (1994) found that the use of bifocals**,** which often results in either neck flexion or extension when viewing a visual display unit (VDU)**,** was significantly associated with neck MSDs. Several studies suggested an exposure-response effect between the number of hours per day using VDUs and the number of cases of neck MSDs (Burt et al. 1990; Rossignol et al. 1987; Knave et al. 1985). Pheasant[9] (Walls 1993, p. 16) argued that most back pain was work related, and caused not as a result of a single injury but as the result of cumulative damage to soft tissue that developed slowly over a number of years due to poor job design and continual poor posture such as slumping or leaning over to work.

A study of keyboard operators with RSI found that working at a keyboard for five or more hours each day was a major causative factor and that sudden increases in workload precipitated injury ('Latest from the experts on tenosynovitis' 1985, p. 41).[10] Problems often occurred when operators returning from leave undertook overtime to catch up their work**,** causing excessive stress to already tired muscles. Fiorentino (1984, pp. 20-21)[11]

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advice, but a fair summary of the variety of sources available at the time.

9 Dr Stephen Pheasant, British consulting ergonomist and author quoted in article by Sarah Walls.

10 Case study presented by Mr Maurice Oxenburgh quoted in 'Latest from the experts on tenosynovitis', *Modern Office*, February 1985, p. 41.

11 Ms Pat Fiorentino, technical inspector, industrial health, Department of Industrial Relations, quoted in 'Repetitious injuries can be prevented' in *Modern Office*, August 1984, pp. 20–21.

noted that “some people have fluidity of movement, a relaxed attitude to their work as well as a good posture, but others seem to take out their frustration or hostility on the keys themselves by banging them – in much the same way as car drivers take out frustration by aggressive driving”. She noted**,** further, that “people with social or work problems are more likely to be candidates for this sort of problem”.

RSI may be caused by “many shared and individual factors” including physical fitness, muscle tension, stress, working long hours, lack of breaks, poor ergonomics and poor work habits (Graps 1998). Hocking, who was medical advisor to Australia’s very large national telecommunications enterprise (1987, p. 220), reported a higher prevalence of RSI among younger employees and a similar incidence for both part-time and full-time staff, suggesting that biological degeneration with age and duration of employment were not major contributing factors, but that acclimatisation to work may be. Personal factors such as weight and diet; contraceptive use and pregnancy; medical conditions including arthritis and thyroid problems; previous trauma; and psychosocial factors such as the level of job security, work autonomy and job satisfaction may all have an impact. Graps emphasised that, while anxiety may worsen symptoms by increasing muscle tension, it was not sufficient to cause RSI, which was “definitely not all in the mind”. RSI is a complex ailment, found in all forms of work, which could be contributed to by many different life-style factors including the person’s family relationships, social problems, employment problems, job overload, being responsible for the work of others and poor working conditions.[12] Each of these stressors can "add to the stress response of the organism, ultimately causing distress" (Jones n.d., p. 6).[13] Armstrong (1992, p. 20) also recognised the multifactorial nature of RSIs, but added that, while personal conditions or activities may be factors, "work activities appear to account for the greatest proportion of cases".

Great contention developed as to whether RSI actually existed and what caused it if it did exist (not for nothing did foreigners refer to 'kangaroo paw').[14] The reports that workers made, were made: the later technical explanation is not the point; rather the relation between the workers' reports and the perceived work setting, including ergonomic arrangements and health promotion advice, is the point of interest here.

The Public Service Association of South Australia Inc, a financially and intellectually well-resourced union closely involved with the issues (1990, p. 37), identified the following as risk factors contributing to repetitive strain injuries:

- *Poor task design*, where lack of variation or lack of rest breaks prohibits the recovery from static and dynamic load on muscles and tendons;

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12 In addition, the increased use of computers as recreational and communication tools means many computer users at work continue to use a computer at home as they deal with their e-mails and/or play computer games.

13 Ergonomist Dr Gerry Jones, Chairman of the Western Australian branch of the Ergonomics Society, speaker at a medical seminar co-sponsored by the Australian Productivity Council and the Ergonomics Society of Australia and New Zealand in Perth, 25 June, quoted in 'RSI – it's really a pain in the neck', p. 6.

14 Article by Auberon Waugh 1986 'Introducing Kangaroo's Paw, a Wonderful New Disease from Australia'[, in *Spectator*. Discussed by T. Nadelson in Millender, Louis and Simmons 1992, p. 223.

- *Rate of work too fast*, as occurs with the use of electronic keyboards that allow the user to work faster than they can physiologically cope with;
- *Time allocated to the task*, where the duration of repetitive movements or the length of time the body is held in a fixed position is prolonged, reducing the body's capacity to recover;
- *Constrained or awkward postures* that require more effort to sustain, placing more stress on the body;
- *Poorly designed furniture*, which may discourage or prevent the use of a comfortable, efficient work posture;
- *The load or force* that is required to perform the movement or task;
- *Unaccustomed work*, as occurs when returning to work after being on prolonged leave;
- *Deadlines* that require an unnaturally fast work rate;
- *Lack of job training* in the use of new technology and appropriate ergonomic principles; and
- *Stress* as a result of the need to meet deadlines, or of overbearing supervision, that increases tension in the muscles.

Worksafe Australia (1996) acknowledged that psychosocial factors such as workplace stress may be important in the development of Occupational Overuse Syndrome. Job stress generally arises where environmental demands either exceed personal capabilities or fail to meet workers' capabilities or expectations (NIOSH 1984, p. 42). Stress can result from factors such as narrow repetitive work, under-utilisation of skills, heavy mental loads, pressure to meet deadlines or to catch up after returning from leave, and overbearing supervision. Operators who feel aggravated and take out their frustration on the keyboard are likely to suffer neck, shoulder and back aches as mental stress causes tensing of skeletal muscles, which, if imposed on any existing postural stress, increases the likelihood of muscular fatigue. Bruxism (grinding teeth) is a symptom of stress that may not occur at work, but may occur when the operator is relaxing or trying to sleep, resulting in aching teeth and shooting pains in the jaws and into the ears (Meilach 1983, pp. 52–53).

Peper et al. (1994, p. 2) also suggested that the development of RSI involved ergonomic and psycho-physiological contributing factors. In addition to inappropriate ergonomic workstation set-up, restricted body movements, asymmetrical work patterns, and the absence of regenerative breaks during work activity, these authors included lack of somatic awareness of tension and relaxation, physiological tension during self-perceived relaxation, excessive focus on tasks and/or flawless work record, work dissatisfaction, and thoracic breathing and/or breath holding during data entry, as further risk factors.

Oxenburgh (1991, p. 57) pointed out a range of relevant considerations: the work a person does may “cause the disorder; contribute to the disorder; accelerate the injury process; provoke symptoms in a previously injured person; or provoke symptoms in an aged, but previously healthy person”. Zaviska (1985, p. 1) had already made the more general point that, if a person has a ‘weak link’ in their body, it will be the first to let go under stress or pressure.

Frequently workers experience symptoms for a considerable length of time before they seek medical attention, and many disorders are unreported. Only in extreme cases are the disorders seriously disabling and, although experiencing discomfort that may affect their work performance and daily living tasks, workers can be very resourceful in finding ways of coping (Armstrong 1992, p. 20). It is interesting to note that, even when conditions do result in disabilities, they are often "handled as a personal problem rather than as work-related problems" (Armstrong 1992, p. 20).

The suggestion that computers themselves could be harmful was initially dismissed because they emit only minute amounts of ionising radiation (Marriott and Stuchly 1986, p. 846). However, weak electromagnetic fields are capable of interacting with biological systems and the effects of the magnetic component of low-frequency radiation continued to be explored (Braidwood 1988, p. 34).

Ergonomic Factors Relevant to the Prevention of Computer-Related Disorders

Strategies for the prevention of computer-related disorders must be based on redesigning the work and systems so that factors identified as causing health problems can be eliminated (PSA 1990, p. 40). A range of health problems have been associated with computer use, usually with a presumption about ergonomics. The following examples indicate both the association and the nature of the presumption (Peper et al. 1994, pp. 8–9).

Eye strain and headaches: inappropriate VDU distance and tilt, incorrect lighting conditions and incorrect optical prescription; incorrect sitting posture and inadequate rest.

Neck and shoulder pain: the source material being in a flat position; the VDU being positioned too far away from the operator ; the head being held off-centre; the VDU being positioned either too high or too low, resulting in incorrect head tilt; the use of bifocals, resulting in an inappropriate head position; hunched shoulders as a result of the keyboard being too high or inappropriate height of chair arms; drooped shoulders as a result of being too far away from the keyboard; arms not being supported; the distance of the computer mouse; and one-sided movements.

Pain in the arms, wrists and fingers: repetitive motion with inadequate rest; striking the keys with too much force; the key design; and the location of the keyboard and mouse, resulting in poor posture.

Back complaints: poor posture and positioning of the hips, shoulders, legs and feet; incorrect chair adjustment; lumbar support not provided.

Pain down the legs: compression from the chair due to inadequate padding or styling, such as the seat pan being too deep or the front of the cushion not being rounded; poor leg position such as crossed legs or a sharp leg bend; and one-sided movements.

Pain in the foot or toes: feet not being on the floor or supported by an appropriate footrest; poor circulation; poor leg position and lack of movement.

Swollen ankles: lack of movement.

Eversmann (1992, p. 74) noted that detailed ergonomic analysis of the workplace and "reorganization of space, redistribution of jobs, and enlargement of jobs", would provide the employer with cost-effective solutions for cumulative trauma disorders. Workstation and ergonomic assessment tools and checklists were useful for evaluating work sites and identifying ergonomic risks. Logically, these should lead to preventative recommendations focused on workstation design, posture and the design of furniture and equipment, job design, software ergonomics, the physical work environment and job training.

Workstation Design

The design of a computer workstation should begin with an analysis of the tasks to be performed, the consequent equipment and materials required, and the anthropometry of the operator(s) (Stevenson 1991, p. 1). The literature suggested that furniture and equipment be arranged to suit the variety of tasks to be performed, to avoid undue twisting of the neck or trunk, and to avoid stretching or lifting. It was recommended that all operations required of the computer user be within arm's length and direct view. Often-used items should be placed within comfortable reach and there should be sufficient clear space available for laying out copy and using a computer mouse. Peper and Shumay (1996) advised computer users to centre the work in front of themselves, e.g. if the task required entering numerical data, the keyboard should be moved to the left so that the numeric keypad was in front, or if the task required more mousing than typing, the mouse should be moved in front.

U-shaped or L-shaped layouts enable operators to swivel easily from one work area to another. Australian Commercial Safety Regulations specified that there will be "not less than 3.5 square metres of floor space exclusive of furniture, fittings and equipment" per person working at a desk (Australian Industrial Safety, Health and Welfare Regulations 1991, 27(1), 53(3)). The PSA (1990, pp.7, 9) recommended that workstations be placed to facilitate communication between operators and avoid depersonalisation of the work environment, and that the floor plan be designed so that the approach to a workstation was at a 45-degree angle from the front, or from the side or front-on, so that employees were not approached from behind. Having the user's back towards the entry to the work area may affect wellbeing by increasing vigilance and putting the worker 'on alert', resulting in sympathetic arousal that activates the muscle trigger points (Peper and Shumay 1996). Worksafe Australia (1989b, p. 16) suggested that where several VDUs are located together, the workplace be organised so that "VDU operators are no closer to any other VDUs than they are to their own" to avoid any risk of radiation.

The PSA provided a complex diagram (Figure 1.1) to illustrate the health risks and other consequences that may be associated with an inadequately designed workstation (PSA 1990, p. 31).[15]

[15] The lack of appropriate workstation design in the home may also contribute to the health problems experienced by computer users.

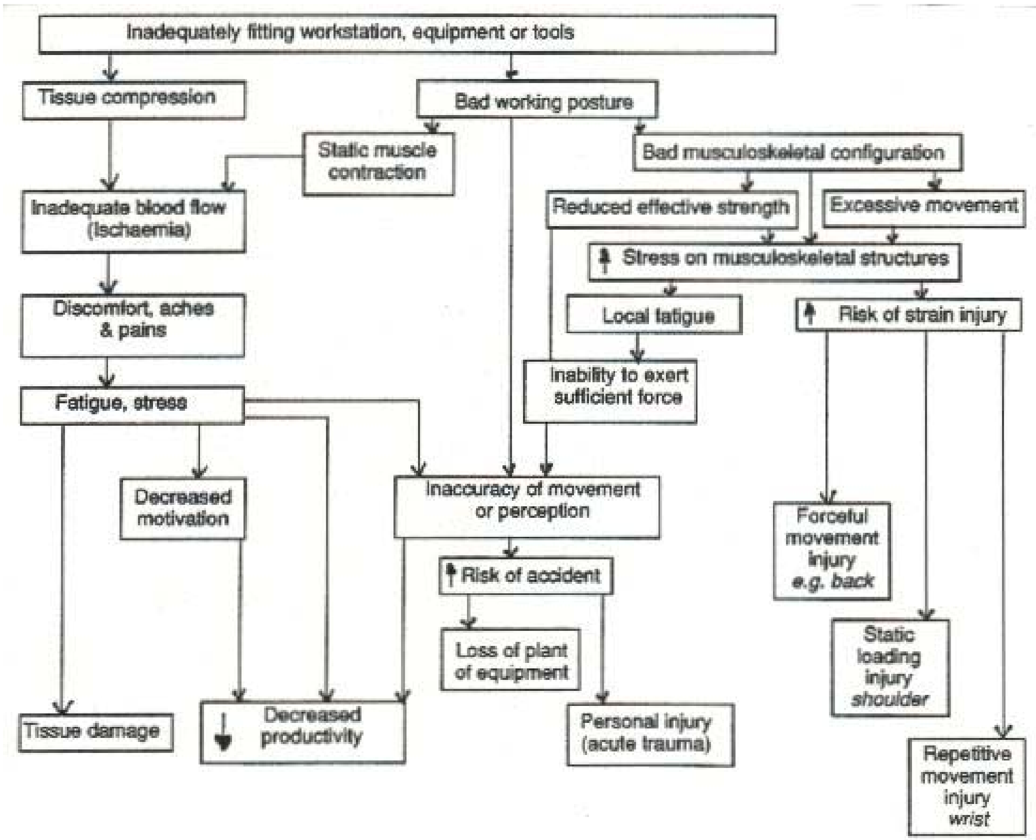

Figure 1.1 Consequences of Failure to Apply Anthropometry Design of Workstations

Posture and the Design/Layout of Furniture and Equipment

The South Australian Health Commission (1988) recommended starting with the correct positioning of the body and then arranging well-designed facilities to conform to each individual's characteristics. They suggested 'two keystones' be used to gauge the correct posture for keyboard operation: keeping the sternum held up whenever an activity is being performed; and placing the weight evenly on the two bones (ischial tuberosities) under the buttocks when sitting, the bones, as the 'support beams' of the body, being used for support rather than the muscles and ligaments. In a good posture the spinal column and pelvis are balanced, so that the weight of the spinal column, torso and head is placed on a vertical line down through the sitting bones into the surface being sat on and the natural curves of the back (cervical, thoracic and lumbar) are maintained. Leaning slightly forward when typing, rather than leaning back and sagging downward, “brings the centre of gravity more over the base of support formed by the thighs resting on the chair” and provides more stability; keeping the torso free and opened upward, reducing tension (Doheny et al. 1995, p. 10).

Chairs used by computer operators should be easily adjustable for height and back support in order to achieve correct posture. In order to encourage operators to make adjustments, it is important that they can reach and operate all controls whilst seated in the chair. If the work involves sideways movement, chairs should rotate to avoid unnecessary twisting of the upper body. Australian standards recommended that chairs have a firm, well-padded seat to help distribute body weight, and that the front edge of the seat be curved or waterfall-shaped to avoid pressure areas under the thighs. The depth of the seat, front to back, should allow clearance between the front of the seat and back of the knee when using the backrest (Standards Association of Australia 1976, p. 9). The seat base should be sufficiently large to allow the buttocks to move to permit changes of posture but should not be so large that the seat cuts into the back of the knee or prohibits the user from making contact with the backrest. It was recommended that the height of the seat above the floor be adjustable between 380 mm and 480 mm for keying tasks and between 380 mm and 510 mm for combined keying/writing tasks (Standards Association of Australia 1990b, p. 14). The height of the chair should be related to the size of the operator and the height of the work surface. As a general rule the top surface of the seat should be the same distance from the floor as the length of the lower leg plus shoe sole so that the feet rest fully on the floor and the seat does not press on the thighs, causing discomfort. The length of the operator's forearms will determine the reach to the keyboard and the position of the chair (Doheny et al. 1995, p. 13). It was generally recommended that typist chairs be gas lifted to enable quick, easy height adjustment, and without armrests, which may interfere with arm movements. Where chair arms are provided, they should be of adequate width, padded, and of a height above the seat that does not result in elevation of the shoulders and the risk of pinched arm nerves (Standards Association of Australia 1990b, p. 10). Chair arms should not prevent the operator from getting sufficiently close to the workstation.

It was also recommended that the backrest of the chair be shaped to form a convex curve of approximately 250 mm radius in the vertical direction and a concave curve of between 550 mm and 750 mm in the horizontal direction, and that this shape be formed by the structural support of the backrest rather than by the cushioning material alone. Once adjusted, the lateral position of the backrest should not change with the transfer of body weight (Standards Association of Australia 1990b, p. 13). Australian Standard AS/NZS 4438: 1997 requires that the horizontal backrest width for height-adjustable swivel chairs be greater than or equal to 360 mm. However, it is important to match the backrest width to the size of the person because if the backrest is too wide there may be inadequate clearance for the elbows, causing them to be stuck out at the sides so that the forearms can move freely when typing. Other consequences may be raising the shoulders to free the elbows and moving back from the desk so that the elbows are held forward, clear of the backrest. Each position can result in discomfort, particularly shoulder pain.[16] It is preferable that chairs be upholstered in a low-contrast colour, non-slip fabric that ‘breathes’ and is at least 90% wool. If chairs are on castors to allow ease of movement, they should have a five-leg star base with a diameter of not less than 580 mm for stability. Chairs should have twin-wheel casters if they are to be used on carpet, or glides if they are to be used on a smooth surface (Standards Association of Australia 1990b, p. 13). These ergonomic principles are particularly relevant as bad seating can result in problems such as lack of concentration, backaches, constant keyboard errors and irritability (Moore 1990, p. 45). Alternating chairs three to four times per day is also suggested as a practical way to reduce backache and fatigue (Weber 1983, p. 10).[17]

It is usually recommended that desks be adjustable to allow the keyboard and VDU to be positioned to suit personal dimensions. The adjustment mechanisms need to be easy to operate from a seated position and should not hinder leg movement (PSA 1990, p. 6). The height of the desk should allow the forearms to be level or angled slightly downward when keying in data. Standards Australia (AS3590.2: 1990) specified a height of 580–730 mm.[18] There should be sufficient desktop space to accommodate the VDU, keyboard and associated equipment, and provide adequate space for writing and resting the hands and

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[16] As discussed by Mr David Brown on the Aus ergo e-mail list on 20 June 2002 and covered in his 1986 video titled ‘Fresh Muscles’.

[17] The last three pages of summary of ergonomic literature raise the question ‘To what extent were these ‘truths’ conveyed to workers or assimilated by them?’.

[18] AS3590.2: 1990 *Screen-based workstations Part 2: Workstation furniture* has been partially superseded by AS/NZS 4442:1997 *Office Desks* and AS/NZS 4443: 1997 *Office Panel Systems.* AS3590 for screen-based workstations is currently under review and AS 1837, *Code of Practice for Application of ergonomics to factory and office work*, has been withdrawn.

arms. The minimum dimensions recommended were 1200 mm x 900 mm for keyboard work only, and 1500 mm x 900 mm for keyboard and clerical work (Standards Association of Australia 1990b, p. 8). It was recommended that desks be a minimum of 550 mm deep and 800 mm wide in order to provide sufficient leg clearance. It was also recommended that desks have a matt-finish surface, in neutral colours to avoid glare, and be constructed without sharp corners, edges or protrusions (PSA 1990, p. 6). Work surfaces should be easy to clean and finished so that it is possible to write on a single sheet of paper with no backing (Standards Association of Australia 1990b, p. 9). Desks should be kept tidy, with items such as books and print-outs clear of the computer's ventilation system.

The keyboard may need to be at a lower level than the VDU and positioned close to the edge of the desk to allow the upper arms to hang by the ribs, and not be lifted forward, and the wrists to be kept level when keying in data. A common error is to place the keyboard on the surface of a writing desk, making the keyboard too high, and raising the shoulders. In this situation it may be necessary to attach a keyboard tray to the desk. The tray should be adjustable, both up and down and forward and back, and wide enough to accommodate both keyboard and computer mouse. The keyboard height should be adjusted so that the upper arms are perpendicular to the floor and the forearms at an angle of 90–100 degrees. If the keyboard is too low, the hands bend backwards, increasing the angle of the wrist. Computer operators should use a light touch on the keyboard and avoid forceful movements.[19] Preferably the keyboard should be thin, with dished keys to allow ease of operation. The use of preset tilt-down keyboards has been found to assist computer operators to work with the wrists in a neutral position and the arms relaxed (Hedge 1995). Worksafe Australia (1989a, p. 25) recommended that keyboards be less than 30 mm thick at the home row of keys, and matt finished to prevent eye irritation from glare and reflection. Keyboards should not slip, tip or rock during normal operation and should be resistant to dirt, dust and moisture (Standards Association of Australia 1990c, p. 4).

In addition to the standard QWERTY design, fixed split, sculpted, adjustable split and other types of alternative keyboard were available. Fixed split keyboards have standard key spacing and size with an opening angle and some vertical angling of the keys. The numeric keypad is sometimes detachable. Sculpted keyboards separate the left and right-hand key fields without angling, with the keys in dished-out depressions. Adjustable split keyboards generally can vary their horizontal and vertical split angles and have detached numeric keypads. Over 80% of respondents in a user survey described by Wright and Andre (1998, p. 22) reported that their alternative keyboard improved posture and comfort, and reduced pain.

Wrist pads may be placed in front of the keyboard to provide a soft resting surface when taking micro breaks rather than placing the hands on the hard corner of a desk, which may

[19] Computer users should also avoid contorting the hand in awkward angles in order to type key combinations with only one hand (Harvard RSI Action 2004).

reduce circulation. It is important, however, that computer users do not rest their wrists on the wrist pad while they are typing (IBM 1999). The hands and wrist should be held straight and level with the arms, not flexed or extended, and hands and arms able to flow over the keyboard, rather than being locked into position at the keyboard. The typing movement is then distributed throughout the whole arm and shoulder.

To achieve a suitable posture, chair and desk heights need to be adjusted so that the operator's forearms are parallel to or slightly lower than the working surface and the wrists are level when keying in data (Worksafe Australia 1989a, p. 23). The operator's elbows should be comfortably in at the sides of the body, and the shoulders relaxed. The document holder and VDU should be positioned so as to avoid excessive bending or twisting of the neck (NIOSH 1984, p. 41). It was generally recommended that the back be kept straight, and the legs used as active positional stabilisers, being at 90 degrees or more to the thighs, which should be well supported on the chair. Knees should be slightly lower than the hips to allow correct positioning of the pelvis and the lower back to be more relaxed. The backrest height should be adjusted to fit into the small of the back to adequately support the spine, yet give clearance for the buttocks, and cause no interference to the shoulder blades. The backrest angle should be adjusted so that the operator is sitting upright while keying (Worksafe Australia 1989a, p. 11). However, NIOSH (1984, p. 32) suggested chairs with high backrests that provide support for the entire back are preferable to those which provide support in the lumbar area only. The operator's chin should be tucked in, lengthening the back of the neck, and the abdomen held up slightly for muscular support. The feet should be shoulder width apart and either flat on the floor or supported by a footrest so that the thighs are level and the front edge of the seat does not cut in underneath them. Some people may need a footrest to raise the legs and remove pressure from the underside of the thighs. Footrests should have variable height adjustments and a non-slip surface that is large enough to allow the feet to be placed in different positions. A loose footrest that can be placed wherever desired, and that can be tilted within a range of 10–30 degrees was recommended (NIOSH 1984, p. 34).

The posture that has been described is usually referred to as the ‘90 degrees’, ‘right angle’ or ‘upright’ posture and is illustrated in Figure 1.2 (PSA 1990, p. 37).

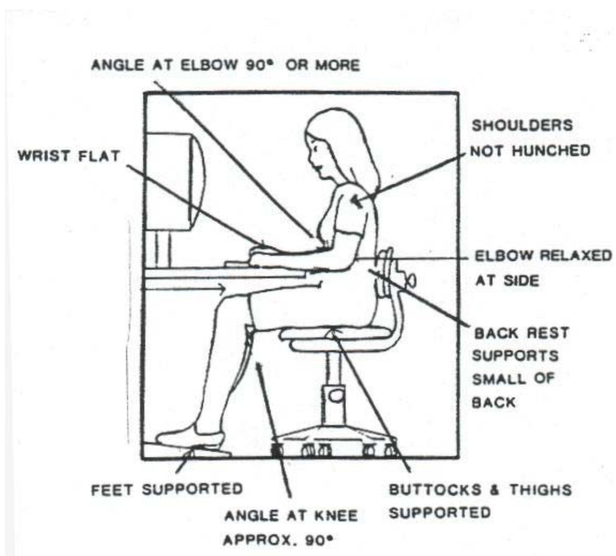

Figure 1.2 Diagram showing the Seating Posture Recommended for Keyboard Work

Descriptions of other postures can be found in the literature, namely the ‘reclined trunk’ posture identified by Grandjean, Hunting and Pidermann (1983), and the ‘forward seat tilt’ posture of Bendix (1984) and Mandal (1981). Dainoff and Dainoff (1987, p. 41) noted that “there are clear advantages and disadvantages to all three postural options”. However, when Miller, Straker and Pollock (1992) investigated the effects that these three sitting postures had on the typing performance of audio typists, they found a significant difference in the length of time that each posture could be maintained, with discomfort being a limiting factor in the forward seat tilt and reclined trunk postures. Dainoff and Dainoff (1987, p. 41) recommended acquiring a chair that is capable of both forward and backward tilt as well as the upright position. The chair could then be “locked into forward tilt” while keying in data, “into backward tilt while editing or writing”, or “into the upright position as a compromise allowing both lumbar support and proper orientation of hands and eyes, or as respite from either of the other positions should they become tiring”. It is generally agreed that there is no ideal posture for all conditions and that if any position is maintained for an extended period of time, muscular fatigue and pain will result from the static load (NIOSH 1984, p. 29).

The VDU should be positioned at a comfortable reading distance; not too close and a maximum distance of 750 mm (Standards Association of Australia 1990b, pp. 6–8). A viewing distance of ‘an arm’s length’ is usually recommended as it reduces the amount of radiation received from the VDU and the eye strain caused by looking at a closer focus point (Doheny et al.1995, p. 14). Standards Australia suggested that the centre of the screen be no higher than 400 mm above the work surface and that forward head tilt be limited to a maximum of 15 degrees to avoid fatigue. They also suggested that the most comfortable viewing zone was 32–45 degrees below the horizontal. If the operator wears bifocal glasses, the screen may need to be adjusted to avoid craning the neck in order to see the screen through the lower part of the bifocal. As the distance from eye to computer screen is generally greater than the usual reading distance, computer operators who wear glasses may need them specially prescribed for computer use. It has been suggested that computer users wear properly focused, single-vision lens glasses with photochromatic lenses that continually adjust to changing light, rather than bifocal or reading glasses which may have the focus set incorrectly for the viewing distance (Meilach 1983, p.52). It is a good idea to measure the actual distance from the eyes to the monitor when seated in the usual working posture to determine the required focal distance. Appropriately prescribed computer multifocals that also allow the wearer to read and see into the distance are a useful option, particularly in overcoming any worker resistance to having a separate pair of glasses for computer work. A document holder can be used to place the hard copy at approximately the same distance from the eye as the screen so that the eyes can make an easy movement from manuscript to screen text. Ideally documents should be placed in front of the user to minimise turning the head to the side and be held on a slanted support to reduce the need to tip the head forward to read them. The use of a document holder can reduce strain on the spine, shoulder and neck muscles, and increase productivity by enabling the operator to work comfortably without twisting the torso or neck. The document holder should be adjustable and strong enough to adequately support all source documents (Worksafe Australia 1989a, pp. 14–15).

Sanders and McCormick (1987, p. 419) argued that it was easier to read screen text under low room illumination as this provides less glare, and recommended that to reduce glare the light source or work area be positioned so that reflected light would not be directed towards the eyes. Studies have shown that "operator performance is better and expressions of visual fatigue are less frequent" with a negative contrast of dark characters on a light background (NIOSH 1984, p. 18). With a lighter background, reflections from the display are less noticeable and the luminance of the display more closely matches that of the surroundings and source documents. VDUs need to be correctly adjusted for contrast and brightness to produce sharply defined images on the screen. Meilach (1983, p. 52) suggested readjusting the screen's contrast during the day as the light changes. It was recommended that screen colours of white, green or orange be selected rather than red or blue, which can cause focusing difficulties (NIOSH 1984, p. 19). It was also recommended that anti-glare, optically coated glass filters be used to increase viewability, together with an anti-static cleaning fluid to keep the screen and anti-glare filter free of dust and fingerprints.

It has been suggested that glare on the computer screen is the primary cause of eye strain in connection with extended computer work (Harper 1991, p. 39). VDUs should be positioned so as to avoid reflections and glare that can reduce display legibility, cause discomfort to the operator's eyes and contribute to poor posture as operators bend forward in an attempt to read the obscured characters (Stammerjohn, Smith and Cohen 1981, p. 2). The VDU should be placed as far from windows as possible, with windows at right angles to the screen, rather than behind or in front. It may be necessary to install curtains, blinds, solar control film or an outside awning to windows to reduce direct sunlight. This will also give an advantage at night when "the darkness outside turns the windows into reflecting, mirror-like surfaces” (NIOSH 1984, p. 8). The use of darker colours for curtains and blinds avoids creating a luminous surface.

Computer operators should check for screen reflections by looking into a blank screen to determine whether they can see overhead lights, windows, belt buckles and other light distortions and, if they can, try to remove them (Meilach 1983, p. 52). Operators should be aware that light may glare off a desk with a shiny surface and even white clothing may cause reflection. It may be necessary to place a room divider or partition behind the computer to reduce outside light and overhead glare. The use of non-reflective paint or coverings on the surrounding walls will also help to reduce glare. Surfaces that diffuse light, such as flat paint and crinkled finishes are more suitable than bright metal, glass or glossy paper (Sanders and McCormick 1987, p. 416). Clark (cited in Weber 1983, p. 10) recommended that the casing of computer equipment have a matt finish and be a neutral colour, such as grey or beige, so that the transition from source material to screen is easier on the operator’s eyes.

Monitor size may also impact on eye fatigue: Harper (1991, p. 39) warned that “the viewer should never be using a monitor that is so small that the type size is at the threshold of what is comfortable to view”. It was recommended that computer users blink regularly to lubricate and relax the eyes, and look across the room or out of a window while waiting for the computer to process information to allow long-distance viewing (Peper and Shumay 1996).[20]

The study by Sheedy (1991) found that more than two hours' computer use a day could create vision problems. The PSA (1990, p. 8) recommended that organisations have a policy of providing eye examinations, with checkups every one to two years for all computer operators doing in excess of one hour of VDU work per day. They suggested that employees have a vision assessment prior to initially commencing work with VDUs to ensure that any defects in eye function were corrected and to provide a record of eyesight before and after a period of VDU work. The PSA emphasised that the aim of having these examinations should be to enable operators to work more comfortably, and not to exclude them from that type of work. It is interesting to note that Cakir et al. (1980) found that a substantial proportion of operators with inappropriately corrected vision had also received treatment for back problems.

Physical Work Environment

The overall level of lighting should provide sufficient illumination to read hard copy without straining. It should not be unnecessarily bright, with all areas illuminated evenly to avoid shadows. Recommended background lighting was 150–200 lux, with supplementary task lighting of at least 300 lux. "Lighting should be designed to minimise the contrast between background luminance and screen luminance"; the luminance ratio

[20] Other suggestions included following a '20/20 rule' – every twenty minutes look twenty feet away for twenty seconds.

between task area and surroundings should not exceed 4:1 (PSA 1990, p. 9). It was recommended that artificial lighting be overhead, with baffles to reduce glare.

The temperature and airflow in the work area need to be comfortable. It was recommended that air conditioning be maintained in the temperature range of 21–26 degrees Celsius, with a flow of seven metres of air per person per second (Australian Information Industry Association 1988). The PSA (1990, p. 11) suggested humidity levels of approximately 50–55% to avoid very dry air or very moist air**,** which is uncomfortable and not conducive to improving productivity. Desks may need to be moved away from windows or doorways to avoid draughts that may cause illness. If heaters or fans are required, they should be positioned to be most effective, but without cords lying around in an unsafe manner.

It is important that noise levels be conducive to concentration as noise from air conditioners, printers, collators, telephones and people talking can cause annoyance, stress and ill-health, affecting work output and accuracy (PSA 1990, p. 7). The recommended sound levels for computer rooms were 45–55 dB(A), and for general office areas, 40–45dB(A) (Standards Association of Australia 1987, p. 6). Sound-absorbing paneling, carpeting and curtaining may be used to reduce noise levels. Desks should not be placed near windows if there is an inappropriate level of outside noise.

The area where computer operators work should be decorated in colours appropriate to the furniture and surrounds, and the climate. Pastel shades were generally recommended rather than bright, distracting colours that may be harsh on the eyes, and an off-white ceiling to enhance the general illumination of the area and decrease glare by increasing the level of brightness around light sources (NIOSH 1984, p. 7; Quibble 1996). The placement of plants, paintings or wall hangings and posters behind the workstation to provide focal interest and act as visual relief centres to assist in alleviating eyestrain were recommended (PSA 1990, pp. 7, 9). Also, it was recommended that computer areas be kept clean as dust, smoking, food and liquids can cause damage to computer equipment and computer operators may feel more comfortable and work more productively in a clean environment (Quibble 1996, p. 95).

Software Ergonomics and Mouse Use

The ease with which a program can be learnt and used can impact on how comfortable the operator feels and their productivity. Most programs incorporate icons and easy to follow menus that can be activated by the use of a pointing device. Computer mouse pointing devices have been cited as the reason for many computer-related hand and arm injuries as a result of arms reaching to the side of the keyboard, deviated wrist postures and repetitive motions (Wright and Wallach 1997). Often the arrangement of the mouse is such that the computer user is forced to work with the right arm extended, abducted away from the body, and the wrist in sustained extension or, alternatively, the computer operator is required to reach forward to use the mouse on top of the desk.

Where a standard keyboard that incorporates a numeric keypad is used the mouse is usually located at the right-hand side of the keyboard and away from the mid-line of the body. Positioning the mouse away from the centre of the body and operating it from the side can put more pressure onto the neck and shoulder muscles, causing aches, pain and headaches and neck and back problems from an elevated and rotated right shoulder (Cook and Kothiyal 1998). The mouse arrangement should allow the operator to work with the shoulders and arms relaxed and the wrist in a neutral position. The mouse should be held lightly, rather than gripped or squeezed, and placed close to the keyboard to avoid reaching. The arm and hand holding the mouse should be close to the body. Wright and Wallach (1997) suggested that the whole arm be used to move the mouse, to avoid over-using the finger and wrist muscles. Manoeuvering the mouse on the mouse pad and pressing it too hard onto the pad may also cause problems. Recommendations included selecting a keyboard that allows the mouse to be placed more centrally, placing the mouse on the opposite side and using the left hand for variation, and using the ‘settings’ function to alter the sensitivity of the mouse so that the operator is not so tense about lining up the cursor.

Australian Standard AS3590.3 specified that a mouse should accommodate a close to neutral hand posture and be as small as practicable. Computer users need to be aware that “sustained operation of the mouse can result in excessive static muscle use of the finger/s poised over the push button/s”, causing pain in the area of the right thumb (Standards Association of Australia 1990c, p. 5).

Some pointing devices had a scrolling button that allowed the reduction of unnecessary repetitive movements, could expand and contract to fit the individual requirements of the operator’s hand, were designed to suit right-handed or left-handed people, and were programmable to increase or decrease cursor speed and make the screen cursor larger or smaller. Other devices included a joystick mouse, designed to overcome the problems of gripping the mouse too tightly, and a vertical mouse with a ‘handshake’ grip, two-way rocker button on the top to provide left and right clicks, and a third button for scrolling. The vertical handshake grip was designed to keep the user’s arm in a more natural, neutral position, reducing the muscle strain and discomfort associated with the standard mouse caused by having the palm facing down (The *Advertiser* 18 November 2000, p. 93).

It was recommended that operators knew the software shortcuts and used the equivalent keyboard commands whenever practicable to reduce the amount of mouse usage (Horrigan Aus_ergo 2001). Voice recognition software and other devices such as trackballs, touch pads, digitiser pens and touch screens were available as alternatives to the mouse.

Job Design

“The design of work methods should be such that the operator can work efficiently, comfortably, without confusion and without incurring undue fatigue” (Standards Association of Australia 1976, p. 7). Australian Standard AS1837 (1976, p. 22) stated that:

- static loading of muscle groups is tiring and should be avoided;
- prolonged maintenance of one position is undesirable and a change of posture is advantageous;

- excessive reaching and twisting movements are tiring and inefficient and should be avoided;
- use of force should be kept to a minimum; and
- when the frequency of certain movements is high, operators need to rest muscles by alternating with other types of work.

Prevention of RSI begins with recognising employees who are at risk and developing protocols for reducing the risks, including the redesign of tasks to be more diverse, and including rest and movement breaks as part of the job structure (Doheny et al. 1995, p. 8). Studies conducted by NIOSH (1984, p. 35) found that the introduction of computers often simplified jobs and eliminated natural work breaks such as obtaining supplies, making copies and filing that had previously been necessary. Therefore, it is important that computer operators have frequent short rests away from the computer throughout the day to enable them to physically and mentally recover from demanding and repetitious work. Prolonged sitting in a rigid position with only a few muscles working results in the build-up of lactic acid, carbon dioxide and other chemicals, which can cause pain and muscle spasm. To overcome this, operators need to leave their chair at frequent intervals and actively move their muscles and joints to improve blood flow and move the harmful build up (Wright 1992). The PSA (1990, p. 40) guideline is a ten-minute rest break every 50 minutes for employees who operate VDUs in excess of one hour per day. The installation of software programs that remind users to take a rest after a preset time or specific number of keystrokes may encourage rest breaks to be taken. Operators should plan their work day to incorporate alternative tasks which are non-repetitive and allow them to move around during the breaks, keeping in mind that visual rest, such as looking into the distance, is also necessary.

Job rotation, or changing to another type of job during the day, avoids doing the same repetitious task for long periods. Varying tasks in this way may not only help in preventing injury and fatigue, but also relieve boredom, and increase motivation and productivity. Computer use should form only part of an individual's job and VDU operation should be rotated amongst a group of employees to avoid long periods of time being spent on single repetitive tasks. Such rotation should be designed in consultation with the operators (PSA 1990, p. 9). The PSA's (1990, p. 40) policy was that word processing centres where the operator's task is only keyboard based be prohibited. It also recommended that operators work at a keyboard for no more than two hours consecutively, with a routine of one hour on and one hour off, and that the maximum period in which an employee operates a VDU be limited to four hours per day.[21]

Work systems need to be designed so that pressure is not able to build up and affect the operator's performance or welfare (South Australian Health Commission 1988). The organisation of work and output levels should be decided in consultation with the operator, taking into consideration the individual's capacity for work. A period of adjustment may be necessary to allow staff to become accustomed to new jobs, work rates or equipment, and the return to work after holidays or sick leave. The work flow should

[21] These remain as the current recommendations of the PSA; there have been no later editions of the *Office Design and Equipment* handbook.

be organised to minimise deadlines and stress associated with working under pressure, with arrangements made for relief staff during peak workload periods and when staff are absent, so that operators are not required to work harder or faster than they physically should. High-speed work was recognised as one of the main causes of repetition disorders. The PSA (1990, p. 40) specified that the maximum keystroke rate for keyboard operations be 10,000 keystrokes per hour, which is approximately equivalent to four A4 single-spaced pages per hour. Operators can reduce stress by planning their work day to even out busy and slow times and by setting realistic expectations of what can be achieved.

Computer operators should be encouraged to perform gentle stretches at the keyboard, during rest periods and after work, to counter potential strain of the neck, back and wrists. These exercises, often referred to as 'pause gymnastics', can reduce tension and fatigue and increase operator flexibility and wellbeing. Computer operators should also take 1–2-second brief regenerative 'micro breaks', and consciously relax their arms and hands when taking a break in typing and/or stopping to think. It was suggested (Peper and Shumay 1996) that micro breaks be taken every 30 to 60 seconds, or at the end of each paragraph or column of data, to interrupt keyboarding and avoid continued tension. Computer users can simply drop their hands into their lap or to the sides of their body, and let them go limp before bringing them back to the keyboard or mouse and continuing to work. Extending the legs frequently while sitting and occasionally rotating the ankles can relieve strain. Every 15 to 30 minutes, the operator should stand and make a large body movement to release low-level static muscle contraction. Wherever possible movement should be integrated into the operator's work style to protect against ongoing muscle tension. This can be achieved by moving the printer to another part of the room, taking the stairs rather than the lift, and going for a walk during the lunch break (Peper and Shumay 1996).

It was also suggested that computer operators regularly scan their bodies for tension and practise 'letting go', to help recognise and release tension before there is pain or discomfort (Peper and Shumay 1996). Peper and Shumay argued that computer users are generally unaware that they hold their shoulders and arms tight as they type and use a mouse and, when soreness makes them aware of the muscle tension, it is often too late to prevent the beginning of injury. They also noted that computer users tend to breathe shallowly in the chest without abdominal movement – a breathing pattern associated with stress and anxiety – and recommended that computer operators practise diaphragmatic breathing throughout the day, especially if they find themselves gasping or holding their breath, to promote relaxation and reduce neck and shoulder tension. Cold hands linked to computer-related disorders as a result of vasoperipheral constriction may occur when the computer operator is stressed and autonomically aroused (Peper and Shumay 1996). Peper and Shumay (1996) recommended that the hands be kept warm, by wearing fingerless gloves if necessary, and that the intake of vasoconstrictive substances such as caffeine be reduced.

Job Training

"All employees should be trained in ergonomically correct working methods" and "managers and supervisors should ensure adequate supervision of employees at all times to maintain these methods" (Standards Association of Australia 1976, p. 29).

"Understanding of and skill in the economical and strain-free use of the body" was thought to be the "key to structuring a safe, comfortable and productivity-enhancing work environment for computer users" (Doheny et al. 1995, p. 12). Training should cover awareness of stress-producing situations and recognition of early signs and symptoms of stress, as well as training in the performance of the main task. The achievement of a safe working environment requires management commitment to ensure not only that the design of the workplace and its tasks are appropriate to the needs of the worker, but also that information, instruction and supervision in relation to the relevant ergonomic principles are provided. This may include education in body awareness, relaxation training and fitness activities in addition to covering areas such as the positioning of furniture and equipment, adjustments, appropriate postures and work habits. Further training in non-verbal communication, negotiation and conflict resolution may minimise personal and interpersonal strain (Doheny et al. 1995, p. 9). The controls planned by the organisation to offset potential health risks should also be explained, along with the arrangements for reporting incidents and injuries, so that appropriate records are maintained and follow-up procedures implemented. Computer operators also need to be made aware of their responsibilities in relation to occupational health and safety.

Legislation, in the form of the Occupational Health, Safety and Welfare (OHS&W) Act, 1986, still operative in South Australia, requires employers to ensure, as far as is reasonably practicable, that an employee at work is safe from injury and risks to health, by providing and maintaining a safe working environment and safe systems of work, providing information and training as necessary, monitoring the health and welfare of employees, preparing occupational health, safety and welfare policies, and keeping records of work-related injuries suffered by their employees (OHS&W Act, Sections 19 and 20). In addition, the Act requires employees to take reasonable care to protect their own health and safety at work and to avoid adversely affecting the health or safety of any other person through act or omission at work. Employees are required to use any equipment provided for health or safety purposes, obey any reasonable instruction that the employer may give in relation to health or safety at work, comply with any approved policy that applies at the workplace, and ensure they are not, by the consumption of alcohol or a drug, in such a state as to endanger their own safety or the safety of others at work (OHS&W Act, Section 21).

An analysis of Australian Bureau of Statistics data showed that, about the date of my field surveys (1994-1999), Australian employees averaged less than one and a half hours of occupational health and safety (OHS) training each year. Women workers and young workers aged between 15 and 24 years received below average rates of OHS training. Also, workers born outside Australia had lower rates of OHS training than Australian-born workers, and small business employees were significantly under-represented among

OHS training participants (National Occupational Health & Safety Commission (NOHSC)[22] 1997b, p. 18).

Good posture does not happen naturally and operators must be taught how to use their body correctly and understand that it is up to them to make full use of the adjustability of their furniture and equipment to ensure good body balance and support (South Australia Health Commission 1988).[23] This view supports that of Murrell (1975, p. 146) who argued, for example, that most people feel a chair of the 'right height' is too low, and for this reason it is "usually not a good idea to leave people to adjust seats without instruction". Also, it has been found the increased adjustability of office chairs is too complicated for a lot of users (Dainoff 1994) and many do not even make basic adjustments for lumbar support height and chair height (Coleman et al. 1998).

Computer operators need to be made aware of the early warning signs of computer-related disorders and the necessity to report suspected overuse or vision problems immediately they become evident so that any corrective action required can be implemented without delay. Pater and Button (1992, p. 56) recognised that "some organizations are concerned that educating employees about CTDs might backfire by heightening fear and raising CTD reports", but warned that keeping employees uninformed can backfire, noting that "smart organizations plan strategies for recovering, should incidence rates rise". They

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[22] It was announced by the Australian Government in May 2004 that the National Occupational Health and Safety Commission will be replaced by the Australian Safety and Compensation Council (ASCC) to establish a national approach to workplace safety and workers' compensation and provide consistency.

recommended that organisations hold sympathetic, positive attitudes and provide appropriate guidance and opportunity for counselling and rehabilitation if required. It was acknowledged that some people believe overuse injuries are exaggerated and exploited for monetary gain, leading to attitudes of cynicism, disbelief and mistrust. Therefore, it is important that employees feel safe and supported in reporting their injury (PSA 1990, p. 39).

"A personal assessment of the computer work environment focusing on identifying physical and emotional stressors can help determine the best course of action to prevent injury" (Doheny et al. 1995, p. 15). It is important that managers and computer operators take the risk of injury seriously and ensure that they are informed about how to avoid problems. It is generally recognised that computer-related disorders are avoidable and are far easier to prevent than cure; it is important, therefore, that organisations aim to convince staff to use ergonomics to provide a safer, healthier workplace.

Psychosocial Work Environment

The incidence of workplace musculoskeletal disorders was often considered to be a social/economic/political problem related to the introduction of new technology (Hocking 1987, p. 221; Kiesler and Finholt 1988, p. 1010). In the 1980s, computers (generally installed at a time of economic depression and planned redundancies) not only changed work practices, resulting in faster pacing of work, increased workloads, fewer rest breaks,

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[23] This is particularly important in relation to multi-use workstations where people job share, as adjustments suitable for one person may not suit another.

reduced staffing levels and increased overtime, but also made work routine and decreased customer contact. Others, however, argued that RSI was not uniquely related to new technology, as shown by its occurrence with old equipment,[24] but was linked more to the resultant feelings of dissatisfaction on the part of workers (Hocking 1987, p. 222; Ryan et al. 1985; Graham 1985). Studies by Graham, and Ryan et al., found job satisfaction correlated with the occurrence of RSI better than ergonomic variables did. Their findings appear to be supported by low incidence of RSI in professional, technical and executive occupations where a high level of job satisfaction would be expected, and a high incidence among women engaged in repetitive, unfulfilling tasks, working in environments that "engender feelings of boredom, powerlessness and alienation" (Gun 1990, p. 379). Hence, it was argued that, if it was job satisfaction that contributed most to the condition, more attention needed to be given to factors in job design that may cause stress.

One of the most influential models used in work-health research was the demand–control–support (DCS) model developed by Karasek and Theorell (1990). This model was instrumental in shifting thinking from the individual's behaviour to the work environment as causal in the development of occupational strain (Dollard 1996, p. ix). The DCS model proposed that high levels of strain occurred when workers had jobs that combined high psychological demands, such as working to deadlines and excessive work, with low levels of job control (decision latitude). Lower levels of strain occurred where demands were

[24] Mr Michael Patkin, in an unpublished report to Telecom Australia, noted that cases of RSI had been reported by SA telephonists working with equipment that was over 50 years old.

low and control was high. A further dimension of the model proposed that social support at work, together with job control, allowed workers to moderate the experience of strain arising from excessive job demands. Theorell et al. (1991) (cited in Johansson 1994, p. 15) found a significant association between high job demands and muscle tension and concluded “that muscle tension may be an important pathway from a poor psychosocial work environment to musculoskeletal symptoms”.

The Significance of the Studies in their Time

It was evident to commentators by the early 1990s that the increased use of desktop computers had resulted in “a group of work injuries with a vague onset, uncertain pathology and confusing treatment” that were generating increasing costs (Eversmann 1992, p. 69). In Australia, Hailstone (1990) reported that, while the epidemic of occupational strain that peaked in 1985 had waned, hundreds of cases were still occurring, causing thousands of days lost from work, and Pater and Button (1992, p. 55) noted that “the incidence of cumulative trauma injuries and illnesses is clearly on the rise in industrialised nations”. The increased specialisation of work meant that many employees used their hands and upper extremities in the same few movements for prolonged periods of time. Repetitive motions, excessive force and/or abnormal positioning of the body had produced a unique set of injuries (Millender, Louis and Simmons 1992, p. ix).

It was also suggested that sociopolitical and economic forces associated with a changing work ethic contributed to these injuries. Some argued that the outbreak of RSI in the 1980s resulted from a combination of computer use and stress. Muscle tightness, caused by the stress of the newly emerging technology, together with new working habits, resulted in a wave of injuries. People worried about machines taking over jobs (computer companies advertised that one word processor could replace four typists) and jobs becoming de-personalised. These fears, together with the fear of falling behind and of being upstaged by colleagues who were more computer literate, were prevalent within organisations, resulting in feelings of alienation and job dissatisfaction (Parker 1990, p. 591; Oxenburgh, cited in Morison 1994, pp. 131–132).

Oxenburgh (Morison 1994, p. 132) stated "There are still people getting injured … The collection of data is atrocious". Morison (1994, p. 132) also argued that, while statistics in relation to computer-related disorders were not readily available, "only the most sceptical people doubt that injuries did occur in the past and continue to happen today". Morison noted that "just how much the situation has improved is hard to determine, because of the difficulty in obtaining focused data" as the collection of statistics by Worksafe Australia was based on musculoskeletal injuries generally and it was not possible to determine those that were specifically computer related. However, Worksafe Australia (1997) reported that the nature of the injury/disease category "Sprains and strains of joints and adjacent muscles" accounted for 47% of all workplace injuries in 1994–95. The most prevalent mechanism of injury/disease was 'body stressing', which encompasses manual handling, repetitive movement and maintenance of constrained or awkward postures. Worksafe noted that body stressing is a high-risk, high-cost problem for the Australian workforce, with there being more than two chances in five that a worker would experience a serious work-related injury/disease as a result of body stressing during the course of their working life. Information from the annual report of Comcare Australia reported in the *Advertiser* (3 November 1997, p. 5) indicated that compensation claims for work-related stress and repetitive strain injuries by public servants in 1996 exceeded \$50m and that "occupational overuse syndrome was clearly overtaking stress as the major workplace complaint to emerge in the 1990s".

The data in Table 1.1 were provided by South Australia's WorkCover Corporation and show the total compensation claims of non-exempt employers for the agency of accident 'computers and keyboards' over all industries for the period 1995–96. This agency includes computers, adding machines and calculators, manual and electronic typewriters, telephone and switchboards; there is no specific code for computer use. Claims from non-exempt employers represented approximately 60% of all claims. Figures for exempt employers for this period were not available. Only the highest three figures are given for each category, classified as Female (F) and Male (M). The 'cost to date' figures are those amounts accumulated from the date of injury. The figures reveal that sprains and strains of joints from "repetitive movement, low muscle loading" accidents affecting the wrists were by far the most prevalent claims and they were experienced mainly by female data processing machine operators.

Table 1.1 Number and Cost to Date of WorkCover Claims of Non-exempt Employers where the Agency was Computers and Keyboards for all Industries for period 1995–96

Accident type	**Total**	**F**	**M**	**Cost to Date**
Repetitive Movement, low muscle loading	102	82	20	$327,987
Muscle Stress while handling objects other than lifting	21	15	6	$13,854
Muscle stress while lifting, carrying or putting down objects	20	5	15	$13,903
Body location				
Wrists	26	24	2	$45,711
Upper limb, multiple locations	21	19	2	$139,137
Neck bone, muscles and tendons	18	11	7	$30,350
Nature of injury				
Sprains and strains of joints and adjacent muscles	78	50	28	$124,714
Musculoskeletal/connective tissue	52	44	8	$157,461
Nervous System/Sense organs	10	9	1	$63,097
Occupation				
Data Processing Machine Operators	24	21	3	$13,149
Office Secretaries and Stenographers	20	19	1	$46,758
Accounting Clerks	12	8	4	$13,196

WorkCover figures for the total number and cost of claims for the agency of accident ‘computers and keyboards’ from 1991–92 to 1996–97 are given in Table 1.2. The data relate to non-exempt employers and the claims are classified as ‘time lost’ claims and ‘no time lost’ claims that incurred costs. ‘Time lost’ claims to 1994–95 involved more than 5 days off work, and claims 1995–96 and later involved more than 10 days off work; ‘no time lost’ claims involved 5 or fewer days off work, except for 1995–96 which involved fewer than 10 days off work. The cost of claims is the cost accumulated from the date of injury, so that older claims have accumulated more costs than recent claims.

Table 1.2 Number and Cost of WorkCover Claims of Non-exempt Employers for the Agency of Computers and Keyboards for the period 1991–92 to 1996–97 by Gender and Time Lost

	Time Lost				No Time Lost				Total	
Year	**Total**	**F**	**M**	**$**	**Total**	**F**	**M**	**$**	**N**	**$**
1991–92	39	31	8	743,407	98	78	20	57,112	**137**	**800,519**
1992–93	34	31	3	756,030	129	111	18	101,137	**163**	**857,167**
1993–94	26	21	5	599,746	121	97	24	106,938	**147**	**706,684**
1994–95	31	26	5	1,356,044	137	109	28	149,534	**168**	**505,578**
1995–96	21	16	5	310,134	130	90	40	106,375	**151**	**407,509**
1996–97	18	17	1	231,924	111	94	17	106,597	**129**	**338,521**

The data presented in Tables 1.1 and 1.2 provide evidence of the high economic costs to business: given the extent of the costs involved one might have anticipated a greater employer effort in this area of safety.[25] The data also highlight that considerably more females than males lodged WorkCover claims. It was argued women were more likely to develop cumulative trauma disorders than men for several reasons: traditionally women were placed on jobs characterised by sustained postures and repetitive-motion tasks; hormonal changes as a result of pregnancy, menopause and hysterectomy can cause fluid retention, which restricts blood flow to tissues and alters the collagen that holds the tendons together; and financial burdens, especially in relation to single mothers, often caused women to work extra jobs and excessive hours (IMPACC USA 1995).[26]

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[25] 2002–03 WorkCover Corporation Statistical Review figures for the agency accident for body stressing 'computers and keyboards' claims in 2002–03 for non-exempt employers was 83, with a cost of $282,111; for exempt employers in 2001–02, there were 137 claims costing $575,263.

[26] Women accounted for two-thirds of the RSI compensation cases in Australia in the 1980s (Kiesler & Finholt 1988, p. 1000). Kiesler and Finholt (1988, p. 1007) noted that, while characteristics such as "small wrist size, pregnancy, oral contraceptives, menopause, and gynaecological surgery" were found to correlate with RSI and were suggested as causes of RSI, the correlation may have existed "only because these attributes are more characteristic of women than men" and "have nothing to do with RSI".

In 2003, it was reported female workers were more likely to suffer sprains and strains and diseases than male workers; in South Australia injuries such as sprains and strains, carpal tunnel syndrome and diseases of the musculoskeletal system and connective tissues accounted for 60% of compensation claims made by women (WorkCover 2003, p. 5).

In the United States of America, medical costs and lost wages resulting from RSI were between \$20 and \$30 billion a year (Quibble 1996, p. 80). The enormity of the problem is illustrated by the US Bureau of Labor statistics given in Table 1.3 (Pinsky 1993, p. 144).

Table 1.3 RSI Cases in the US, 1978 to 1990

Year	Number of RSI Cases	Percentage of all Illnesses
1978	20,200	14
1979	21,900	15
1980	23,200	18
1981	23,000	18
1982	22,600	21
1983	26,700	25
1984	37,700	28
1985	37,000	30
1986	45,500	33
1987	72,900	38
1988	115,300	48
1989	146,900	52
1990	185,400	56

These statistics show a sustained increase in the number of RSI cases, representing 56% of all illnesses in 1990.

Work-related injury and disease are a significant social and economic burden. In Australia, NOHSC (1997a, p. 12) estimated that one in 12, or over 650,000 workers, suffered a work-related injury or illness each year, with approximately 175,000 resulting in five or more days' absence from work. Economic losses from work-related injuries and disease imposed a heavy burden on the economy, with the total cost of work-related injury and disease to the Australian community in 1995–96 dollars conservatively estimated to be $27 billion each year. As a comparison, crime costs in Australia were estimated to be $18 billion to $20.5 billion per year, and the Australian current account deficit for 1995–96 was $20.3 billion. The data given in Table 1.4 show that there has been a considerable reduction in the incidence of injury and disease at work since the late 1980s, but no significant improvement since 1991–92. The number of cases decreased from 1991 to 1993, and then increased again, highlighting “the need for continued effort in this area” (NOHSC 1997a, p. 12).

Table 1.4 National Occupational Injury and Disease Cases in Australia 1987–88 to 1994–95

Years	**No. of Cases**	**Incidence Rate** (for every 1000 wage and salary earners)
3-year average **1987–88 to 1989–90**	193,363	32
1990–91	182,973	31
1991–92	161,101	25
1992–93	160,994	25
1993–94 (estimated)	172,428	27
1994–95 (estimated)	176,030	26

Emmett (1995, p. 8) noted that “workplace injury and disease shows no sign of being easily eliminated – and needs urgent and continued attention”. Emmett went on to say that “part of the problem was an unhealthy and unsafe complacency” by “some unions, employers, bureaucrats and individuals” and that it is “a sad commentary about our values that we still allow this massive burden of preventable injuries and diseases”. He noted that workplace injury and diseases are estimated to cost Australia $20 billion a year, one-third of which was borne by employers and one-third by governments, and “perhaps most disturbingly” one-third by the victims and their families. Emmett acknowledged that quoting the cost hides the “true nature of the injury to people, the personal tragedies, the aspirations lost and families hurt” and the fact that much of the cost is “borne by those who do not directly create the hazardous conditions”.

The huge cost of workplace injury and disease indicates its importance to the nation, organisations, employees and the community generally. This review of the literature in relation to computer-related disorders and ergonomic issues gives insight into the extent of research and volume of documentation that has been undertaken over many decades. However, despite the number of books, journal articles, occupational health and safety manuals, standards and guides, brochures and leaflets prepared, and the amount of information on the Internet concerning ergonomics and the use of computers, there appears to be a general lack of knowledge of recommended ergonomic principles and/or a general disregard of their application by many computer users.

CHAPTER 2

DESIGN AND METHOD

This chapter details the nature and purpose of the research and describes the selection of the sample and the design of the survey instruments used to collect the data from managers and computer users. It also outlines the procedures and outcomes of pre-testing the survey instruments and the administration of the questionnaires. Finally, consideration is given to the statistical analysis undertaken. The major aim of the empirical studies presented here was to provide answers to the research questions listed in Chapter 1 and included under the discussion in this chapter of the nature and purpose of each study.

In order to answer the research questions relating to the application of ergonomic principles to computer use within organisations, a number of surveys were conducted. Subjects participating in the surveys included managers and computer operators from a variety of organisations that regularly use computer equipment, in both urban and regional locations. This chapter explains the methodology of six inter-related studies that form the basis of this thesis.

Studies I and *II* inquired into the knowledge of and priority given to ergonomic principles in relation to computer use within organisations. Study I, conducted in 1994, formed the foundation of the subsequent studies and focused on organisations located in the regional city of Whyalla. Study II, undertaken in 1996, was similar to Study I but was conducted in organisations located in the Adelaide metropolitan area.[27] In both Study I and Study II data were collected on ergonomic awareness, perceptions of the importance placed on ergonomics within organisations, ergonomic training, and work and organisational practices relevant to ergonomic computer use. Information on the incidence of work-related complaints of pain was also gathered.

Study III investigated the knowledge of ergonomic principles in relation to the use of desktop keyboard-operated computer technology of post-graduate students and academic staff within a university environment. The Study, conducted in 1996, was an extension of Studies I and II, which enquired into the knowledge of and priority given to ergonomics by managers and computer users within organisations of different types, sizes and occupations located in the city of Whyalla and in the Adelaide metropolitan area, but not including universities. Work within universities was undergoing considerable change as, in addition to the usual word processing function of computers, e-mail was becoming the main form of communication and the world-wide-web was being used extensively for research. Hence, computer use was expected to be very high within universities and, therefore, computer-related complaints of pain were expected to be prevalent among university staff and students. At the time it was probable that the majority of university staff and students had received no education in keyboard operation and ergonomic computer use. In addition to enquiring into the level of knowledge and the priority given to ergonomics within the organisation, this study

[27] Study I was the basis of a Masters dissertation titled ‘Knowledge of and Priority given to Ergonomics in relation to the use of Desktop Keyboard-Operated Computer Technology within Organisations’, Sawyer, J. K., 1994.

focused on how the university demonstrated commitment to the ergonomic use of computer technology.

Studies IV and *V*, undertaken in 1998, were conducted within the same organisations in Whyalla that were surveyed in Study I and gathered data four years later. *Study IV* extended the previous work on ergonomic awareness, organisational practices in relation to the ergonomic use of computers, and the priority ergonomic principles were given within the organisations in Study I, by researching further the aspects of health and the workplace. Data were gathered on both psychological health and physical health symptoms. The study also enquired into the level of job satisfaction experienced and collected information relating to the work environment. *Study V* was a quasi-longitudinal study that investigated the change in ergonomic knowledge, application, perceptions and practices from the time the Whyalla organisations were first surveyed in 1994, to 1998.

Study VI extended even further the foci of Studies I and IV, which enquired into ergonomic practice and employee health within Whyalla organisations. This study, undertaken in 1999, was conducted solely within one large, private-sector organisation in Whyalla that had approximately 2000 employees at the time. Additional biographic details were gathered from respondents and more detailed information obtained about their physical health symptoms and their impact on the individual and in the work situation. The questions regarding job satisfaction and psychological health remained the same but a new scale adapted to emphasise more the ergonomic aspects of the work environment replaced the standard Work Environment Scale (WES) (Moos 1986) used in Study IV. In addition, a set of personality scales and a series of questions designed to indicate the respondent's attitude to compliance were included.

Nature and Purpose

Studies I and II

Studies I and II sought information on the knowledge of and priority given to ergonomics and the use of computers by computer operators and managers within organisations. These areas were considered to be important for two main reasons. First, although a large amount of information had been placed into the public arena in the 1980s when desktop computer technology was introduced and there appeared to be an epidemic of related repetitive strain injuries, computer users were still suffering computer-related disorders in the 1990s. From a rationalist perspective, the injuries of the '90s should not have occurred. After the experiences of the 1980s, there should have been improved knowledge of preventative ergonomic principles and work practices should have changed accordingly. In fact, the observed habits of computer users demonstrated instances of either a lack of awareness, or a disregard, of ergonomic principles relating to the use of computers. In addition, the images of computer use portrayed in print materials and viewed on television often appeared to ignore the application of ergonomics.

Since, contrary to the rationalist perspective, many people appeared to be unaware of the ergonomic principles in relation to computer use, or if aware, did not consider their application to be important, two research questions were posed:

1. What is the knowledge among managers and computer users within organisations of ergonomic principles in relation to the use of desktop keyboard-operated computer technology?
2. What priority is given to ergonomics in relation to the use of desktop keyboard-operated computer technology within organisations?

The initial Whyalla study (Study I) indicated that ergonomic principles relating to the use of desktop keyboard-operated computer technology were generally not known and not practised within many organisations. The findings also revealed that low priority was given to ergonomics and computer use. *Study II* was conducted in response to feedback received from ergonomists and conference delegates in relation to the reported findings of Study I. After Study I it was suggested that the isolated city of Whyalla might be 'off the main line' of ergonomic information. Also, it could be expected that there would be a lack of professional ergonomists in the community, further limiting the knowledge and application of ergonomic principles within the Whyalla organisations. Therefore, it seemed sensible to replicate Study I among firms in the Adelaide metropolitan area. The metropolitan and remote area findings could then be compared to determine if there were any significant differences.

Study III

Study III was conducted in response to feedback received from academic staff on the reported findings of Studies I and II. It was noted that the nature of work within universities and the university workplace were undergoing considerable change due to the increased use of computers. Questions were being asked about the ergonomic practices surrounding this increased usage. Hence, it was decided to survey academic staff and post-graduate students as both groups were expected to have a high level of computer use.

The study aimed to provide answers to the following two research questions:

1. What is the knowledge among university academic staff and post-graduate students of ergonomic principles in relation to computer use?
2. What priority is given to ergonomics in relation to computer use by academic staff, post-graduate students and the university?

Study IV

Study IV extended the previous research that enquired into the knowledge of ergonomics and the priority ergonomics is given by managers and computer operators within organisations in Whyalla. The aim of this study was to investigate the relationships between ergonomic knowledge regarding the use of desktop keyboard-operated computers and the work environment. The study concentrated on the job satisfaction and psychological and physical health of managers and computer operators within the Whyalla organisations selected.

That focus was in line with the emphases of the social psychology of work literature of the time. Studies of the relationship between computer use and stress demonstrated that increased computer use resulted in changes to work processes, social relationships, management style and the nature and content of job tasks (Smith 1997). It follows that the physical and psychological demands of computer use can be different from those of other modes of work. Other research indicated that psychosocial aspects of the work environment contribute to the development of work-related musculoskeletal disorders (Johansson 1994). The demand–control–support (DCS) model (Karasek and Theorell 1990) had been used in studies specifically predicting musculoskeletal disorders for computer use (Faucett and Rempel 1994). The DCS model indicates that the highest level of strain occurs when workers have jobs combining high psychological demands with low levels of job control. Psychological job demands encompass stressors in the work environment such as how hard employees work, the presence of deadlines, personal conflicts, and job security (de Jonge and Kompier 1997). Job control refers to the decision-making latitude employees are allowed regarding their work and the skills utilised. Social support is included as part of the model on the basis that social support may act to buffer the effects of job demands on psychological wellbeing (Daniels 1999).

With that literature in mind, Study IV asked two questions:

1. To what extent does the level of knowledge of ergonomic principles in relation to computer use predict individual health symptoms?
2. What is the relative importance of ergonomic knowledge and the psychosocial work environment in determining health symptoms?

Study V

Study V set out from data gathered in the survey conducted for Study IV (which related to the questions that remained unchanged from Study I), used a quasi-longitudinal design and surveyed the Whyalla organisations that had been studied four years earlier. The purpose was to compare responses collected four years apart, in the expectation of discovering:

1. What change, if any, had occurred in the knowledge of ergonomic principles relating to computer use among managers and computer users within the organisations surveyed four years earlier?
2. What change, if any, had occurred in the priority given to ergonomics in relation to computer use within the organisations surveyed four years earlier?

Study VI

This study was designed to investigate the importance of knowledge of ergonomics, attitude, and factors within the work environment to the application of ergonomic principles relating to computer use, and to the health symptoms experienced by managers and computer operators within a large organisation. The questions in mind were:

1. What is the respondents' attitude in terms of compliance?
2. What is the relative importance of personality, ergonomic knowledge and the cultural work environment in determining behaviour in relation to the application of ergonomics to computer use?
3. What is the relative importance of personality, ergonomic knowledge and the cultural work environment in determining health symptoms?

Sample Selection

Studies I and II

Study I was confined to organisations operating in the city of Whyalla, an industrial city with a population at the time of approximately 26,000 and a wide range of organisations of various types, sizes and occupations. Firms were selected to participate in the study on the basis that they were expected to have a high degree of daily computer use and represented a mix of small and medium–large-sized, public and private-sector organisations, across a range of occupations. Guided by local knowledge, a list of organisations likely to meet these criteria was compiled from the Whyalla telephone directory. The 71 organisations chosen to participate in the study – comprising 34 small and 37 medium–large, and 41 private-sector and 30 public-sector firms – were selected from this list.

Study II followed the same methodology adopted in the initial study. The subjects selected to participate in the study were members of public and private-sector organisations in the Adelaide metropolitan area. The organisations varied in type and size (defined by the number of employees) and were selected on the basis that they were expected to have a high degree of daily use of desktop keyboard-operated computer technology.

A list of organisations expected to have a high daily use of desktop computers was prepared by examining entries in the Adelaide telephone directory. The aim was to select 15 small organisations and 15 medium–large organisations from both the private and public sectors. This number would provide a minimum of 30 respondents for each of the four categories, assuming a response was received from both a manager and a computer operator within each organisation. Because the size and computer use of organisations could not be determined in advance of contacting each organisation, it was necessary to include some additional organisations in order to achieve a minimum of 15 organisations in each of the four categories. A final selection of 89 organisations, comprising 50 privately owned and 39 government-owned organisations, and 41 small and 48 medium–large organisations, were invited to participate in the study.

Study III

This study was confined to one large university located in South Australia and involved both academic staff and post-graduate students, as each group could be expected to have a high use of computers as part of their university work. A sample of 400 post-graduate students and 400 academic staff was selected, as it was believed this sample size could provide the number of responses required to be representative. A total of 400 random name and address labels representing 200 each of post-graduate research and coursework students were obtained. These included both internal and external students but not those located offshore. A random list of names and addresses of 400 academic staff was also obtained from the Human Resources department of the university.

Studies IV and V

For *Studies IV* and *V*, Whyalla organisations that had previously participated in Study I were surveyed four years on. Subjects participating in the survey again included managers and computer users drawn from a variety of organisations representing a mix of public and private sectors and small and medium–large-sized organisations that were expected to have a high usage of desktop computers. Whyalla's population had declined from approximately 26,000 people at the time of the earlier study to approximately 23,000 people, with a consequent loss of some organisations. A total of 51 organisations, 25 from the private sector and 26 from the public sector, and 29 small and 22 medium–large-sized, were invited to participate in the study; this was fewer than the 71 organisations (34 small and 37 medium–large, and 41 private-sector and 30 public-sector) in Study I.

Study VI

Study VI was conducted with managers and non-managers who regularly used a computer at work within a large private-sector industrial organisation in Whyalla. The aims of the project were explained to the Manager of the Human Resources department, who gave consent for the study to be undertaken and requested that the Human Resources department contact appropriate staff within the organisation. Staff expected to have a high daily use of desktop computers were invited to participate in the study via an internally generated and distributed e-mail message that requested participation and advised that the firm was giving its support to the project. Staff therefore selected themselves to participate in the study, and the sample was non-random and may not be representative of the population. Fifty people volunteered to participate in the study. The respondents could have colluded to give the firm a good result but this was unlikely because it was a confidential research study for academic purposes. Further, it must be recognised that, while volunteers may be those who are happy in their jobs, those employees who are unhappy at work could also have taken the opportunity to express their views by selecting to participate in the study.

Data Collection

Data may be collected in a variety of ways including mailed questionnaires, telephone interviews, personal interviews, observation, and more recently web-based questionnaires. Most of the information was collected by a combination of telephone interviews and mailed questionnaires.[28] Both processes can yield useful contextual information. The telephone interview was used to collect key data regarding organisation size. This method ensured that the information was received efficiently from one person per organisation – the manager – and that the data would be both accurate and consistent. Telephone interviews have the further advantage of allowing the investigator to clarify and probe, as well as enlisting support for the study by making personal contact.

The questionnaire was considered to be the most efficient method of collecting the remaining data because of the large number of organisations involved. The time needed for face-to-face interviews and visits to workplaces to make direct observations was beyond the resources of the study. Also, while less personal than interviews, mail surveys provide confidentiality and individual anonymity and may therefore increase participation and encourage honest replies. This is particularly important for these studies because of their sensitive nature. Holmes, Hodgson and Nevell (1991) argue that

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[28] At the time the studies were conducted these traditional collection methods were appropriate as web-based questionnaires were not being used.

mail surveys not only have a cost advantage but also allow respondents to be targeted and specific questions asked. In addition, mailed questionnaires allow contact with respondents who might not otherwise be accessible.

However, Holmes, Hodgson and Nevell warn of certain problems with mailed questionnaires. These include a danger that respondents may misunderstand some questions, or deliberately supply incorrect answers and that the survey document could be passed on by the targeted respondent to an assistant who may give a different perspective or level of response. As well, the survey may not be completed and returned if the issue is sensitive, or if the respondent considers the research question to be unimportant. These factors may give a low response rate and introduce non-response bias.

Studies I and II

Because no existing questionnaire seemed suitable for Study I, it was necessary to develop an instrument. Accordingly, a questionnaire titled *Ergonomics and Computer Technology* (Appendix 1) was tested and prepared for distribution. The same nine-page document, containing 28 items, was distributed in Study II to organisations located in the Adelaide metropolitan area. It was designed as a dual-purpose document that could be answered by both managers and computer operators within the organisations selected. It sought to elicit responses that would indicate knowledge of and priority given to principles of ergonomics as these relate to the use of desktop keyboard-operated computers. It was acknowledged that the subjects being surveyed would require particular assurance that their responses would be treated confidentially and that no individual respondent would be able to be identified in the results of the study. Accordingly, detail to this effect was included in the initial instructions to the questionnaire.

The survey instrument was structured to collect both quantitative and qualitative data. The quantitative data were in the form of closed questions that simply required a tick or the circling of the most appropriate response. The qualitative data was collected in the form of open-ended questions designed to gather additional information in the form of comments and/or elaboration. ‘Any other comments’ were also welcomed.

The first six questions in the survey instrument collected biographical data such as age and gender, position within the organisation, type of organisation (government-owned or privately owned), and other background information in relation to the respondents such as their estimated average daily hours of use of a computer and where they had learnt to use a computer. In addition, the manager of each organisation was asked by telephone to provide information on the approximate number of people employed in their organisation so that it could be defined as either small or medium–large-sized based on the number of its employees.

The questions that followed those eliciting biographical data sought to determine whether managers and computer operators were aware of the ergonomic principles related to the use of desktop keyboard-operated computers, how information relating to ergonomics was received by them, and how this information had been applied in the workplace. Participants were given the opportunity to explain what tasks could be undertaken in rest breaks, and the factors to be taken into consideration when choosing office furniture and equipment, and in organising their work day. Participants were also asked whether they had attended an educational program/training session provided by their organisation that included information on ergonomics and the use of computer technology, and approximately how much time they had spent in training/update sessions in relation to ergonomics and the use of computers provided by the organisation in the past 12 months.

The following sample of the questions contained in the survey instrument illustrates the format of questions designed to elicit information concerning the respondent's knowledge of ergonomics (Figure 2.1).

8. Have you attended an educational program/training session provided by your organisation that included information on ergonomics in relation to the use of computer technology?

In the last 12 months ☐
In the last two years ☐
Over 2 years ago ☐
Never ☐

If yes, how have you applied the knowledge acquired about ergonomics to your own work situation?

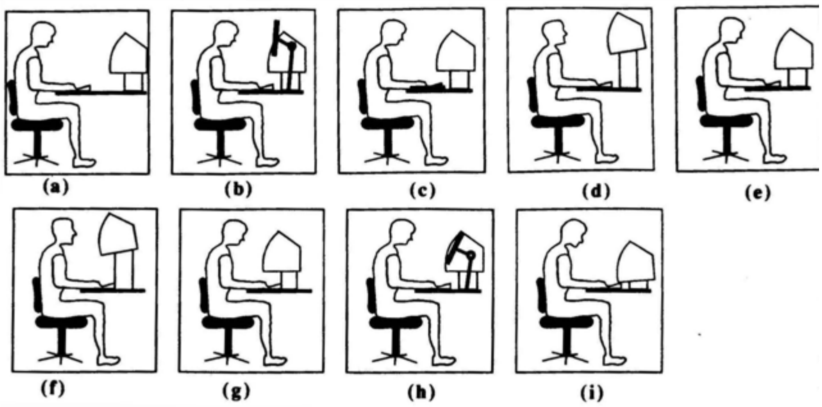
....
....
....

Figure 2.1 Example of Survey Questions

The questionnaire incorporates, in part, a strategy used by O'Grady, Porter and Chua (1993) to determine the knowledge of members of the accountancy profession of their Code of Ethics. These authors used the technique of asking respondents to react to different scenarios representing areas of the Accounting Code of Ethics. The number of correct responses was then used as a surrogate for the respondent's knowledge of the

Code. ‘Not sure’ and incorrect responses were both treated as indicating lack of knowledge. Using a similar strategy, in this study, two questions that included sketches of various scenarios covering work posture and the layout of computer equipment were used to determine the knowledge of principles of ergonomics relating to the use of computers. Figure 2.2 shows the format used for these questions.

16. **Study the diagrams carefully to determine whether accepted ergonomic principles are being applied <u>in relation to posture and the layout of equipment.</u> circle the appropriate response below and indicate the reason for your response.**



(a) **Yes** **No** **Unsure** **Reason:** ....
....

(b) **Yes** **No** **Unsure** **Reason:** ....
....

(c) **Yes** **No** **Unsure** **Reason:** ....
....

(d) **Yes** **No** **Unsure** **Reason:** ....
....

(e) **Yes** **No** **Unsure** **Reason:** ....
....

(f) **Yes** **No** **Unsure** **Reason:** ....
....

(g) **Yes** **No** **Unsure** **Reason:** ....
....

(h) **Yes** **No** **Unsure** **Reason:** ....
....

(i) **Yes** **No** **Unsure** **Reason:** ....
....

Figure 2.2 Example of Questions containing Scenarios

Participants were also asked what priority they thought their organisation placed on the importance of ergonomics in relation to the use of computers, and whether they believed these ergonomic principles were being given sufficient priority in their organisation. In a question based on the 'motivational scale exercise' used by Bird and Loftus (1976), respondents were asked to rate items to indicate the importance they believed their organisation placed on the item.

The questionnaire also sought to determine the priority that ergonomic principles were given by asking if the organisation had a written policy in relation to both the ergonomic use of computers and the rehabilitation of employees affected by computer-related disorders. Questions asking whether the organisation had appointed a person charged with the responsibility for ensuring that appropriate ergonomic principles were applied by computer users, and how the organisation responded to breaches of recommended work practices relating to ergonomics and the use of computers were also included. Other questions asked respondents whether computer users were required to report incidents of computer-related injury and whether records relating to such injuries were kept by the organisation. A question asking whether respondents had ever suffered a work-related complaint of pain in the arm, neck or some other part of the body was also included.

Study III

The *Ergonomics and Computer Technology* questionnaire used in Studies I and II was modified as described below and distributed to the selected participants within the university under the title *Ergonomics and the Use of Desktop Computers*. Changes were made in the biographical section to reflect the educational, rather than business, nature of the organisation and questions not readily associated with an educational institution such as one based on the ‘motivational scale exercise’ used by Bird and Loftus (1976) were omitted. The survey instrument was structured to collect both quantitative and qualitative data, using open-ended questions to gather additional information. The questionnaire was approved by the relevant ethics committee.

Study IV

For Study IV, a newly developed questionnaire titled *Ergonomics, Computers and Organisations* was used to survey the selected Whyalla organisations that had participated in Study I four years earlier. Based on the survey instrument titled *Ergonomics and Computer Technology* administered in Studies I and II, it was a dual-purpose questionnaire that could be answered by both managers and computer operators within the organisations selected. This questionnaire was designed to collect additional data and elicit responses that would not only assist in determining the level of ergonomic knowledge in relation to the use of desktop computer technology within the organisations but also the extent and nature of any health symptoms experienced by managers and computer operators, the level of job satisfaction of the respondents, and information about the work environment. It was also used to collect data that could be compared to responses received in Study I as the basis for a quasi-longitudinal study.

This revised survey instrument comprised four parts. **Part A** contained the same six questions as in Studies I and II that elicited biographical data and background information for each respondent. Again, managers were asked in the telephone interview for information regarding the number of employees in the organisation so that the size of the organisations could be defined in terms of the number of employees.

Part B included the questions from the initial questionnaire that sought to indicate the level of knowledge of ergonomics within organisations. Respondents were asked if they were aware of the ergonomic principles that relate to the use of computers, whether they had attended an educational program/training session provided by their organisation that included information on ergonomics and computer use, and whether they believed they needed to spend more time in such training/update sessions. Participants were also asked whether they believed ergonomic principles were being given sufficient priority in their organisation and whether they had read documents that included information on ergonomics in relation to computer use in the past twelve months. The questionnaire also asked if the organisation had a written policy in relation to both the ergonomic use of computers and the rehabilitation of employees affected by computer-related disorders. Questions were also included asking whether the organisation had delegated to a person, responsibility for ensuring that employees followed recommended ergonomic practices, whether computer users were required to report incidents of computer-related disorders, and whether records were kept relating to such disorders. Respondents were asked whether they took regular rest breaks away from the computer and whether their organisation emphasised the importance of keeping ergonomic work practices in mind when using a computer. The two questions used previously that asked respondents to study diagrams of various scenarios in relation to sitting posture and positioning of the arms and wrists (9 diagrams), and in relation to posture and the layout of equipment (9 diagrams) were also included. For each of the 18 diagrams, participants were asked to indicate whether accepted ergonomic principles were being applied by circling ‘Yes’, ‘No’ or ‘Unsure’ as appropriate and to give the reason for their answer. A correct response and a correct reason were assumed to be indicative of the respondent’s knowledge. An ‘Unsure’ response, incorrect response, incorrect reason or a non-response was assumed to indicate lack of knowledge. Respondents were rated on a scale of 0 to 18 on the correctness of their responses.

Part C sought to determine the psychological wellbeing of respondents, based on the concept that a relationship exists between psychological distress and musculoskeletal disorders (Johansson 1994). It contained the standardised twelve-item version of the *General Health Questionnaire* (GHQ-12) (Goldberg 1978), which ascertains how the respondent has felt over the past two weeks, by having respondents rate their response, on a four-point scale, to questions such as ‘Have you recently been able to concentrate on whatever you’re doing?’, ‘Have you recently lost much sleep over worry?’ and ‘Have you recently felt that you are playing a useful part in things?’, with typical responses being: ‘not at all’ (=1), ‘no more than usual’ (=2), ‘rather more than usual’ (=3) and ‘much more than usual’ (=4).[29] The higher the score, the higher the level of psychological distress experienced by the respondent.

In a question based on the initial work of Cheek and Miller (1983) respondents were also asked to indicate how often in the last month they had suffered from twelve

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[29] Although devised approximately 25 years ago, this standardised scale was used because it has well-established psychometric qualities (Banks et al. 1980).

specific physical health symptoms that are commonly associated with computer use. These items included symptoms such as 'eye strain', 'elbow problems' and 'neck tension' and were scored on a four-point scale under the headings 'sometimes', 'many times', 'always', or 'never' if not applicable.

A question from Warr, Cook and Wall's (1979) *Global Job Satisfaction* questionnaire was included to indicate the respondent's level of job satisfaction. Smith (1997) found that highly monotonous computer work was linked to lower job satisfaction and more frequent psychosomatic complaints. Respondents were asked how satisfied or dissatisfied they felt about their present job, and responses were scored on a seven-point scale from 1 = extremely dissatisfied to 7 = extremely satisfied. Low scores equate with high strain. An additional question tested job security by asking, 'Do you consider that your job might be under threat?', with a yes = 1 or no = 2 response.

Part D contained items from the *Work Environment Scale* (WES) (Moos 1986). The WES is a generic, 90-item, self-report questionnaire in which respondents answer 'true' or 'false' to statements about their working environment. It can be used to describe or contrast the social environment of different work settings and to compare employee perceptions within the same organisation. Levels of work demands, supervisor support, control, clarity, autonomy, peer cohesion, involvement, innovation, physical comfort, and work pressure in a specific job can be determined by reference to normative data (Dollard 1996). Respondents were asked to answer either 'True' or 'False' to 36 statements designed to measure workload, autonomy and support within the work environment. A total score was obtained from nine items in relation to peer cohesion, supervisor support, control and work demands. These subscales are those consistent with the Karasek demand–control–support model (Karasek and Theorell 1990) as follows:

- Demands – the *Work pressure* subscale measure the degree to which the pressure of work and time urgency dominate the work environment, e.g. 'it is very hard to keep up with your workload'.
- Control – the *Autonomy* subscale measures the extent to which employees are encouraged to be self-sufficient and to make their own decisions.
- Support – Combines the *Peer cohesion* subscale, which measures the extent to which employees are friendly and supportive of one another, e.g. 'staff often talk to each other about their personal problems', and the *Supervisor support* subscale, which assesses the extent to which management is supportive and encourages employees to be supportive of each other, e.g. 'staff discuss their personal problems with supervisors'.

A question was also included to determine whether the individual respondent had previously completed an *Ergonomics and Computer Technology* questionnaire as a participant in Study I four years earlier. The final question invited 'Any other comments'.

Study V

As previously indicated the data for this quasi-longitudinal study, involving Whyalla firms that had participated in Study I, were collected by the common questions in the survey instruments administered in Study I and Study IV.

Study VI

For this study the *Ergonomics, Computers and Organisations* questionnaire used in Study IV was expanded considerably for administration to participants within the large private-sector organisation located in Whyalla. The resulting instrument was titled *An Analysis of Ergonomic Principles and Work* (Appendix 2) and comprised seven parts.

Part A was increased to collect extra biographical and background information in relation to the respondents, with additional questions on respondent's level of education, the length of time they had been working in their current position, the average number of hours worked per week, whether they wore glasses, and their individual fitness levels. Questions were also included in relation to the security, prestige and pay levels of their position within the organisation:

- *Level of education* was coded 1 = Secondary education, 2 = DETAFE level, and 3 = University level.
- *Length of time in current position* was measured in years.
- *Hours worked per week* was collected in hours and subsequently coded 1 = < 38 hours, 2 = 38–40 hours, 3 = 41–43 hours, 4 = 44–46 hours and 5 = > 46 hours per week.
- *Estimated average daily use of a desktop computer* was measured in hours, separated into hours at work and hours at home.
- *Wearing glasses* was coded 1 = yes, 2 = no and *Wearing bifocals* was coded as 1 = yes, 2 = no and 3 = not applicable. These questions were included because wearing glasses, particularly bifocals, has been identified as a factor that results

in neck tension as computer operators extend or crane their necks to read material on the display screen (Martin and Dain 1988).

- *Physical fitness* was assessed using 1= low level, 2 = medium level, 3 = high level. *Exercise* was measured using an ordinal scale, reflecting a frequency of 30 minutes or more: 7 = every day, 6 = 5–6 days per week, 5 = 3–4 days per week, 4 = 1–2 days per week, 3 = once a fortnight, 2 = less than once a month, and 1 = less than once a year. These questions were included because physical fitness is generally accepted as a way of reducing and relieving work-related musculoskeletal disorders.
- *Job security*, *job pay levels* and *job prestige* were measured using the ordinal scales 1 = insecure, 2 = secure, 3 = very secure; 1 = low paid, 2 = adequately paid, 3 = highly paid; and 1 = low prestige, 2 = medium prestige and 3 = high prestige. These questions were relevant because it has been found that workers in low-paid, low-prestige and insecure jobs experience more health symptoms than those in higher paid, more skilled occupations (Smith 1997).

Part B contained questions that inquired about the ergonomic practices of the respondent and the two questions described above, with various scenarios in relation to work posture and the layout of computer equipment, to determine the ergonomic knowledge of the respondents. Questions sought to determine whether participants were aware of the ergonomic principles that relate to computer use, whether they applied them to their work situation, and if so, in what ways. The same questions as in the previous instruments asked participants whether they had attended an educational program/training session provided by their organisation that included information on ergonomics and the use of computers; approximately how much time they had spent in such training/update sessions in the past 12 months; whether they believed they needed to spend more time in training/update sessions; and whether they had read any material that included information on ergonomic computer use in the past 12 months. Participants were also asked whether they took rest breaks away from the computer and, if so, how often and what activities were usually undertaken during these breaks; and whether they took regular micro-breaks or rest pauses, and carried out pause gymnastics when using a computer. An additional question asked how often participants stop and rest their eyes with long-distance viewing when doing computer work. The final question asked whether participants believed ergonomic principles were given sufficient priority in their organisation.

Part C also contained contain the twelve-item *General Health Questionnaire* (GHQ-12) (Goldberg 1978) as a measure of mental health, and the final item from Warr, Cook and Wall's (1979) *Global Job Satisfaction* scale, namely, ‘Taking everything into consideration, please indicate how satisfied or dissatisfied you feel with your present job’. This question is relevant because a low level of job satisfaction may contribute to poorer mental and physical health in workers, particularly in relation to lower back pain (Bigos et al. 1991, 1992; Vallfors 1985).

Part D added questions that dealt with compliance in general, designed to ascertain how respondents applied knowledge in other areas, as an indicator of their general attitude towards compliance and risk-taking and any links with their compliance related to ergonomic advice. It included questions in relation to sunbaking, cigarette smoking and the drinking of alcohol. Participants were asked initially whether they were aware of the health problems associated with each activity and scored 1 = yes, 2 = no. They were then asked to indicate how often they performed related activities such as using a sunscreen regularly when outdoors, how often they smoked cigarettes, and how often they drank more than the recommended standard alcoholic drinks per day, on a five-point scale, 1 = never to 5 = very frequently.

Part E gathered additional data about the physical health symptoms experienced by the respondents. It included questions that aimed to determine whether the symptoms were work related, and also to assess the severity and impact of any health symptoms experienced in various parts of the body in the past 12 months.

An adapted physical health index was used similar to that used by Morrison et al. (1992), developed from the work of Cheek and Miller (1983). A list of 24 health symptoms was prepared based on those described in the literature as being symptoms experienced by computer operators. The list included items such as ‘headaches’, ‘eye strain’, ‘waking during the night with pain or numbness in hands’, ‘elbow problems’, ‘lower back problems’, ‘aches or pain in shoulders’, and ‘neck tension’, but items not considered relevant to this study such as ‘hay fever’, ‘hearing problems’, ‘kidney trouble’ and ‘heart disease’ were omitted. Participants were asked to indicate how often they had suffered from the symptoms on a five-point scale of 1 = never to 5 = very frequently, to provide consistency with the scales used for questions in other sections of the survey instrument. An opportunity was provided for respondents to specify other symptoms they may have experienced in the past month. Johansson (1994, p. 88) argues “self-reports provide reliable information” and “are suitable for application at different work-places and with a large number of workers”.

Next, a question asked to what extent symptoms in various parts of the body were solely related to the participant’s present work, partly related and partly not related to the present work, and solely related to factors other than the present work, measured on a five-point scale of 1 = solely related to present work to 5 = solely related to non-work activities. Then followed a question asking, if the symptoms were work related, whether the respondent had reported the problem to their organisation.

A question was included that asked how much out-of-work time, in hours, was spent in activities ergonomically similar to work. A list containing items such as ‘play computer games’, ‘watch television’ and ‘knit or crochet’ was provided, along with scope for participants to give details of any other activities they believed might be relevant. It must be acknowledged that risk factors such as forceful, repetitive movements and awkward postures exist in many sporting activities, although usually with “substantial breaks for recovery and shorter durations for intense tasks” compared to the work situation (NIOSH 1997).

The questions that followed were developed from material contained in the standardised *Nordic Musculoskeletal Questionnaire* (NMQ) (Kuorinka et al. 1987), which provides reliable information on musculoskeletal symptoms (Johansson 1994). The NMQ provides a diagram of the human body divided into anatomical parts and asks respondents to indicate whether they have had trouble (ache, pain, discomfort) in the various parts in the past 12 months. Using similar questions, the respondents were asked whether parts of the body, given in a list, had ever been hurt in an accident that is unrelated to work. They were then asked whether pain or discomfort in the parts of the body listed had prevented them from doing normal activities in the past 12 months at work and, separately, at home and for how long, in total number of days. The next question asked whether the respondent had consulted a health professional in the past 12 months due to pain or discomfort in the parts of the body listed, and the number of such visits. This was followed by a question inquiring whether the participant had had to change jobs or duties, and the number of days lost from work, because of the problem in the past 12 months. A final question asked whether the participant returned to their original job/duties.

Part F contained questions that inquired into factors of the work environment within the organisation such as job demands, supervisor support, peer cohesion and control over work. This section adapted the concepts contained in the *Work Environment Scale* (WES) (Moos 1986) used in Study IV. Using information from the literature regarding the ergonomic use of computers, a 25-item measure was developed that required respondents to rate statements regarding work tasks, supervision, responsibility given, application of ergonomics, and other relevant factors relating to their workplace, on a five-point scale of 1 = never to 5 = very frequently (refer Appendix 2).

In addition, a personality questionnaire with good psychometric properties known as The Quick Scales (Brebner 1998) was included. This test, containing five scales that measure extroversion, emotionality, openness, conscientiousness and agreeableness, was used to ascertain whether personality factors were relevant to compliance or non-compliance in relation to the application of ergonomic principles to computer use. Questions such as ‘how lively, outgoing and extroverted are you?’, ‘do other people make you flustered, take you for granted, or try to push you around?’, ‘how active, quick and responsive are you’ and ‘do you feel lonely, unhappy, or a bit left out of activities you would like to be part of’ were used, requiring responses on a seven-point scale from 1 = not at all to 7 = extremely, which can be computed to form the five subscales.

Again, the final question asked for ‘Any other information’, giving respondents the opportunity to elaborate or provide additional information.

Validation of Questionnaire

The *Ergonomics and Computer Technology* questionnaire used in Studies I and II, and effectively in Studies III and V, had previously been pre-tested. First, it was given to several experts – one in ergonomics and four in academia, including a lawyer and a statistician – with a request to review the format and content and also to comment on clarity, comprehensiveness, relevance, reliability and validity. *Reliability* refers to ‘the consistency or stability of the measures of a variable over time or across representative samples’ and is required for validity (Shelley 1984, p. 255). *Validity* can refer to ‘face validity’ – the extent to which a measure looks as though it measures what is intended; or ‘content validity’ – the extent to which a measure is tapping the underlying construct of interest (Sanders and McCormick 1987, p. 33). These concepts were explained to the experts who were asked to comment on the first version.

The experts generally considered the questionnaire was suitable for the purpose. Some suggestions were received and as a result minor revisions were made and the question asking whether respondents had ever suffered a work-related complaint of pain in the arm, neck or some other part of the body was added. The reason advanced for the additional item was that those who have been adversely affected are likely to be more knowledgeable about the relevant ergonomic principles.

The questionnaire was then tested in a field trial, with a small group of subjects similar to those for whom the instrument was designed. The specific aims of this investigation were to check that the survey instrument captured the information required to complete the objectives of the study, to identify any ambiguities or problem areas within the survey instrument, and to determine the time required to complete the questionnaire.

Four organisations, located in Whyalla but not part of the main sample, were chosen from the Whyalla telephone directory to participate in the field trial. A small, a medium and a large firm from the private sector and a public sector department were selected using the criteria that these organisations were likely to have a high usage of desktop computers and represented a mix of size, type and occupation. Each of the four organisations was sent a letter giving a brief outline of the study and seeking the participation of the organisation in the research. The letter was followed up by a telephone call several days later to determine whether the organisation was willing to participate in the study and to obtain details of the total number of people employed, and of these, how many were regular computer users. This information enabled the appropriate number of questionnaires to be forwarded to the organisations and the size of the organisations to be defined in terms of the number of people employed, when analysing the responses received.

A total of 10 completed questionnaires were received from the 19 that had been distributed – one from the small firm, two from the medium-sized firm and seven from the government department. This represented a 100% response rate from the small and medium-sized privately owned organisations, and a 44% response rate from the publicly owned organisations, giving an overall response rate of 53%. The participants in the field trial reported no problems in comprehending the wording used in the questions and were generally satisfied with the time required to complete the questionnaire, which was approximately 25 minutes. An important outcome of conversations with the subjects in the trial was the need to add, as part of the instructions on the title page of the instrument, a request that each respondent work independently when completing the questionnaire. The field trial indicated that the survey instrument did capture data appropriate to answering the research questions and that the study would be feasible and worthwhile.

The instrument developed for Study IV used the first questionnaire as its basis but also included the *General Health Questionnaire* (GHQ-12) (Goldberg 1978), a 12-item physical health index based on Cheek and Miller's (1983) work, Moo's (1986) *Work Environment Scale* (WES), and a question from Warr, Cook and Wall's (1979) *Global Job Satisfaction Questionnaire*. The GHQ-12 is a frequently used, short, efficient standardised test that is generally accepted as being valid and reliable (Banks 1983).

The 12-item version is clinically validated (Banks 1983) with good psychometric properties (Banks et al. 1980). Likewise, the WES is a cost-efficient, brief measure that is suitable for most work settings (Jones and Dubois 1989) and has good test–retest reliabilities (Moos 1986). The final item of Warr, Cook and Wall's (1979) scale was used to assess job satisfaction because it is argued that a global index of job satisfaction (a single-item measure) is a valid measure of general job satisfaction (Wanous et al. 1997).

The instrument used in Study VI was given to several experts for an assessment of its clarity and general suitability for the purpose and to gain ethics approval. The questionnaire was considered to be suitable for the purpose and in accordance with the guidelines for ethics approval. The experts suggested that an additional question be included that inquired whether the respondent believed their job was under threat, because this was often a contributing factor to stress in the workplace. As a result, the question was included in Part C of the questionnaire.

The instrument that was further developed for Study V was also pre-tested by an expert, who reported that it was clear and suitable for the purpose.

Administration of Questionnaires

Studies I, II, IV and V were conducted with a variety of private and public-sector organisations. Letters of introduction were posted to the organisations selected requesting their participation in the study. These letters were followed up a few days later by a telephone call requesting the participation of the organisation in the study and asking how many people were employed by the organisation, and of these how many were regular computer users. This information enabled the firms to be classified as either ‘small’, where there were fewer than ten employees, or ‘medium–large’, where there were more than ten employees. The information was also used to determine how many copies of the questionnaire were to be forwarded. It was predetermined that a maximum of ten questionnaires would be sent to any one organisation so that some balance was maintained between organisations. The appropriate number of questionnaire documents was then forwarded, with a covering letter and an addressed, reply-paid envelope for each copy of the questionnaire, to each firm for distribution to the manager and computer operators. Each organisation on the compiled list was allocated a number. This number appeared on all copies of the questionnaire sent to that organisation so that non-responding firms could be determined and reminders given.

The mailed questionnaires were accompanied by reply-paid return envelopes to encourage confidentiality and a high response rate. Research on response rates has shown that mailed questionnaires generally present a problem in that only a minority return them; the use of follow-ups, or reminders, is the most successful technique to increase response rates (Holmes, Hodgson and Nevell 1991).

Of the 71 Whyalla organisations selected to participate in Study I, 51 returned questionnaires, giving a participation rate of 72%. Individuals returned 170 useable questionnaires from a possible 339, giving a response rate of 50%. In Study II, letters of introduction were posted to 83 private organisations and 61 government organisations in the Adelaide metropolitan area, with 89 of the organisations indicating a willingness to participate in the study. Of these, 72 returned questionnaires, giving a participation rate of 81%. Individuals returned 229 useable questionnaires from a possible 496, giving a response rate of 46%.

Although 51 organisations were invited to participate in Study IV, questionnaires were distributed to a total of 44 organisations, 20 in the private sector and 24 in the public sector. 34 organisations returned questionnaires, giving a participation rate of 77%. Individuals returned 97 useable questionnaires from a possible 196, giving a response rate of 50%. In Study V, the quasi-longitudinal study, responses from 111 individual respondents representing 29 organisations from Study I (conducted in 1994) were compared to the findings in Study IV, undertaken in 1998.

For the university study, Study III, a copy of the questionnaire was sent to each person selected, together with an introductory letter that explained briefly the project and requested participation in the study. Each questionnaire was coded to enable follow-up reminders to be made and to allow distinction between replies from academic staff and post-graduate students. Of the 400 academic staff and 400 post-graduate students surveyed, a total of 226 useable responses were received – 117 from academic staff and 109 from post-graduate students (64 internal students, 45 external students), yielding a response rate of 28%. This is a considerably lower response rate than that for the other studies. This may be due in part to the fact that there was more personal contact in the prior studies or that the university study was given lower priority by the subjects, due to factors such as heavy workloads, fatigue or examination period.

Study VI involved surveying individuals within a single large-sized, private-sector firm. A coded questionnaire, with a reply-paid envelope addressed to the researcher attached, was sent via the firm's internal mail system to the 50 people who had volunteered to participate in the study. Non-responses were followed up by a telephone call several days after the due date. As a result 39 useable questionnaires were received, giving a response rate of 78%.

Most of the data used in these studies were generated from a mailed questionnaire. This method has the usual presumed limitation that the responses are shaped by the field of interest covered by the instrument – and the usual presumed benefit of honest responses when participation is voluntary.

Statistical Analysis

Studies I and II

The collected data were coded and entered into the computer package Minitab (Minitab Inc 1995). Descriptive and frequency analyses were computed and analysed for all relevant variables, across organisations and between them, to arrive at answers to the research questions defined in the study. The analysis compared variables such as respondents' position within the organisation, gender of respondents, attendance at an education/training session, and reported awareness of ergonomic principles. Other variables compared included whether respondents had read any documents that contained information on ergonomics relating to computer use in the past 12 months, the perceived priority of ergonomics within organisations, whether the organisation had a written policy on procedures relating to ergonomics and computer use, and whether records of computer-related injury were kept by organisations. Evidence of these background factors was compared in relation to the size and type of organisation, with Chi Square analysis for independent groups used to test for association between categorical variables.

Comparisons were also made by applying *t*-tests for independent groups to test for differences between private and government organisations with respect to the estimated average daily use of computers. Further *t*-tests for independent groups were used to test for differences in average daily use of computers between male and female respondents and between respondents reporting work-related complaints of pain and those not reporting work-related pain. Principal component factor analysis was used to identify groupings of items from the 'motivational scale exercise' that respondents rated according to the importance they believed their organisation placed on the items. The significance level for testing all null hypotheses was set at the 0.05 level.

Study III

The data collected for the university study were also coded and entered into Minitab. Descriptive and frequency analyses were computed for all variables. Principal component factor analysis was conducted on the responses to the two questions containing the diagrams regarding posture and layout. Comparisons were made between relevant variables, in particular between gender and complaints of pain and hours of use and complaints of pain. Again, the significance level for statistical testing was set at the 0.05 level.

Study IV

The data collected were coded and entered into the Statistical Package for the Social Sciences (SPSS) (Norusis 1990) for analysis. Descriptive and frequency analyses were computed for all relevant variables. Factor analysis with principal component extraction was used to identify groupings.[30] Hierarchical multiple regression was used to assess the effect of groups of independent variables on the outcomes measured, namely psychological distress, physical health symptoms and job satisfaction.[31]

Ergonomic variables were measured using dichotomous responses to 12 questions. Factor analysis with principal component extraction was performed using the 12 ergonomic variables and, following Varimax rotation,[32] three factors were extracted that accounted for a total of 61.9% of the variation. The first factor contained items pertaining to whether the organisation had a written policy on procedures relating to ergonomics and computer use, whether the organisation kept records of or reported computer-associated incidents, and whether the organisation had a written policy linked to computer-related injuries. The second group related to personal factors such

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[30] Factor analysis is used to reduce a larger number of variables into smaller groupings of variables that are correlated with each other, known as factors. The aim is to determine whether the variables can be described by a much smaller number of factors and therefore become more manageable (Burns 2000).

[31] In undertaking hierarchical multiple regression analysis, predictor variables are added sequentially to determine the correlation with the dependent variable and how much each successive variable adds to the overall prediction (Burns 2000).

[32] Varimax rotation is used to give a clearer separation of the factors by simplifying the factor matrix to facilitate interpretation (Hair et al. 1995).

as individual awareness of ergonomic practices in relation to computer use, beliefs regarding the need for more time to be spent on ergonomic knowledge; reading of material on ergonomics in relation to computer use in the past 12 months, and perceptions of the priority given to ergonomics and computer use in the organisation. The final group related to both organisational and personal factors and included items such as whether regular breaks are taken away from the computer, whether anyone was delegated the responsibility for ensuring appropriate ergonomic practice in the organisation, and the emphasis the organisation placed on safe ergonomic computer use.

These variables were then added together to form new variables (‘Group1A’ etc) that were entered into a multiple regression, the objective being to predict the changes in the dependent variable (psychological distress, physical health symptoms or job satisfaction) in response to changes in the several independent variables. These were entered hierarchically in the regression analysis. The biographical variables (Age, Gender, Position, Organisation size, Organisation type, and Hours of use) were entered in one block; a second block contained the 12 ergonomic variables together with the composite variable representing the responses to the two questions containing the diagrams; and a third block contained the composite variables representing the responses to the four subscales of the *Work Environment Scale* (Moos 1986) (*Work Pressure, Autonomy, Supervisor support* and *Peer cohesion*) that were used, together with the variable representing the responses to the question on job security. These blocks were examined against the variable ‘GHQ12’, (representing the aggregated *General Health Questionnaire* scores measuring psychological distress), Job satisfaction, and the variable ‘Hstotal’ (representing the aggregated physical health symptoms scores), in three separate runs. To maximise the data, it was necessary to use mean substitution in the regression analysis as a substitute for missing values.

A further factor analysis was conducted on the 12 items of physical health symptoms and three factors were extracted, accounting for 56.8% of the variance. These factors were rotated using oblique rotations, and three identifiable factors emerged with item loadings of more than 0.5. The first factor related to upper body symptoms such as neck tension, upper back problems, muscular aches/pains in shoulder, and migraine/severe headache. The second factor related to arm symptoms and was identified through the items of elbow and arm symptoms. The third factor related to hand symptoms through the items of pain in the fingers and thumbs and wrist pain.

A hierarchical regression model was set up as follows: first demographic variables were entered (Age, Gender, Position, Organisational size, Organisational type and Hours of use); next the three factors identified in addition to accurate ergonomic knowledge were entered; finally psychosocial aspects of the work environment (Demands, Control, Support and Job security) were entered. Dependent measures were Psychological distress, Job satisfaction and three physical factors; namely, Upper body symptoms, Arm symptoms and Hand symptoms. The significance level for testing all null hypotheses was set at the 0.05 level.

The data were also entered into the STATISTICA (StatSoft Inc 2001) software package and a ridge regression analysis[33] performed, because the reported health symptoms were highly correlated, in relation to the health symptoms and hours of daily computer use, leading to good model with an 81.3% explanation of the variance.

Study V

The 1994 data from Study I were coded and entered into the SPSS file containing the 1998 data previously entered for Study IV. Descriptive and frequency analyses were computed for all relevant variables. An analysis of relevant variables was made across organisations and between organisations. Variables were also compared across the time period to determine what changes had taken place.

Again, the analysis compared variables such as respondents' position within the organisation, gender of respondents, average daily computer use, attendance at an education/training session provided by the employer and reported awareness of ergonomic principles. Comparisons were also made between variables such as whether the organisation had a written policy in relation to ergonomic computer use, whether a person within the organisation had been delegated responsibility for ensuring employees followed ergonomic work practices, whether the organisation emphasised the importance of keeping ergonomic work practices in mind while using computers, whether the organisation kept records relating to incidents of computer-related injury, and whether the organisation had a written policy on procedures related to

[33] Ridge regression is a technique used to obtain a model that more clearly reflects the effects of the predictor variables (Hair et al. 1995, p. 128).

rehabilitation of employees affected by computer-related injury. Comparisons were made between these items and the type of organisation. Chi Square analysis for independent groups was used to test for association between categorical variables.

Study VI

The collected data were coded and entered into the SPSS software (Norusis 1990) for analysis. Descriptive and frequency analyses were computed for all relevant variables. An analysis of relevant variables was made in order to arrive at answers to the research questions defined for this study.

The analysis compared variables such as respondents' position within the firm, gender of respondents, attendance at training sessions, whether respondents had read any documents that included information on ergonomics relating to computer use, responses to the diagrams of posture and layout, and reported awareness of ergonomic principles. Other variables compared included average daily computer use, whether respondents took rest breaks and micro-breaks, whether respondents wore glasses or bifocals, respondents' fitness level, job security and prestige, reported job satisfaction and health symptoms. Chi Square analysis for independent groups was used to identify significant associations between categorical variables.

Regression analysis was used to provide answers to the specific research questions. In relation to the application of ergonomics, univariate log-binomial regression analysis[34] was performed on each of the potential predictors for the binary variable Apply.

[34] Log-binominal regression was used to account for the 'yes/no' format of the questions.

Separate analyses were performed for the predictors for ergonomic knowledge, personality and work environment using the variables for gender, age, position, reported awareness of ergonomic principles, whether respondent had attended training in ergonomics by organisation, whether respondent had read material on ergonomics, the diagrams representing posture and layout of equipment, the *Work Environment Scale*, and the four personality subscales. The final multivariate model included the variables that had a p-value of less than 0.2 in the univariate analyses. Significance for the final models was assessed at the 0.05 level. The results were reported using relative risks and 95% confidence intervals.

Fisher's exact test was used to determine whether there was an association between the variable Apply and the variables in the Compliance scale. Significance was assessed at the 0.05 level.

In relation to physical health symptoms, the continuous variable Health symptom was log-transformed,[35] then univariate linear regression analysis was performed on each of the potential predictors. Again, separate analyses were performed for the predictors for ergonomic knowledge, personality and work environment using the previous variables and including additional variables regarding levels of fitness, amount of exercise undertaken, the security, remuneration and prestige of the respondents' position, and the GHQ-12 results. The final multivariate model included the variables that had a p-value of less than 0.2 in the univariate analyses. Significance for the final model was assessed

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[35] Log transformation was necessary in relation to the physical health symptoms as the Hstotal variable did not have a normal distribution.

at the 0.05 level. All analyses were performed using SAS version 8.2 (SAS Institute 2001).

Factor analysis with principal component extraction was used to identify underlying constructs of the Compliance scale and the *Quick Scales* personality measure, the GHQ-12, the Physical health symptoms scale and the *Work Environment Scale*.

The significance level for testing all null hypotheses was set at the 0.05 level.

Summary

This chapter has outlined the purpose, design and research methods adopted in the studies forming the research for this thesis. Chapters 3–7 provide the results of the analyses undertaken.

CHAPTER 3

FINDINGS: STUDIES I AND II

Study II aimed to determine the differences, if any, in the knowledge of and priority given to ergonomic computer use between organisations located in the Adelaide metropolitan area and those located in the city of Whyalla (Study I). The findings for Study I are included with those for Study II for comparison. Study II extended the initial work by focusing on organisations located in the Adelaide metropolitan area as opposed to those in the regional city of Whyalla.

496 questionnaires were distributed in Study II: 86 replies were received from 38 private organisations and 143 were received from 34 government organisations. A total of 62 questionnaires were received from small-sized organisations where employees numbered 10 or fewer, and 167 questionnaires were received from medium–large organisations where employees numbered more than ten. Response rates varied from 35% to 52%, with an average response rate, based on 229 completed and useable questionnaires, of 46%. Table 3.1 gives details of the organisations surveyed and the respective response rates.

Table 3.1 Number of Questionnaires Returned and Response Rates for Types of Organisation (Private or Government) ordered by Size (Small and Medium–Large)

Type of Organisation	Max Possible Response		Actual Response		Per cent Returned	
	Study II	Study I	**Study II**	Study I	**Study II**	Study I
Small private (<=10 employees)	**62**	70	**31**	31	**50**	44
Medium–large private (> 10 employees)	**159**	63	**55**	31	**35**	49
Small government (<=10 employees)	**61**	53	**31**	30	**51**	57
Medium–large government (> 10 employees)	**214**	153	**112**	78	**52**	51
Total	**496**	339	**229**	170	**46**	50

A greater number of questionnaires were distributed in Study II due to there being more computer users in the medium–large organisations selected, giving a larger number of cases than in Study I. It is believed that the higher response rate in Study I was due to the more personal contact with firms in the follow-up/reminder stage.

Table 3.2 provides a profile of the respondents, indicating their age, gender and position within each organisation. The results for both studies are similar for each variable.

Table 3.2 Number and Percentage of Respondents by Age, Gender and Position within Organisation

Variable	Category	Number		Per cent	
		Study II	Study I	**Study II**	Study I
Age	18-27 years	**51**	37	**22**	22
	28-37	**60**	58	**26**	34
	38-47	**77**	48	**34**	28
	48-57	**33**	25	**14**	15
	Over 57 years	**8**	1	**4**	0.6
Gender	Male	**82**	64	**36**	38
	Female	**147**	104	**64**	62
Position	Non-Manager	**174**	106	**76**	65
	Manager	**52**	57	**23**	35

In both Studies I and II the majority of respondents were women who worked in non-management positions. In Study II the majority were aged between 38 and 47 years and in Study I between 28 and 37 years.[36] The small organisations, both government and privately owned, tended to have younger employees than the medium–large organisations (Chi Square = 5.742, df = 1, $p < 0.05$) and the privately owned organisations tended to have younger employees than the government-owned organisations (Chi Square = 7.932, df = 1, $p < 0.05$). The small privately owned organisations had a greater proportion of male employees and the small government-owned organisations a greater proportion of female employees (Chi Square = 10.559, df = 3, $p < 0.05$).

Thirty-five per cent (57% Study I) of males who replied to the questions were managers whereas only 17% (21% Study I) of females who responded were managers. The higher prevalence of men in management roles accords with the employment

[36] Age is discussed further under the summary section at the end of this Chapter.

[37] Age is discussed further under the summary section at the end of this Chapter.

situation in Australia and is relevant to these studies because it can be expected that they will have less knowledge of ergonomic computer use than women who have traditionally trained for keyboarding positions. Association between gender and position was statistically significant in both studies (Chi Square = 9.522, df = 1, $p < 0.01$ for Study II; Chi Square = 22.47, df = 2, $p < 0.01$ for Study I). More managers were from government organisations (56% Study II; 60% Study I) than from privately owned organisations (44% Study II; 40% Study I), and most non-managers were also from government organisations (64% Study II; 68% Study I), reflecting the higher participation of government organisations.

The average estimated daily use of desktop keyboard-operated computers increased sharply between the two studies, to 4.33 hours (3.3 hours Study I), with a range of zero to 12 hours per day (7.5 hours Study I), indicating that even in the two years between the studies computers were being increasingly relied upon in the day-to-day operation of organisations. As expected, with more women working in non-management positions, the mean daily use for females (4.56 hours Study II; 3.8 hours Study I) was higher than for male users (3.42 hours Study II; 2.4 hours Study I) in both studies and the differences in mean usage were significant statistically ($p < 0.05$ Study II; $p < 0.01$ Study I). In Study II, the average daily use of non-managers (4.52 hours) was greater than for managers (3.67 hours) and employees in medium–large organisations spent more time on the computer (4.84 hours) than employees in small organisations (2.43 hours); these results were also statistically significant ($p < 0.05$ and $p < 0.01$).

In Study II the estimated average daily use of computers was similar for both private and government organisations (mean of 4.32 hours for privately owned organisations and 4.33 hours for government organisations), whereas in Study I mean usage was higher in government organisations (3.5 hours) than in privately owned firms (2.8 hours). It is noteworthy that the Public Service Association of SA (1990) recommends that computer operators work at a keyboard for no more than two hours consecutively, and that a routine of one hour on and one hour off be adopted. The PSA also recommends that the maximum period in which an employee operates a VDU should be limited to four hours per day. An average daily use of 4.33 hours seems sufficiently above the recommended norm to make awareness of the principles of ergonomics – and their application – the practice with computer use if workplaces are to be efficient and safe.

Findings Relating to Knowledge of Ergonomics

In both Studies I and II the majority of respondents indicated that they had learnt to operate a computer on the job (Table 3.3). Those selecting that they had learnt in some 'Other' way were generally self taught at home.

Table 3.3 Number and Percentage of Responses Reporting Where Respondents Learnt to Operate a Computer

	N		**Per cent**	
Response Received	**Study II**	Study I	**Study II**	Study I
On the Job	**150**	121	**66**	71
Educational Institution	**62**	20	**27**	12
Other	**17**	10	**7**	
Both On the Job and Educational Institution	**–**	17	**–**	10
Non–responses	**–**	2	**–**	1
Total	**229**	170	**100**	100

However, when asked whether they had attended an educational program/training session provided by their organisation that included information on ergonomic computer use, the majority had not (Table 3.4). Either few opportunities for education and training about the use of computers were provided by organisations or few employees attended the sessions.

Table 3.4 Number and Percentage of Respondents Reporting Attendance at Education/Training Sessions Provided by their Organisation

Frequency	**N**		**Per cent**	
	Study II	Study I	**Study II**	Study I
In the last 12 months	**16**	8	**7**	5
In the last 2 years	**11**	12	**5**	7
Over 2 years ago	**34**	18	**15**	11
Never	**166**	130	**72**	76
Non-responses	**2**	2	**1**	1
Total	**229**	170	**100**	100

Study II revealed statistically significantly higher attendance by respondents from the government organisations (Chi Square = 23.321, df = 1, $p < 0.05$) and respondents in medium–large organisations were more likely to attend such sessions than those in small-sized organisations (Chi Square = 6.234, df = 1, $p < 0.05$). In Study I, while there tended to be higher attendance within government and medium–large organisations, the results were not statistically significant (Chi Square = 6.77, df = 3, $p > 0.05$ for both).

Only 42 respondents (18% of total respondents) replied to the question asking approximately how much time had been spent in training/update sessions related to ergonomics and the use of computers, provided by their organisation in the past 12 months, confirming that few people had attended such training and suggesting a lack of interest by the individual or employer. The time reported ranged from 0 to 72 hours,[38] with a mean of 2.32 hours. In Study I the responses were too few to allow any meaningful statistic to be calculated. As reported in Table 3.5, a clear majority of respondents in both studies believed they needed to spend more time in such ergonomic training/update sessions.[39]

Table 3.5 Number and Percentage of Respondents Reporting whether they Believed they Needed More Time in Training/Update Sessions

	N		**Per cent**	
Response	**Study II**	Study I	**Study II**	Study I
Yes	**135**	97	**59**	57
No	**62**	40	**27**	24
Non-responses	**32**	33	**14**	19
Total	**229**	170	**100**	100

Respondents were asked how they had applied the knowledge of ergonomics received in training provided by their organisation to their work situation. The majority of responses in both studies indicated that their knowledge of ergonomics was applied primarily in the layout of the workstation and in making appropriate adjustments to furniture and equipment (Table 3.6). However, most respondents did not answer this question, which is consistent with few participating in such ergonomic training. In Study II only seven responses were received from respondents in privately owned organisations and in Study I not one of the respondents from the small privately owned organisations offered a response.

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[38] It is reasonable to assume that not all 72 hours were devoted to ergonomics in what, presumably, was a two-week computer training course.

[39] Training is an important issue and is discussed further in Chapter 9.

Table 3.6 Responses Reporting how Respondents Applied their Knowledge of Ergonomics to their Work Situation

How Knowledge was Applied	N*	
	Study II	Study I
In layout of office and workstation	**21**	8
By making adjustments and using recommended postures	**15**	4
In purchase of furniture, chair, footrest and document holder	**13**	5
By checking lighting and screen glare	**7**	–
By taking rest breaks	**7**	–
By being aware of the issues and following guidelines	**5**	1
By ensuring other staff are aware of ergonomic principles	**2**	1

*** N** indicates the number of times the item was identified.

Respondents were provided with a definition of ergonomics and the aspects of work to which it can be applied and then asked whether they were aware of the ergonomic principles and recommended adjustments and layouts that relate to the use of computers. The results in both studies were similar, with most replying that they were not aware (Table 3.7). Study II revealed that employees from the government organisations were more aware of the ergonomic principles than those from non-government organisations and this was statistically significant (Chi square = 16.264, df = 1, $p < 0.01$); in Study I, the results were not statistically significant (Chi square = 0.65, df = 1, $p > 0.05$). In both studies, government and non-government employees who responded indicated that their knowledge of ergonomics came mainly from in-house training and their occupational health and safety personnel (Table 3.8).

Table 3.7 Number and Percentage of Respondents Reporting whether they were Aware of the Principles of Ergonomics relating to the Use of Computers

Response	N		Per cent	
	Study II	Study I	**Study II**	Study I
Yes	**108**	79	**47**	46
No	**119**	90	**52**	53
Non-responses	**2**	1	**1**	1
Total	**229**	170	**100**	100

Table 3.8 Responses Reporting how Respondents Received their Knowledge of Ergonomics relating to Computer Use

How Knowledge was Received	N*	
	Study II	Study I
In-service training, OH&S personnel, union representatives, information supplied by employer and ergonomic assessment of workstation	**68**	33
Various literature including journals, advertising and videos	**26**	12
School, business college, TAFE or university courses, computer courses	**18**	27
Previous job experience and expertise within the office	**16**	–
Professional bodies and conferences, physiotherapists, ergonomists	**5**	6

*** N** indicates the number of times the item was identified.

Almost three-quarters of the respondents had not read any documents that included information on ergonomics in relation to the use of computers in the preceding 12 months (Table 3.9).

Table 3.9 Number and Percentage of Respondents Reporting whether they had Read Documents on Ergonomic Computer Use

Response	N		Per cent	
	Study II	Study I	**Study II**	Study I
Yes	**57**	43	**25**	25
No	**169**	123	**74**	73
Non-responses	**3**	4	**1**	2
Total	**229**	170	**100**	100

A large proportion of respondents reported that their job involved tasks other than those requiring the use of a computer (94% Study II; 92% Study I). This is an ergonomically sound response and is in contrast to the ‘typing pool’ situation, where the person’s job was only to enter data, with no scope for variation in tasks. Respondents were then asked what factors were taken into consideration in organising their work day. Table 3.10 presents the responses received. Varying tasks to give breaks from computer work, and deadlines and priorities were the main factors identified in both studies. The first factor is again ergonomically sound, indicating knowledge of the need to schedule breaks from computer work by varying tasks and job rotation. However, in both Studies I and II clerical work and writing activities were frequently given as tasks that could be done to break up computer work, suggesting a lack of understanding of the purpose of such breaks. The second factor gave an indication of work pressures. A comment was received that “understaffing does not allow organising work”. Some respondents replied that there were no factors considered as it was not possible to organise their work day.

Table 3.10 Responses Reporting Factors Considered by Respondents in Organising their Work Day

Response Received	**N***	
	Study II	Study I
Varying tasks, spacing work out to give breaks from computer work	**82**	18
Deadlines, priorities	**71**	41
Nature of tasks, general office practices, meetings and appointments	**32**	–
Time management	**18**	6
Customer demands, work to be done	**7**	16
None, not possible	**16**	6
Availability of staff, availability of computer, peak periods	**12**	2
Correct clothing, temperature	**2**	–
Health and safety and industrial relations issues	**–**	2
Hours per day of computer use, amount of time looking at screen	**–**	2
Too many	**–**	2
Doing computer work in the morning when refreshed from overnight break	**–**	1

*** N** indicates the number of times the item was identified.

A large proportion of respondents also recognised that rest breaks were relevant to the use of computers (97% Study II; 95% Study I). However, in comparison, only 75% of respondents in Study II and 62% in Study I indicated that they did take rest breaks. When asked how often rest breaks should be taken the range of responses were as shown in Table 3.11. The majority of respondents replied that rest breaks should be taken every hour, which is in accordance with ergonomic principles and the recommendations of the Public Service Association of SA (1990). It is noteworthy that 11% of respondents in Study II (17% Study I) did not answer the question and a further 3% (6% Study I) indicated that they were unsure about the recommendations regarding rest breaks.

Table 3.11 Responses Reporting How Often Rest Breaks should be Taken

Response Received	N*	
	Study II	Study I
5–30 minutes	**40**	27
30–60 minutes	**113**	86
11/2–2 hours	**26**	2
2–3 hours	**10**	15
3–4 hours	**2**	1
As needed	**5**	–
Unsure	**7**	10
Non-responses	**26**	29
Total	**229**	170

* **N** indicates the number of times the item was identified.

To further assess their understanding of ergonomic principles, respondents were asked what tasks could be undertaken in rest breaks. Table 3.12 lists the activities identified by the respondents in both studies. In Study II the most common reply was ‘other office duties’ although many respondents appreciated the need to exercise and rest the eyes. In Study I the majority correctly reported that activities such as filing, photocopying and doing the mail were appropriate.

Table 3.12 Activities Respondents Believed could be Undertaken in Rest Breaks

Activity	N*	
	Study II	Study I
Other duties such as clerical and administration tasks, paperwork, collating information, and reading	**111**	45
Walk, leave seat and move around, such as deliveries	**81**	32
Stretch and exercise including hand, neck and breathing exercises	**57**	44
Filing, photocopying, sending faxes, mail, restocking, and tidying	**52**	48
Rest body, mind and eyes, eye exercises	**41**	21
Tea/coffee/toilet /fresh air break	**25**	8
Answer telephone	**24**	11
Reception, counter work	**5**	7

*** N** indicates the number of times the item was identified.

Of those respondents identifying 'Other duties such as clerical tasks' as suitable activities to be undertaken in rest breaks, 27 (12%) (14 (8%) Study I) indicated that written work and reading were suitable tasks, which suggests a lack of knowledge of ergonomics in relation to taking rest breaks as these activities would not rest the eyes and/or muscles that had previously been used, and would not therefore fulfil the purpose of taking rest breaks.

A question was also asked to determine what factors respondents would take into consideration when choosing office furniture and equipment. As illustrated by the summary in Table 3.13, ergonomic factors such as the height of desks and chairs, comfort, and compliance with occupational health and safety requirements were the main factors considered in both studies. These responses indicate an awareness that computer users need furniture and equipment that can be adjusted to suit their individual requirements.

Table 3.13 Responses Reporting Factors Considered by Respondents when Choosing Office Furniture and Equipment

Response Received	N*	
	Study II	Study I
Size and heights of desk and chair, plenty of work room and leg room	**88**	18
Comfort	**71**	59
Ergonomic Design, OH&S guidelines, industry standards, safety	**64**	35
Practicality, suitability, to requirements of job and work output	**51**	25
Adjustability	**44**	33
Appearance, shape, colour	**38**	23
Support for posture	**33**	14
Quality, durability, stability	**23**	15
Personal needs of staff, staff disabilities	**14**	–
User and environmentally friendly	**14**	8
Cost	**13**	12
Lighting, glare	**13**	12
Screen type, size, colour, screen filter	**8**	2
No Arm Rests on chairs, smooth running castors	**5**	–
Footrests, Document holders	**5**	–
Placement, location, space	**–**	16
Materials, coverings, surface	**–**	4
Noise, pollution	**–**	4
Availability, accessibility and reputation of supplier	**5**	2
Ventilation, windows, doorways	**2**	6
Unsure	**2**	3

*** N** indicates the number of times the item was identified.

Often additional information was provided along with the replies to this question. In both Studies I and II respondents mentioned that they were not involved in the selection of office furniture and equipment as this was the task of management. Comments were received such as “arranged by manager”, “selected for us by Head Office”, “not my job”, and “office furniture original from first day of operation (1968); no hope of getting up-to-date furniture”. These remarks suggest that sometimes computer users were not able to participate in decision-making involving their work and therefore may have had little control over their job situation. They also indicated employee dissatisfaction and a non-consultative leadership style by the organisation’s management.

To further test their knowledge, respondents were asked to study diagrams to determine whether accepted ergonomic principles were being applied, first in relation to sitting posture and positioning of the arms and wrists (Question 15), and then in relation to posture and the layout of equipment (Question 16). Respondents answered ‘Yes’, ‘No’ or ‘Unsure’ as appropriate and gave the reason for their selection. A correct answer and a correct reason were assumed to be indicative of knowledge whereas an ‘Unsure’, incorrect answer, incorrect reason, or a question left blank, were assumed to indicate lack of knowledge. There were nine diagrams in each question. The findings for Questions 15 and 16 generally indicated a poor knowledge of ergonomic principles although there was an improvement in Study II, with respondents from the Adelaide firms performing approximately 7% better than those from the Whyalla organisations (Figures 3.3 and 3.4). While most respondents were aware of the obviously ‘bad’ postures and layouts, less than one-third recognised positions that were generally recommended. Of the scenarios depicting recommended postures and layouts, diagrams (g) and (h) in question 15 and diagram (e) in question 16 were correctly identified by less than 27% (20% Study I), and diagram (h) in question 16 was correctly identified by only 31% of respondents (22% Study I).

Both Study I and Study II respondents were most knowledgeable about diagrams (a), (b), (f) and (i) in Question 15 and diagrams (a), (d) and (i) in Question 16. In Question 15, these diagrams show the computer operator sitting with knees raised because the chair is too low; sitting on the front edge of the seat, not using the backrest of the chair; sitting with legs crossed; and sitting in a slouched position.

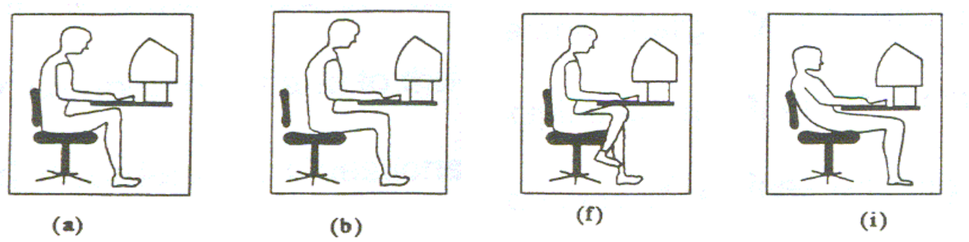

Figure 3.1 Diagrams (a), (b), (f) and (i) Survey Question Number 15

In Question 16, these diagrams show the computer operator sitting too far away from the VDU; craning the neck upwards to look into the VDU when it is positioned too high, and bending the neck to look down into the VDU when it is positioned too low.[40]

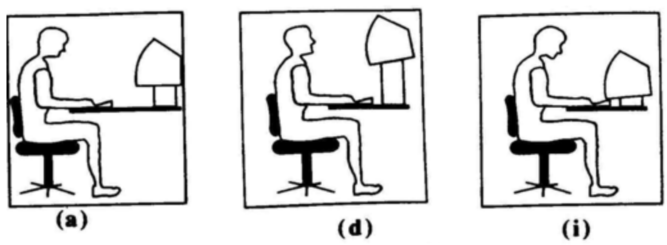

Figure 3.2 Diagrams (a), (d) and (i) Survey Question Number 16

The largest difference between the correct answers given in Studies I and II related to Question 15 scenario (c), for which more respondents from Adelaide firms identified the longer chair seat cutting into the back of the operator's knees.

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[40] Positioning of the VDU is discussed further in Chapter 9, pp 331-332. The information available to the participants at the time of the research, and against which their responses were judged to be correct, was not always correct according to current thought. It may be that the participants had an experiential understanding of the postures as being appropriate.

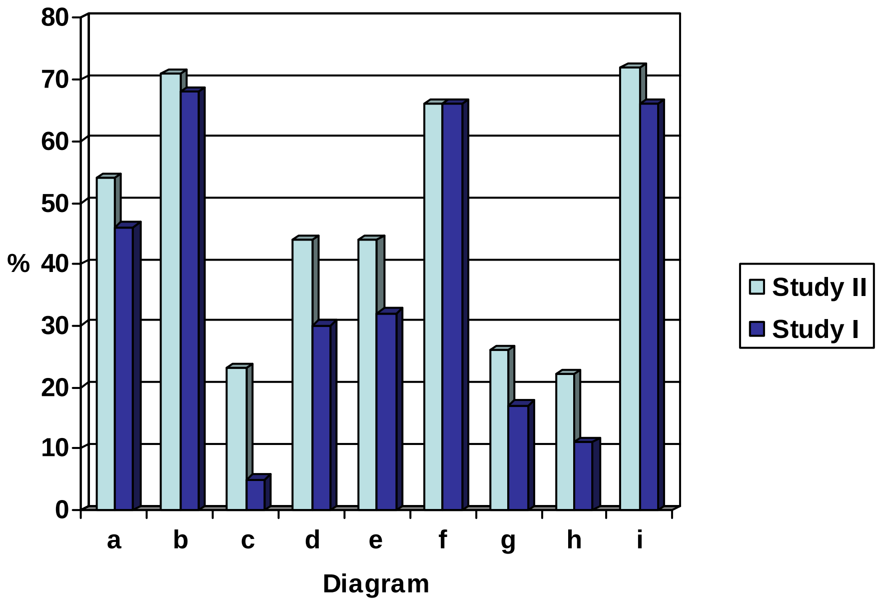

Figure 3.3 Percentage of Correct Responses to Scenarios Regarding Sitting Posture and Positioning of the Arms and Wrists (Survey Question Number 15 (a) to 15 (i))

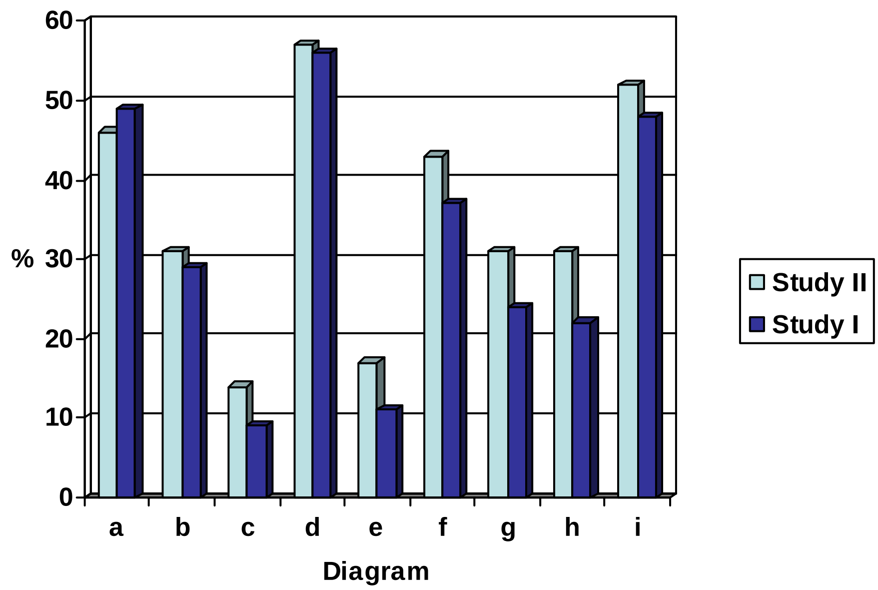

Figure 3.4 Percentage of Correct Responses to Scenarios Regarding Posture and the Layout of Equipment (Survey Question Number 16 (a) to 16 (i))

None of the diagrams was responded to correctly by all respondents (even where a diagram represented obviously bad posture). Question 15, diagrams (c) and (h), (and also (g) Study I) regarding sitting posture and positioning of the arms and wrists, and Question 16 diagrams (c) and (e), (and also (g) and (h) Study I) regarding posture and the layout of equipment, were answered correctly by less than 25% of respondents. Overall, the average of correct answers for Questions 15 and 16 was 42% (35% Study I).

In Study II an analysis of the correct answers to Questions 15 and 16 indicated that respondents from government organisations were more knowledgeable than those from privately owned organisations; in Study I, government and private organisations had a similar knowledge (Figures 3.5 and 3.6).

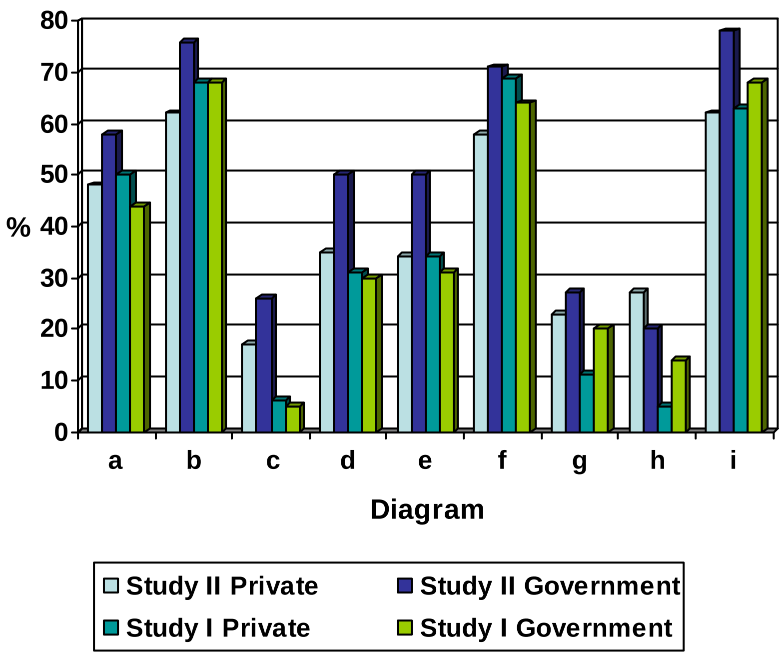

Figure 3.5 Percentage of Correct Responses to Scenarios Regarding Sitting Posture and Positioning of the Arms and Wrists by Organisational Structure (Survey Question Number 15 (a) to 15 (i))

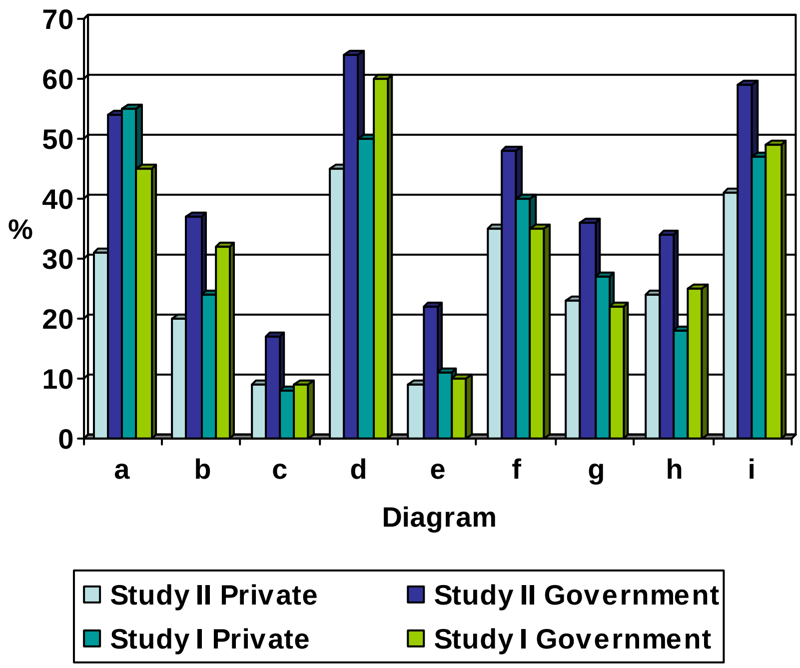

Figure 3.6 Percentage of Correct Responses to Scenarios Regarding Posture and the Layout of Equipment by Organisational Structure (Survey Question Number 16 (a) to 16 (i))

Correct answers were provided (as an average across all scenarios) by 46% (35% Study I) of respondents from government organisations and by 34% (34% Study I) of respondents from private organisations. This suggests that, even if well intentioned, many of the computer users were not aware of the adjustments and positions required for safe computer work and this lack of knowledge was greater within privately owned organisations.

Respondents generally recognised the importance of having ergonomically designed and adjustable furniture and equipment and the need to vary tasks throughout the work day to allow breaks away from the computer. Most also understood the need to rest the eyes and exercise during rest breaks. However, as indicated by the respondents and suggested by the answers to the diagram questions, more time in training/update sessions in relation to ergonomics and computer use was required.

Findings Relating to Priority given to Ergonomics

Given that respondents were not relatively well informed, answers to the question as to whether they carried their knowledge into practice promise some insight into health promotion-as-education. Respondents were asked whether they carried out pause gymnastics or exercised when using computers. The responses received indicate that the majority of respondents did not (Table 3.14).

Table 3.14 Number and Percentage of Responses Reporting whether Respondents carried out Pause Gymnastics or Exercised when Using Computers

	N		**Per cent**	
Response	**Study II**	Study I	**Study II**	Study I
Yes	**42**	38	**18**	23
No	**185**	123	**81**	72
Non-responses	**2**	9	**1**	5
Total	**229**	170	**100**	100

Of the 42 who said they did exercise, 12 indicated they did so ‘Regularly’ (5% of total respondents), 25 indicated ‘Occasionally’ (11%), and five answered ‘Rarely’ (2%). In Study I, nine (5% of total respondents) replied ‘Regularly’, 22 (13%) ‘Occasionally’ and seven (4%) ‘Rarely’.

When asked specifically what priority they believed their organisation placed on the importance of ergonomics in relation to the use of computers, the majority of respondents in both studies answered ‘Low’ priority. ‘High’ priority was selected by less than 10% of respondents (Table 3.15).

Table 3.15 Number and Percentage of Respondents Reporting the Priority Placed on the Importance of Ergonomics by their Organisation

	N		Per cent	
Response	**Study II**	Study I	**Study II**	Study I
High Priority	**20**	16	**9**	9
Medium Priority	**94**	57	**41**	34
Low Priority	**114**	90	**50**	53
Non-responses	**1**	7	**0**	4
Total	**229**	170	**100**	100

Study II results of a comparison between the priority selected and type of organisation were not significantly different; in Study I higher priority was given to ergonomics within government organisations than within private, and this was statistically significant (Chi Square = 6.90, df = 5, $p < 0.05$). For both studies the results of tests for association with size of organisation were not statistically significant ($p > 0.05$).

Respondents were also asked whether they believed ergonomic principles in relation to the use of computers were given sufficient priority in their organisation. The results displayed in Table 3.16 show that in both studies a clear majority believed they were not given sufficient priority.

Table 3.16 Number and Percentage of Respondents Reporting whether Ergonomic Principles were given Sufficient Priority in their Organisation

	N		Per cent	
Response	**Study II**	Study I	**Study II**	Study I
Yes	**60**	44	**26**	26
No	**159**	112	**70**	66
Non-responses	**10**	14	**4**	8
Total	**229**	170	**100**	100

These responses were compared with those relating to whether respondents had read any documents that included information on the ergonomic use of computers in the preceding 12 months. Thirty-seven per cent of respondents who believed ergonomic principles were given sufficient priority had read such documents (48% Study I), whereas of those who believed ergonomic principles were not given sufficient priority, only 21% (16% Study I) had read any, and the results were statistically significant (Chi Square = 6.236, df = 1, $p < 0.05$ Study II; Chi Square = 16.88, df = 1, $p < 0.01$ Study I).

To help assess the priority given to ergonomic computer use by organisations, respondents were asked whether their organisation had a written policy on procedures related to ergonomics and the use of computers. In both studies less than 20% of respondents believed their organisation had such a policy (Table 3.17).

Table 3.17 Number and Percentage of Responses Reporting whether Organisation had a Written Policy on Ergonomics and the Use of Computers

	N		**Per cent**	
Response	**Study II**	Study I	**Study II**	Study I
Yes	**37**	33	**16**	19
No	**86**	76	**38**	45
Unsure	**106**	61	**46**	36
Total	**229**	170	**100**	100

Study II responses were tested for association with both organisational size and type but the results were not statistically significant ($p > 0.05$). In Study I, association with organisational size was not significant but the results relating to type were significant, indicating that government organisations were more likely to have a written policy on ergonomics than were private organisations (Chi Square = 13.94, df = 2, $p < 0.05$).

A second part of the question asked 'If not, is your organisation in the process of formulating a written policy on procedures related to ergonomics and use of computer technology'. As reported in Table 3.18, most respondents were unsure.

Table 3.18 Number and Percentage of Responses Reporting whether Organisation in process of Formulating a Written Policy on Ergonomics and Computer Use

	N		**Per cent**	
Response	**Study II**	Study I	**Study II**	Study I
Yes	**7**	2	**3**	1
No	**57**	46	**25**	27
Unsure	**91**	71	**40**	42
Non-responses	**74**	51	**32**	30
Total	**229**	170	**100**	100

In both Studies I and II the majority of respondents were also unsure whether their organisation had a written policy in relation to rehabilitation of employees affected by computer-related disorders. Less than 25% of respondents believed their organisation had such a policy (Table 3.19).

Table 3.19 Number and Percentage of Responses Reporting whether Organisation had a Written Policy on Rehabilitation of Employees Affected by Computer-Related Injury

	N		**Per cent**	
Response	**Study II**	Study I	**Study II**	Study I
Yes	**40**	37	**18**	22
No	**60**	44	**26**	26
Unsure	**128**	85	**56**	50
Non-responses	**1**	4	**0**	2
Total	**229**	170	**100**	100

Study II revealed government organisations were more likely to have such a policy than privately owned organisations; only 4% of respondents from private organisations replied positively compared with 26% from government organisations and this was statistically significant (Chi Square = 68.29, df = 2, $p < 0.01$).

A second part of the question asked “If not, is your organisation in the process of formulating a written policy on procedures related to rehabilitation of employees affected by computer-related injury”. Again a large proportion of respondents were undecided and either replied that they were unsure or left the question unanswered. The responses received are summarised in Table 3.20.

Table 3.20 Number and Percentage of Responses Reporting whether Organisation in process of Formulating a Written Policy on Rehabilitation of Employees Affected by Computer-Related Injury

Response	N		Per cent	
	Study II	Study I	**Study II**	Study I
Yes	**4**	4	**2**	2
No	**51**	35	**22**	21
Unsure	**88**	62	**38**	36
Non-responses	**86**	69	**38**	41
Total	**229**	170	**100**	100

When asked whether their organisation stressed the importance of computer users keeping recommended ergonomic work practices in mind while operating computer equipment, a clear majority of respondents answered ‘No’ (Table 3.21).

Table 3.21 Number and Percentage of Responses Reporting whether Organisation Stresses the Importance of Ergonomic Work Practices

Response	N		Per cent	
	Study II	Study I	**Study II**	Study I
Yes	**68**	52	**30**	31
No	**157**	114	**68**	67
Non-responses	**4**	4	**2**	2
Total	**229**	170	**100**	100

Study II revealed that government-owned organisations tended to place more emphasis on the importance of ergonomics than privately owned organisations (Chi Square = 6.769, df = 1, p < 0.01).

Respondents were asked whether a person in their organisation had been delegated responsibility for ensuring that employees followed recommended ergonomic practices. As reported in Table 3.22, almost two-thirds of respondents answered that a person had not been delegated this responsibility.

Table 3.22 Number and Percentage of Responses Reporting whether a Person had been Delegated Responsibility for Ensuring Ergonomic Practices were Followed

	N		**Per cent**	
Response	**Study II**	**Study I**	**Study II**	**Study I**
Yes	76	46	33	27
No	144	111	63	65
Non-responses	9	13	4	8
Total	**229**	170	**100**	100

Study II indicated that government-owned organisations were more likely to delegate such responsibility than privately owned organisations (Chi Square = 34.503, df = 1, p < 0.01).

In both studies the majority of respondents did not know how their organisation responded to breaches of recommended work practices relating to computer use and many replied that ‘it doesn’t’. Some answered that the question was ‘not applicable’ and that there were no breaches. A large percentage left this question blank. Comments such as “it’s totally up to me” and “we are unaware of guidelines, therefore we just go ahead and do our jobs" were received. The replies received are summarised in Table 3.23.

Table 3.23 Responses Reporting how Organisation Responded to Breaches of Recommended Work Practices

Response Received	N*	
	Study II	Study I
Unsure	**50**	33
It doesn't, wouldn't be noticed	**29**	16
Review and suggest changes, counselling	**21**	8
Educating users, OH &S officer would deal with it	**19**	5
No breaches, not applicable	**16**	11
Rectify asap, provide correct/support equipment, arrange rehabilitation when necessary	**9**	1
Slowly	**4**	1
Head Office would deal with it	**1**	–
Verbal warning	**1**	–
Only if WorkCover claim	**–**	1
Instant dismissal	**–**	1

*** N** indicates the number of times the item was identified.

When asked whether computer users were required to report incidents of computer-related injury, the majority of respondents replied in the affirmative but in both studies a large proportion were unsure (Table 3.24).

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Table 3.24 Number and Percentage of Responses Reporting whether Computer Users were Required to Report Incidents of Computer-Related Injury

Response	N		Per cent	
	Study II	Study I	**Study II**	Study I
Yes	**150**	107	**66**	63
No	**21**	10	**9**	6
Unsure	**56**	49	**24**	29
Non-responses	**2**	4	**1**	2
Total	**229**	170	**100**	100

Even more respondents were unsure whether their organisation kept records relating to incidents of computer-related injury (Table 3.25).

Table 3.25 Number and Percentage of Responses Reporting whether Organisation Keeps Records Relating to Computer-Related Injury

Response	N		Per cent	
	Study II	Study I	**Study II**	Study I
Yes	**94**	70	**41**	41
No	**45**	31	**20**	18
Unsure	**89**	64	**39**	38
Non-responses	**1**	5	**0**	3
Total	**229**	170	**100**	100

In both studies government organisations were more likely to keep records relating to incidents of computer-related injury than were private organisations and this was statistically significant at the 0.01 level (Chi Square = 40.812, df = 2 Study II; Chi Square = 18.06, df = 2 Study I).

A question based on the 'motivational scale exercise' used by Bird and Loftus (1976) required respondents to rate items related to organisational objectives on a scale of 1 ('extremely important') to 5 ('not important at all'), to reflect the importance they believed their organisation placed on the item. Table 3.26 reports how each item was rated.

Table 3.26 Percentage of Respondents Rating each Item to Reflect the Importance they Believed their Organisation Placed on the Item

Item	**Study II**						Study I					
	Ratings					**Non-Res %**	Ratings					Non-Res %
	1 %	**2 %**	**3 %**	**4 %**	**5 %**		1 %	2 %	3 %	4 %	5 %	
a Provide personal satisfaction	**14**	**19**	**40**	**15**	**7**	**4**	16	19	35	16	10	4
b Improve labour relations	**7**	**23**	**45**	**12**	**8**	**5**	11	28	33	18	5	5
c Enhance public relations	**29**	**30**	**23**	**6**	**8**	**4**	31	28	24	9	3	5
d Increase production rate	**27**	**35**	**23**	**7**	**4**	**5**	37	28	21	8	1	5
e Give legislative compliance	**26**	**20**	**30**	**10**	**6**	**7**	29	23	27	10	6	5
f Improve product quality	**32**	**33**	**20**	**7**	**4**	**4**	38	29	20	5	3	5
g Reduce injury rate	**29**	**27**	**29**	**7**	**3**	**5**	39	19	24	11	3	5
h Improve operating costs	**33**	**33**	**20**	**6**	**4**	**4**	42	24	21	6	2	5
i Increase job pride	**15**	**25**	**31**	**16**	**9**	**4**	9	24	31	18	4	5
j Reduce liability potential	**28**	**29**	**25**	**9**	**5**	**4**	32	25	25	9	3	5
k Improve customer relations	**44**	**21**	**18**	**8**	**5**	**4**	42	23	20	7	4	5

When ratings '1' and '2' are summed, the items respondents rated as most important were as follows:

	% (1 +2)		
Rank	**Study II**	Study I	**Item**
1	**66**	66	**h** Improve operating costs
2	**65**	67	**f** Improve produce quality
3	**65**	65	**k** Improve customer relations
4	**62**	65	**d** Increase production rate
5	**59**	59	**c** Enhance public relations
6	**57**	57	**j** Reduce liability potential
7	**56**	58	**g** Reduce injury rate
8	**46**	52	**e** Give legislative compliance
9	**40**	43	**i** Increase job pride
10	**33**	35	**a** Provide personal satisfaction
11	**30**	39	**b** Improve labour relations

These results are similar to those of Bird and Loftus (1976),[41] who found 'improve operating costs', 'increase production rate' and 'improve product quality' were the top three items, 'provide personal satisfaction' the bottom item, and 'reduce injury rate' generally placed between 6th and 8th position.

Using principal component analysis[42] three components, accounting for 72% (74% Study I), of the total variation were extracted. These components were rotated using Varimax[43] to give the factor loadings shown in Table 3.27.

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41 The work of Bird and Loftus (1976) is discussed further in the summary section at the end of this Chapter.

42 Principal component analysis reduces the dimension of the data, which leads to a smaller set of variables which are easier to interpret (Petkov 1999).

43 Varimax rotation is used to give a clearer separation of the factors by simplifying the factor matrix (Hair et al. 1995).

Table 3.27 Rotated Factor Loadings Relating to Rating of Items by Respondents

	Item	Factor 1		Factor 2		Factor 3	
		St II	St I	**St II**	St I	**St II**	St I
a	Provide Personal Satisfaction	**0.083**	0.223	**0.906**	-0.870	**0.076**	0.181
b	Improve Labour Relations	**0.284**	0.203	**0.752**	-0.730	**0.162**	0.315
c	Enhance Public Relations	**0.841**	0.262	**0.166**	-0.203	**0.135**	0.138
d	Increase Production Rate	**0.713**	0.851	**0.098**	-0.153	**0.336**	0.244
e	Give Legislative Compliance	**0.448**	0.111	**-0.007**	-0.100	**0.633**	0.859
f	Improve Product Quality	**0.671**	0.801	**0.385**	-0.305	**0.295**	0.172
g	Reduce Injury Rate	**0.057**	0.298	**0.378**	-0.308	**0.796**	0.748
h	Improve Operating Costs	**0.567**	0.737	**0.146**	-0.206	**0.544**	0.230
i	Increase Job Pride	**0.166**	0.199	**0.841**	-0.811	**0.167**	0.133
j	Reduce Liability Potential	**0.321**	0.224	**0.113**	-0.208	**0.798**	0.841
k	Improve Customer Relations	**0.836**	0.548	**0.182**	-0.272	**0.172**	0.178

The results enabled ready interpretation of the factors and gave the following groupings, which suggest that three distinct attitudes existed within the organisations. The items in Group 1 show job centredness, those in Group 2 employee centredness, and those in Group 3 can be interpreted as the 'ergonomic' factor.

Group 1 Job centredness
Enhance public relations
Improve customer relations
Increase production rate
Improve product quality
Improve operating costs

Group 2 Employee centredness
Provide personal satisfaction
Increase job pride
Improve labour relations

Group 3 The ergonomic factor
Reduce liability potential
Reduce injury rate
Give legislative compliance

For Study I, Group 1 contained the last four items only; Groups 2 and 3 contained the same three items.

In Study II, factor scores[44] were then calculated for every respondent in each of the three groupings and further analysis revealed that government organisations had a higher score than private organisations for job centredness (t = 2.75, $p < 0.05$), but there was no significant difference between medium–large and small-sized organisations. In relation to employee centredness, government organisations also had a higher score than private organisations (t = 3.47, $p < 0.01$) and medium–large organisations had a higher score than small organisations (t = 2.46, $p < 0.05$). There were no significant statistical differences between organisational types (t = 1.62, p = 0.11) or sizes (t = 1.89, p = 0.062) in relation to the 'ergonomic' factor.

An analysis of variance[45] using the four categories of small privately owned, medium–large privately owned, small government and medium–large government organisations showed that job centredness was statistically significant on the four groups ($F = 3.23$, $p < 0.05$) and that medium–large government organisations had a higher score, indicating that they were more job-centred than medium–large private-sector organisations. Employee centredness was also statistically significant on the four groups ($F = 6.18$, $p < 0.01$), with the score for small privately owned organisations lower than that for the other three categories. The 'ergonomic' factor was statistically significant on the four groups ($F = 4.09$, $p < 0.01$), with small privately owned organisations having a higher

[44] A factor score is a composite measure created for each observation on each factor extracted. The factor weights are used in conjunction with the variable values to calculate a score that can be used to represent the factor(s) in subsequent analyses (Hair et al. 1995).

[45] Analysis of variance (ANOVA) and *t*-tests both test for mean differences but ANOVA can compare two or more conditions whereas *t*-tests are limited to two conditions (Burns 2000).

score than the other three, suggesting these firms placed more emphasis on reducing injury and liability. The findings from the motivational scale exercise and the high proportion of negative and unsure responses received to the questions enquiring about the existence of policies and procedures related to ergonomics and computer use suggest that, even if there was ergonomic training, there was no structural framework in place to reinforce the advice and no emphasis on the protection of computer users.

If ergonomic health promotion is, at least partly, based on the notion that knowledge leads to application, which in turn increases wellbeing, it made sense to ask respondents whether they had ever had a work-related complaint of pain in the arm, neck or some other part of the body. In both studies over one-third of respondents reported they had experienced such a work-related complaint. (Table 3.28).

Table 3.28 Number and Percentage of Responses Reporting whether Respondents ever had a Work-related Complaint of Pain in some Part of the Body

	N		**Per cent**	
Response	**Study II**	Study I	**Study II**	Study I
Yes	**79**	62	**35**	37
No	**147**	104	**64**	61
Non-responses	**3**	4	**1**	2
Total	**229**	170	**100**	100

Study II respondents experiencing work-related complaints of pain were more likely to be aware of the relevant ergonomic principles than those not reporting pain (Chi Square = 3.918, df = 1, $p < 0.05$). This is consistent with the expectation that people who had suffered health disorders might become more knowledgeable as a result. However, while in Study I 52% of people experiencing pain reported not being aware, this association was not statistically significant (Chi Square = 0.05, df = 1, $p > 0.05$).

Also, in Study II there was a statistically significant higher incidence of complaints of pain within government organisations (public 75%, private 25%) (Chi Square = 8.358, df = 1, $p < 0.01$). Further, as may be anticipated if based on the premise that those who had experienced pain would be more aware, more people in government bodies reported being aware of ergonomic principles. While in Study I 71% of respondents experiencing complaints of pain were from government organisations and 29% from private firms, the results were not statistically significantly different (Chi Square = 4.66, df = 1, $p > 0.05$).

In Study II association with gender was not statistically significant, but in Study I more females (72%) than males experienced a complaint of pain and this was statistically significant (Chi Square = 4.57, df = 1, $p < 0.05$). While in both studies a larger proportion of non-managers reported a complaint of pain, association with position within the organisation was not significant statistically.

The estimated average daily use of computers for those respondents not reporting a work-related complaint of pain was 4.09 hours (2.7 hours Study I), and for respondents who did experience work-related pain, it was 4.67 hours (4.2 hours Study I). In Study I, a *t*-test of difference between these means of estimated daily computer use was highly significant statistically ($p < 0.01$).

A breakdown of the complaints specified by respondents in relation to the various parts of the body where pain was experienced is presented in Table 3.29. Neck complaints were the most common problem, followed by back and shoulder pain.

Table 3.29 Work-related Complaints of Pain in Various Parts of the Body

Part of Body	N*	
	Study II	Study I
Neck	**37**	39
Back	**22**	23
Shoulders	**14**	15
Forearms	**10**	5
Wrists	**9**	10
Head	**9**	3
Hands	**6**	2
Eyes	**5**	10
Fingers, thumbs	**4**	2
Elbows	**2**	2
Ribs	**–**	1
Legs	**–**	1
Knees	**–**	1
Ankles	**–**	1

*** N** indicates the number of times the item was identified.

These findings accord with those of Winkel and Oxenburgh (1990), Bergqvist (1984) and others, who found most problems were concerned with centrally rather than peripherally located pain and concluded that keyboard work is associated with high risk for shoulder–neck disorders due to lack of physical variation in the shoulder–neck region.

The final question in the survey instrument invited ‘any other comments’. The major themes in the comments received are represented by the following examples:

> *Aches and pains are considered ‘par for the course’. Most secretaries just accept this. Perhaps a media campaign would highlight the problem.*
>
> *I think our organisation has totally ignored the concept of ergonomics and computer technology – so far that I had never even heard of it!*
>
> *Information needs to be given regularly because people forget and new people get overlooked.*

I have experienced pain – but have never made an issue with my employer as it is probably due to me not following ergonomic principles properly.

My training has been mainly O H S & W. More emphasis given to lifting properly, posture, chair height and not specifically related to computer technology.

Highlighted lack of attention to ergonomic issues. Ergonomic consults have been used for some work areas and recommendations generally implemented.

Ergonomic practices in place would save $ for Workcover.

Pressure of work discouraged good practices.

Among a lesser number of positive comments, people remarked:

I enjoy data work, therefore, I take care to change position and vary jobs, so I am not in front of computer for long periods. I am also aware of radioactive waves – so I take care not to have my back in a position with another computer behind me.

Staff are asked to take up exercise programs – unfit people are very prone to 'computer' injuries.

Staff with stress and depression problems are counselled which also reduces 'computer' related and other general health and well-being problems.

What a good way to heighten awareness of what I don't really know but should know. It would be interesting to see the results. It would also be interesting to see other views of co-workers. Thanks. Good luck.

In Study I, lack of money was frequently given as a reason for organisations not implementing ergonomics, indicating that occupational health and safety was being compromised by small budgets.

Some of the comments demonstrated a good understanding of the broad issues surrounding healthy computer use. It was particularly pleasing to see mention of psychological health as a related matter. Other comments highlighted that computer users were experiencing health problems as a result of their work – and that they were accepting them as being part of the job and taking personal responsibility for them. The comments suggest that organisations could be more diligent in discussing ergonomic issues with their employees and in dealing with the work pressures being experienced so that computer users felt they could take the time to care for their health at work.

Summary of the Findings

The majority of respondents in Study II were females, aged between 38 and 47 years, who worked in non-management positions within medium–large government organisations located in the Adelaide metropolitan area. The profile is similar to that found in Study I**,** conducted with organisations located in the regional city of Whyalla**,** except that, two years later, in Adelaide, the sample was drawn from an age group 10 years older.[46] Being in their late thirties and forties it is likely these Study II women had been in the workforce for a considerable length of time and would have required special training in ergonomics to reduce the risk of computer-related disorders when computers were introduced into their workplace. The age range suggests they received keyboard training 20 to 30 years earlier, during the period 1966–76, when typewriters were used for teaching keyboard skills in educational institutions and computer technology was not available in most organisations. As a result, these respondents would have learnt typing techniques appropriate for typewriters, but not the ergonomic principles related to the use of desktop computers, which require altered work habits to accommodate the different touch, layout and speed of the new technology. In addition, the age bracket indicates they were working in the period before economic rationalism

[46] The newer city of Whyalla is likely to have had a younger workforce in most industries than a similar industry would have had in the longer established Adelaide metropolitan area.

and the strong push for increased efficiency and productivity, when the pace was not so fast and the work pressures not so demanding.

In both studies most respondents (66% Study II; 71% Study I) had learnt to operate a computer on the job, yet 72% (76% Study I) of respondents had never attended an educational program/training session on the ergonomic use of computers provided by their organisation. Very few respondents (7% Study II; 5% Study I) had spent time in such training/update sessions in the preceding 12 months. Over half (59% Study II; 57% Study I) believed they needed to spend more time in training/update sessions related to ergonomics and computer use. Seventy-four per cent of respondents (73% Study I) had not read any documents that included information regarding ergonomics and the use of computers in the past 12 months. While in both studies a large proportion of respondents learnt to operate a computer on the job, it is noteworthy that there was a substantial increase, from 12% in Study I to 27% in Study II, in those who had learnt in an educational institution. However, although 27% of respondents in Study II initially indicated that they had learnt to use a computer in an educational institution**,** only 8% later replied that they had received their knowledge of ergonomics via school, business college, TAFE, university or computer courses, suggesting that their courses did not contain material on ergonomics.[47]

Over half of the respondents (52% Study II; 53% Study I) reported that they were not aware of the principles of ergonomics relating to the use of desktop computers. Those

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[47] In Study I, this did not appear to be such a problem: 12% of respondents replied that they had learnt to operate a computer in an educational institution and a further 10% indicated they had learnt both on the job and in an educational institution, compared to 16% who answered that they had received their ergonomic knowledge from school, TAFE or university studies.

respondents who replied that they were aware had generally received their knowledge in-house from occupational health and safety (OH&S) courses, OH&S manuals, OH&S representatives or union representatives. This was true for respondents from both private and public-sector organisations in the Adelaide metropolitan area (Study II), whereas in Study I most public-sector respondents had received their information from their OH&S department, but those from private firms generally cited an educational institution, mostly TAFE, as the source. This suggests that in the regional area government organisations had more expertise and resources available internally to provide the ergonomic education than privately owned organisations that relied on an outside body. Overall in Study II, it appears that government organisations had older, female employees who were more likely to have attended education/training sessions on ergonomic computer use and were more ergonomically aware than employees within smaller, privately owned organisations that had younger, predominantly male employees in management positions.

The responses to the scenarios in the two questions designed to test knowledge of ergonomic principles relating to posture and the positioning of the arms and wrists and the layout of equipment relevant to computer use indicated that deficient knowledge existed within organisations. In both studies only the very obvious scenarios were correctly answered by more than half of the respondents; respondents generally failed to identify those factors in the scenarios that required a sound knowledge of ergonomics to be able to answer correctly. Importantly, the average correct responses for the commonly recommended postures and layouts were only 21% in Study II and 13% in Study I. The overall average of correct answers in Study II was 42%, which is a 7% improvement when compared to Study I (average 35%), showing that respondents from the Adelaide metropolitan area were more knowledgeable than those from Whyalla. Study II showed respondents from government organisations located in the Adelaide metropolitan area had more ergonomic knowledge than those from privately owned firms, the average correct answers from government organisations being 46% (35% Study I) compared to 34% (34% Study I) from private firms.

In both Studies I and II few respondents (approx. 30% Study II; 10% Study I) replied to the question asking how they applied their knowledge of ergonomics to their work situation. This suggests that they did not know how to, and therefore did not, apply ergonomic principles to their work. This aligns with lack of ergonomic training and appears to be confirmed by the responses regarding rest breaks and pause gymnastics. While respondents generally believed rest breaks were relevant to computer use and should be taken approximately every 60 minutes, many (25% Study II; 38% Study I) did not take them and a considerable proportion (14% Study II; 23% Study I) either did not or were unable to reply as to how often rest breaks should be taken. Also, while the majority of respondents recognised the need to schedule breaks away from computer work and the need to change the position of the body, others (12% Study II; 8% Study I) indicated that written work and reading were suitable tasks to be undertaken during rest breaks. Less than one-quarter of respondents (18% Study II; 23% Study I) answered that they exercised when using computers, and of these the majority did so only 'occasionally'. In both studies, only 5% of respondents replied that they undertook pause gymnastics 'regularly'. Although they appeared to be aware that different movements are desirable when taking rest breaks, many were not aware that 'rest breaks' should be 'exercise breaks' and that repetitive tasks and activities using the same muscles as in computer work should be avoided.

In Study II, the size and height of desks and chairs and the amount of work room available were the factors most frequently considered by respondents when choosing office furniture and equipment. These were followed by comfort, ergonomic design/standards and OH&S guidelines, indicating an awareness of the need for specially designed and adjustable furniture and equipment, and the importance of being comfortable while working. These findings align closely with those of Study I and it is noteworthy that in both studies comments that the selection of office furniture and equipment was a management task, carried out with no input from the computer user, were received.

Very few respondents (6% Study II; 8% Study I) had jobs that only required the use of a computer. This is ergonomically sound as it provides for variation in tasks. In Study II, ergonomic issues such as varying tasks and spacing out work to give breaks away from the computer were given by the majority of respondents as factors to be considered in organising their work day. In Study I, the majority cited deadlines, urgencies and priorities. However, consistent with the findings of Study I, many of the Study II respondents appeared to have no control over the planning of their work day, as deadlines and priorities dictated the organisation of their work.

While the estimated average daily length of use of computers of 4.33 hours in Study II and 3.3 hours in Study I is relevant to the need to be aware of and apply ergonomic principles, the range of use from 0 to 12 hours per day in Study II and 0 to 7.5 hours in Study I, which far exceeds the limit of 4 hours recommended by the Public Service Association of SA, is cause for concern. It is noteworthy that the average daily use of computers for respondents who had experienced a work-related complaint of pain in some part of the body was 4.67 hours in Study II and 4.2 hours in Study I, which is greater than the recommended four-hour limit. In both studies the estimated average daily use of computers by females was significantly greater than for males. In Study II use was also significantly greater for respondents in non-management positions and higher in medium–large-sized organisations than in small organisations. In Study I, computer use was higher in government organisations, but in Study II the results were similar for both government organisations and privately owned firms.

It is reasonable to expect that people who have had a work-related complaint of pain would as a result be more aware, and as anticipated, the responses in Study II showed a statistically significant link between experiencing pain and reported awareness of the relevant ergonomic principles. The findings highlighted that a considerable proportion of employees (35% Study II; 37% Study I) experienced work-related pain, particularly neck pain. In Study II, such complaints were significantly more frequent within government organisations than in private ones. In Study I, they were significantly more frequent in females than in males.

In relation to priority given to ergonomics within organisations, the findings indicated that few respondents (16% Study II; 19% Study I) believed their organisation had a written policy on procedures related to ergonomics and the use of computers, or a written policy related to rehabilitation of employees affected by computer-related injury (18% Study II; 22% Study I). Those organisations without such policies were generally not considered to be in the process of formulating them. A large proportion of respondents answered ’unsure’ or left these questions blank, suggesting that they did not know the situation within their organisation. In Study I, government organisations were significantly more likely to have a written policy on ergonomic computer use than privately owned organisations. In Study II, government organisations were significantly more likely to have a written policy related to the rehabilitation of employees – perhaps because their employees experienced more complaints of pain.[48]

In both studies the majority of respondents (68% Study II; 67% Study I) indicated that their organisation did not stress the importance of keeping ergonomic work practices in mind when using computers and that no-one in their organisation had been delegated the responsibility for ensuring that ergonomic practices were followed (63% Study II; 65% Study I). In Study II, government organisations were more likely to place emphasis on ergonomics and were more likely to have a person responsible for ensuring employees followed ergonomic practices than privately owned organisations. Most respondents did not know how their organisation responded to breaches of recommended work practices. Many people believed their organisation 'doesn't' respond.

While the majority of respondents (66% Study II**;** 63% Study I) indicated that computer users were required to report incidents of computer-related disorders a considerable proportion (24% Study II; 29% Study I) were unsure as to whether they were required to report such incidents and some (9% Study II; 6% Study I) replied that they were not required to do so. Further, while 41% of respondents in both studies indicated that their organisation kept records relating to computer-related injury, many

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[48] Or because of government policy in order to get WorkCover exemptions – but the question remains, 'Do employees know of the policies?'

(39% Study II; 38% Study I) were unsure and a substantial percentage (20% Study II; 18% Study I) replied that their organisation did not keep these records.

Only 9% of respondents in both studies believed that high priority was placed on the importance of ergonomic computer use by their organisation; approximately half (50% Study II; 53% Study I) believed ergonomics was given low priority. Most (70% Study II; 66% Study I) believed ergonomic principles in relation to the use of computers were not given sufficient priority within their organisation. While in Study I government organisations gave significantly higher priority to ergonomic computer use than private firms, this was not statistically significant in Study II.

In both studies the rating of items from the 'motivational scale exercise' (Bird and Loftus 1976) according to the importance respondents believed their organisation placed on them indicated that three distinct attitudes existed within organisations. Groupings of attitude emerged that reflected people who were job centred (the group containing the items 'increase production rate', 'enhance public relations', 'improve customer relations', 'improve produce quality' and 'improve operating costs'); another group who were employee centred (the group containing the items 'provide personal satisfaction', 'increase job pride' and 'improve labour relations'); and a third group (containing the items 'give legislative compliance', reduce liability potential' and 'reduce injury rate') reflected those who were concerned with compliance and reduction of injury and can be construed as the 'ergonomic' factor. The concept put forward by Bird and Loftus (1976) is that safety programs must be promoted on the basis of what they will do to accomplish those items high on the motivational scale. In these two studies the top three items perceived to be given priority within organisations were ‘increase production rate’, ‘enhance public relations’ and ‘improve customer relations’.

In Study I and Study II, the final question, asking for ‘any other comments’ was often left blank but the comments received generally indicated a lack of knowledge, a lack of emphasis and priority, and a lack of support and commitment in relation to ergonomic computer use within organisations. Many computer users were not aware of ergonomics and appeared to accept aches and pains as part of the job; others referred to work pressures that ‘discourage good practices’.

CHAPTER 4

FINDINGS: STUDY III

Studies I and II inquired into ergonomic practices in two different places, at two different points in time. By 1994 (the time of Study I), desktop computers had been introduced for over a decade and the concerns voiced loudly in the 1980s, when there were numerous reports of repetitive strain injury associated with computer use, had quietened.

Study III further extended the initial work, through a survey of academic staff and post-graduate students within a university in 1996. This time, the survey aimed to determine whether the knowledge of and priority given to ergonomic principles in relation to the use of desktop keyboard-operated computers within a university environment was similar to that of the organisations surveyed in the previous two studies. In the 1990s, academic staff and students within universities were emerging as a large new cohort of people who were using computers daily for extended periods to carry out their work yet had not received the appropriate keyboard training that previously typists would have undertaken. The questionnaire used in Studies I and II was modified as appropriate and distributed to 400 academic staff and 400 post-graduate students. As shown in Table 4.1, 226 replies were received, giving a response rate of 28%. This is lower than for Studies I and II, where the response rates were 50% and 46% respectively. It is reasonable to assume that this may in part be due to the fact that there were no telephone interviews conducted in this study and therefore less personal contact.

Table 4.1 Number of Questionnaires Returned and Response Rates by Type of Respondent

Type of Respondent	Max Possible Response	Actual Response	Per Cent Returned
Academic staff	400	117	29
Post-graduate students	400	109	27
Total	800	226	28

As shown in Table 4.2 the majority of respondents were between 38 and47 years of age and female. Most responses were received from people working within the education discipline.

Table 4.2 Number and Percentage of Respondents by Age, Gender and Faculty/Campus

Variable	Category	N	Per cent
Age	18–27 years	21	9
	28–37	54	24
	38–47	81	36
	48–57	54	24
	Over 57 years	16	7
Gender	Male	107	47
	Female	119	53
Discipline	Aboriginal and Islander Studies	8	4
	Information Technology	14	6
	Art, Architecture and Design	9	4
	Business and Management	33	15
	Education	43	19
	Engineering and the Environment	30	13
	Health and Biomedical Sciences	33	15
	Humanities and Social Sciences	29	13
	Nursing	19	8
	Whyalla	6	3
	Non-responses	2	1

The estimated average daily use of a computer reported by respondents ranged from zero to 10 hours with a mean of 3.3 hours. This is similar to the first study where the results were 3.3 hours mean use, ranging to 7.5 hours per day, and less than the second study where the mean use was 4.3 hours, ranging to 12 hours per day. While the majority of respondents indicated that their average daily use was four hours or less, 23% replied that they used the computer five or more hours per day. This is relevant in that the Public Service Association of SA (1990) recommends the maximum period in which an employee operates a VDU should be limited to four hours per day, with no more than two hours consecutive use.

Findings Relating to Knowledge of Ergonomics

A clear majority of respondents replied that they had not received educational training provided by the university that included information on ergonomics in relation to the use of computers (Table 4.3).

Table 4.3 Number and Percentage of Respondents Reporting whether they had Received Educational Training in Ergonomics provided by the University

Frequency	N	Per cent
In the past 12 months	3	1
In the past two years	2	1
Over 2 years ago	13	6
Never	208	92
Total	226	100

The results for the ‘Never’ grouping (92%) are considerably higher than the 76% and 72% for Studies I and II respectively.

Participants were asked how they had applied the knowledge of ergonomics received in such training. As shown in Table 4.4, post-graduate students generally did not apply ergonomic principles to their computer use and academic staff primarily used their knowledge in the selection, layout and adjustment of their computer equipment.

Table 4.4 Responses reporting How Respondents Applied their Knowledge of Ergonomics

How Knowledge was Applied	N* Staff	N* Students
In selection, layout and adjustment of equipment	29	1
Using correct posture	7	-
Taking breaks	6	2
Exercising and stretching	2	-
Being aware of the issues such as prolonged use	4	1
In teaching students	1	-
Management of computer pool	1	-
Consulted OH&S officer	1	-

*** N** indicates the number of times the item was identified.

It is evident that a larger number of replies were received in relation to this subsequent question than the number of respondents who indicated they had received such training. It can be assumed that in their keenness to illustrate that they possessed some knowledge of ergonomic computer use respondents overlooked the fact that the question actually related to knowledge acquired from training by the university.

The responses in Table 4.5 show approximately how much time had been spent in educational training in relation to ergonomics and computer use provided by the university and, although not entirely consistent with those in Table 4.3, again reflect that the large majority of respondents had not spent any time in such training.

Table 4.5 Number and Percentage of Respondents Reporting Time Spent in Educational Training in Ergonomics Provided by the University

Response	N	Per cent
20 min – 1 hour	12	5
2–3 hours	9	4
5–6 hours	2	1
10 hours	1	1
Never	197	87
Non-responses	5	2
Total	226	100

When asked whether they believed they needed more time in educational training regarding ergonomic computer use provided by the university, over half thought they did need more ergonomic training (Table 4.6). A non-response rate of 16% indicates that a considerable proportion of respondents were undecided.

Table 4.6 Number and Percentage of Respondents Reporting whether they Believed they Needed more Time in Educational Training

Response	N	Per cent
Yes	127	56
No	64	28
Non-responses	35	16
Total	226	100

This result is consistent with Studies I and II, where 57% and 59% respectively answered ‘yes’.

Respondents were given a definition of ergonomics and the aspects of work to which ergonomics can be applied and asked whether they were aware of the ergonomic principles that relate to the use of computers. As shown in Table 4.7, most answered that they were not aware.

Table 4.7 Number and Percentage of Respondents Reporting whether they were Aware of the Principles of Ergonomics relating to the Use of Computers

Response	N	Per cent
Yes	95	42
No	130	57
Non-responses	1	1
Total	226	100

The positive responses are slightly less than in Studies I and II, which were 46% and 47% respectively. Respondents answering that they were aware of the ergonomic principles were then asked how they had received this information. The responses were summarised and from the summary the categories presented in Table 4.8 were identified.

Table 4.8 Responses Reporting how Respondents Received their Knowledge of Ergonomics relating to Computer Use

How Knowledge was Received	N* Staff	N* Students
University circulars, ITU, in-house	18	–
OH&S department or advisor	17	3
Media, reading material	13	12
General conversation, various sources	11	4
Lectures, studies, educational program	9	5
Part of teaching, involvement professionally	10	11
Professional such as doctor, physiotherapist, Ergonomist	3	3
Manufacturer's guidelines	1	–

*** N** indicates the number of times the item was identified.

Most academic staff gained their ergonomic knowledge from within the university. This is consistent with the findings in the previous studies, in which the respondents generally received their knowledge of ergonomics in-house. The media was the main source of information for the students.

Respondents were also asked if they had read any documents that included information on ergonomics in relation to the use of computers in the preceding 12 months. As shown in Table 4.9 the majority had not.

Table 4.9 Number and Percentage of Respondents Reporting whether they had Read Documents on Ergonomic Computer Use

Response	N	Per cent
Yes	57	25
No	165	73
Non-responses	4	2
Total	226	100

This is consistent with the results of Studies I and II, in which 73% and 74% respectively indicated that they had not read any such documents.

Respondents were asked what factors they take into consideration in organising their work day. This question was included to determine whether the respondents were aware of the need to undertake various tasks away from the computer throughout the day in an endeavour to change work postures, rest the eyes from VDU work and avoid static loading of the muscles. The responses are summarised in Table 4.10.

Table 4.10 Responses Reporting Factors Considered by Respondents in Organising their Work Day

Response Received	**N* Staff**	**N* Students**
Urgency, deadlines, priorities	66	46
Survival, workload	42	34
Timetable	26	16
Availability of time, time allocation, breaks	23	33
Mood, interest, goals	11	24
Students, patient care	9	3
Mixing a variety of tasks	7	15
Tiredness, stress levels, physical/mental peaks	8	–
Solid concentration in morning	6	1
Comfortable, workable environment	6	3
Personal/external commitments	4	3
Avoid long stretches of repetitive work at anything	1	–
Academic – not ergonomic	1	–
Resources, accessibility to computer, desk, files	–	8
Balancing exercise and study	–	1

*** N** indicates the number of times the item was identified.

For both staff and students, urgencies and deadlines were by far the most important factors influencing the organisation of their work. Availability of time also appeared to be a key factor, particularly for the post-graduate students. Both groups indicated that they organised for ‘survival’ in managing their work. This is consistent with Study I, in which the majority of responses (24% of respondents) clearly indicated that priorities and deadlines dominated the organisation of work. However, in Study II most respondents recognised the need to vary tasks and space out work to give breaks away from the computer (36%), and deadlines and priorities were the second category most identified (31%). In this study 56% of academic staff and 42% of post-graduate students cited urgencies and deadlines as the main factor considered.

The majority of respondents (92%) believed that rest breaks were relevant to the use of computers and most understood that rest breaks away from the computer should be taken approximately every one hour (Table 4.11). The mean time after which respondents thought a rest break should be taken was 57.66 minutes. 83% of respondents reported that they did actually take rest breaks (Table 4.12).

Table 4.11 Responses Reporting How Often Rest Breaks Should be Taken

Response Received	N	Per cent
0–20 minutes	27	12
30–45 minutes	41	18
50–60 minutes	97	43
1-1/2–2 hours	27	12
4–5 hours	2	1
Non-responses	32	14
Total	226	100

Table 4.12 Number and Percentage of Respondents Reporting Taking Rest Breaks

Response	N	Per cent
Yes	188	83
No	35	16
Non-responses	3	1
Total	226	100

In Studies I and II 95% and 97% of respondents respectively believed rest breaks were relevant to the use of computers but only 62% and 75% respectively indicated that they did take rest breaks.

When asked what tasks could be undertaken during rest breaks, respondents identified the tasks categorised in Table 4.13.

Table 4.13 Activities Respondents Believed could be Undertaken in Rest Breaks

Activity	N* Staff	N* Students
Stretching, exercise, hand/eye/back relaxation	73	78
Different work, tasks not involving the same muscle groups, phone calls	53	48
Adjusting eye focus,	18	24
Non-sitting activities, walking	36	35
Tea/lunch/fresh air break/talking	24	29
Check posture	–	2
Reading and Marking	–	2
None	2	–
Don’t know	3	–

*** N** indicates the number of times the item was identified.

The majority of respondents suggested stretching, exercise and relaxation of the muscle groups used in computer work as suitable activities. The responses generally indicated an awareness of the need to undertake non-sitting activities and tasks that use different muscles. Only two respondents gave reading and marking as suitable activities. These are tasks that would not rest the eyes and/or the muscles that had previously been used and would not satisfy the purpose of taking rest breaks.

To elicit knowledge of the ergonomic requirements of office furniture and equipment respondents were asked what factors they would take into consideration when choosing office furniture and equipment. Table 4.14 summarises the replies.

Table 4.14 Responses Reporting Factors Considered by Respondents when Choosing Office Furniture and Equipment

Response Received	N* Staff	N* Students
Adjustability	113	61
Office space, layout, placement, lighting	69	34
Comfort	51	54
Style, aesthetics, size, anthropometrics	30	36
Practicality, functionality, flexibility, tasks	26	7
Price	23	24
Ergonomic, OH&S recommended, safety	21	18
No choice, inherited others	15	4
Colour, surface	15	–
Stability, solidity, quality, durability	11	9
Availability, accessibility	8	3
Ease of use	7	10
Technical advice, speed, efficiency	6	1
My health, back injury, physical wellbeing	2	1
Noise level	1	–
Height and width of desk, screen height, size	–	21
Posture support	–	19

*** N** indicates the number of times the item was identified.

The adjustability of the furniture and equipment was the primary factor identified, followed by consideration of the office layout and placement of the furniture and equipment and comfort. This is consistent with the findings of Studies I and II, in which respondents indicated comfort, ergonomic design and adjustability as key factors.

Two questions included in the questionnaire were specifically designed to test the respondents' knowledge of the commonly recommended ergonomic principles relating to desktop computer use. Questions 15 and 16 asked respondents to study a series of diagrams representing various sitting postures and layout of equipment scenarios and indicate whether accepted ergonomic principles were being applied in each diagram by circling ‘Yes’, ‘No’ or ‘Unsure’ and giving a reason for their answer. There were nine diagrams (labelled a to i) in each question. The answers are presented in Figures 4.1 and 4.2.

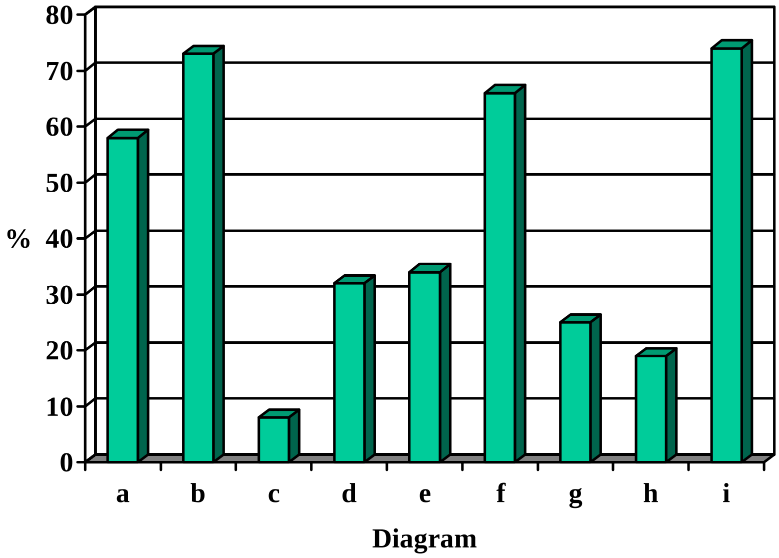

Figure 4.1 Percentage of Correct Answers to Scenarios Regarding Sitting Posture and Positioning of the Arms and Wrists (Survey Question Number 15 (a) to 15 (i))

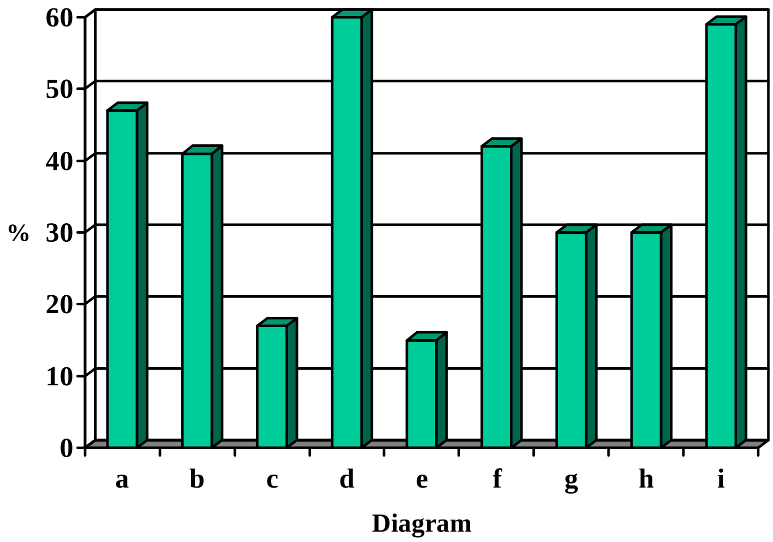

Figure 4.2 Percentage of Correct Answers to Scenarios Regarding Posture and the Layout of Equipment (Survey Question Number 16 (a) to (i))

Consistent with Studies I and II, respondents were most knowledgeable about diagrams (i), (b), (f) and (a) in question 15 and diagrams (d), (i) and (a) in question 16. In question 15, these diagrams show the computer user slouching in the chair, sitting on the edge of the seat, sitting with knees crossed and positioning the chair too low so that the knees are higher than the thighs. In question 16, in each diagram the monitor was positioned too high, too low or too far away. Each of these diagrams should be easily identified by computer users as reflecting poor ergonomic practice.

Five scenarios in question 15 – diagrams (c), (d), (e), (g) and (h) regarding sitting posture and positioning of the arms and wrists – were answered correctly by 34% or less of respondents, and four scenarios from question 16 – diagrams (c), (e), (g) and (h) regarding posture and the layout of equipment – were answered correctly by 30% or less of respondents. It is noteworthy that these included those scenarios depicting the recommended postures and layouts – diagrams (g) and (h) in question 15 (25% and 19% respectively) and diagrams (e) and (h) in question 16 (15% and 30% respectively). Study I and II findings were similar, with the recommended postures and layouts being correctly identified by less than 20% and 27% respectively. The average correct responses for all scenarios was 41% (35% Study I; 42% Study II). [

A principal component factor analysis was carried out on the correct responses and three factors emerged that collectively explained 49.7% of the total variation. These factors were rotated using Varimax, giving the loadings shown in Table 4.15.

Table 4.15 Rotated Factor Loadings relating to Correct Responses to scenarios in Survey Questionnaire number 15 (a) to (i) and number 16 (a) to(i)

Item	**Factor 1**	**Factor 2**	**Factor 3**
Question 15			
(a)	0.742*	–0.182	0.047
(b)	0.720*	–0.257	0.069
(c)	0.248	–0.048	0.220
(d)	0.476	–0.215	–0.042
(e)	0.516	–0.142	0.006
(f)	0.729*	–0.211	0.177
(g)	0.109	–0.072	0.687*
(h)	0.463	0.347	0.423
(i)	0.743*	–0.206	0.134
Question 16			
(a)	0.283	–0.624*	0.140
(b)	0.210	–0.597	0.356
(c)	0.076	–0.243	0.709*
(d)	0.261	–0.748*	0.219
(e)	–0.002	0.166	–0.642*
(f)	0.181	–0.734*	0.218
(g)	0.161	–0.679*	–0.005
(h)	0.025	–0.220	0.731*
(i)	0.269	–0.570	0.289

There were three distinct groupings of closely related items as follows:

Factor 1 **Poor posture**
Question 15 Diagram (i) slouching in chair
(a) chair too low, knees raised
(f) knees crossed
(b) sitting on front edge of chair

Factor 2 **Poor positioning of VDU**
Question 16 Diagram (d) VDU too high
(f) VDU too close and too high
(g) VDU too close
(a) VDU too far away

Factor 3 **Recommended posture**
Question 16 Diagram (h) good posture and layout
(c) good posture, but documents on desk
(e) good posture and layout
Question 15 Diagram (g) good posture and positioning of arms and wrists

The items in the first group are those diagrams that respondents were most knowledgeable about, depicting obvious poor posture and positioning; group 2 contained diagrams relating to incorrect positioning of the VDU; and group 3 contained three of the four diagrams that illustrated the recommended postures, plus diagram (c) from question 16, which showed good posture even though there was no document holder used.

Findings Relating to Priority given to Ergonomics

A question asking whether the respondents carried out pause gymnastics or exercised when using a computer was included to investigate the priority ergonomics was given by computer users. As shown in Table 4.16, 59% of respondents did not carry out pause gymnastics and, of those who did, most did so only ‘Occasionally’.

Table 4.16 Number and Percentage of Respondents Reporting how often they carry out Pause Gymnastics or Exercise when using a Computer

Response	N	Per cent
Regularly	30	13
Occasionally	43	19
Rarely	15	7
Never	134	59
Non-responses	4	2
Total	226	100

These are more favourable responses than in Studies I and II, in which 72% and 81% respectively replied that they did not carry out pause gymnastics or exercise and, of those who did, only 5% in both studies indicated that they did so ‘Regularly’.

A large proportion of respondents were unsure whether the university had a written policy on procedures related to ergonomics and computer use. As indicated in Table 4.17, only 12% replied in the affirmative.

Table 4.17 Number and Percentage of Respondents Reporting whether University had a Written Policy on Ergonomics and Computer Use

Response	N	Per cent
Yes	27	12
No	5	2
Unsure	190	84
Non-responses	4	2
Total	226	100

In Studies I and II the positive responses were 19% and 16% respectively.

Respondents generally believed the university placed a low level of importance on ergonomics in relation to computer use (Table 4.18).

Table 4.18 Number and Percentage of Respondents Reporting the Priority they believe is placed on Ergonomics and Computer Use by the University

Response	N	Per cent
High	18	8
Medium	57	25
Low	113	50
Non-responses	38	17
Total	226	100

There was a high non-response rate for this question, indicating that many were unsure, or undecided on how to respond, probably because they had not given the matter of ergonomics much consideration in the past. In both Studies I and II, 9% reported ‘High priority’; 34% and 41% respectively reported ‘Medium priority’; and 53% and 50%

reported ‘Low priority’. The non-response rate was much lower in the previous two studies, being 4% and zero respectively.

When asked if they believed ergonomic principles in relation to computer use were being given sufficient priority within the university, respondents generally believed they were not. A high non-response rate indicated that many were unsure or not prepared to respond (Table 4.19).

Table 4.19 Number and Percentage of Respondents Reporting whether they believed Ergonomic Principles relating to Computer Use were given Sufficient Priority within the University

Response	**N**	**Per cent**
Yes	20	9
No	137	61
Non-responses	69	30
Total	226	100

In the previous two studies 66% and 70% respectively believed ergonomic principles in relation to computer use were not given sufficient priority within their organisation. However, the non-responses were only 8% and 4% respectively for Studies I and II.

Various comments were received in relation to this question. Staff indicated that they were unsure of what training courses, if any, had been available. One commented, “It may be aimed more at general staff who know to take scheduled breaks. Academics are not targeted”.

Comments received from the post-graduate students included:

> *Only once to my knowledge did someone inspect our computer 'set up'. Obviously some consideration occurs because we have extremely good chairs. Something was mentioned regarding the position of our screen in relation to the window.*
>
> *My course does not require extensive use of computers, so I don't see this as a pressing necessity. However, I would appreciate some education.*

A related question asked respondents to elaborate on how this priority was demonstrated within the university. Comments from respondents who ticked 'yes' to ergonomics being given sufficient priority were few, whereas comments from those who ticked 'no' were extensive. The following are some of the favourable comments received.

From academic staff:

> *Policy exists, training exists, up to us to follow through for our own welfare.*
>
> *Staff are encouraged (but not compelled) to adopt good practices.*
>
> *Ready availability of information and support.*
>
> *Instruction of students in computer pools.*

From post-graduate students:

> *Providing adjustable ergonomic computer chairs. Sessions in computer training.*
>
> *Office staff are required to be provided with ergonomic equipment – but not academic staff.*

Some comments received from respondents who indicated that ergonomics were not given sufficient priority are:

From academic staff:

> *Merely look into any academic's office – 19th century desk and unsuitable chair.*

Chair uncomfortable but feel can't justify funds from limited budget to replace it.

I am appalled (seriously) at what I see going on around me in terms of excessive use being made of computers without breaks. When I have cautioned my staff and colleagues about this, they reply "Oh, there is so much to do: I will never get it all done if I take breaks." I understand this, because I give the same reply when people say to me "you should take afternoon/morning breaks and a decent lunch break." My reply to them is "I'll never get ...!"

From postgraduate students:

Look at the computers in the City [campus] library and computer pools.

General student population is not well informed.

No information provided in computer suite on good posture etc.

Most students and staff don't use appropriate ergonomic principles. Mostly there's not enough time to ensure work to be carried out in ergonomic manner.

Comments from academic staff focused on the use of existing furniture, with no consideration of the changes new computer equipment might require. Other comments from staff related to lack of incentives, information and follow-up. There was a focus, too, on lack of funding and the desire for cost minimisation. Some students commented that they had not heard of ergonomics before. The comments received from students generally indicated a failure on the part of the university to educate in this area. Mention was also made of poor furniture and layout of computer pools. One student commented:

Pools for computers are not set up to assist with this. Many staff don't know or reinforce this in other classes.

Respondents were asked to indicate whether they had ever experienced a computer-related complaint of pain in the arms or neck or some other part of the body. A high proportion reported that they had experienced such pain (Table 4.20).

Table 4.20 Number and Percentage of Respondents Reporting Computer-related Complaints of Pain

Response	N	Per cent
Yes	132	58
No	90	40
Non-responses	4	2
Total	226	100

It is noteworthy that in Studies I and II the percentage of respondents reporting they had experienced such pain was considerably lower, being 37% and 35% respectively.

Females were more likely to experience pain than males and this was statistically significant (Chi Square = 4.141, df = 1, $p < 0.05$). Of respondents experiencing pain, 58% were female and 42% male. This is consistent with previous research that found women were more likely to develop complaints of pain than men, due to a combination of sustained postures, repetitive motion, and hormonal changes as a result of pregnancy, menopause or hysterectomy, that can cause fluid retention, restricting the blood flow to tissues and altering the connective tissue that holds the tendons together (IMPACC USA 1995).

As computer use increased so did the incidence of complaints of pain. The estimated average daily use of those respondents reporting a complaint of pain was 3.61 hours and for those not reporting pain it was 2.86 hours and this was statistically significant ($p < 0.05$). It is noteworthy that respondents who scored poorly on the diagrams relating to posture and workstation layout often reported experiencing a computer-related complaint of pain.

A follow-on question asked respondents who had experienced computer-related pain to provide more detail. A summary of the complaints specified by respondents is given in Table 4.21.

Table 4.21 Computer-Related Complaints of Pain Reported by Respondents

Part of the Body	N* Staff	N* Students
Neck aches and stiffness	49	38
Back aches	23	20
Eye problems	18	16
Arm aches	18	8
Shoulder pain	12	14
Wrists	9	13
Elbow	7	2
Hands	5	4
Fingers, thumbs	4	4
Head aches	4	3
Knees	2	1
Legs	1	–

* N indicates the number of times the item was identified.

Neck aches and neck stiffness were the main health problems experienced by academic staff and post-graduate students, and backaches were the second most common complaint. These findings are consistent with those of Studies I and II, in which neck problems were also the most common complaint, and also align with those of Winkel and Oxenburgh (1990), Bergqvist (1984) and others, who found most computer-related problems were concerned with centrally located pain and in particular shoulder–neck disorders. One academic respondent commented:

> *When I'm not on clinic and I sit all day at the computer. I have had lower back pain in the past. But I know what to do to stop it (stretching exercises).*

Other academics commented that they were treated by a chiropractor and had regular back/neck massages. Post-graduate students mentioned experiencing pain problems arising from poor posture and mouse use.

The final question in the survey instrument asked for 'Any other comments'. The comments received were extensive, particularly from academic staff. Some staff thought ergonomics and computer training should be made mandatory. One commented:

> *My computing skills leave a lot to be desired. Ergonomic issues are important and we should be given ideas for exercise to help meet problems plus shown posture, position etc., through short courses.*

This argument was also captured in the comment:

> *I believe it's inept of the university to provide equipment but not ensure staff are adequately trained to use it.*

On the other hand the following comment was also received:

> *People just have to do what is comfortable. If uncomfortable – change something or take a break! Easy and obvious isn't it! We certainly don't need 'big brother' to tell us how to work.*

It is noteworthy that a number of comments received expressed concern in relation to the dangers of radiation from computers. One respondent commented:

> *I think a brief summary of ergonomic guidelines especially radiation safety and minimising eye strain should be circulated to all staff using computers.*

Further comments received from academics included:

> *It is important to continually make staff aware of the need for breaks on computers (maybe some good posters around) as I personally forget to take breaks and to do exercises when I become absorbed in my work.*

> *I think these matters are important but I'm so busy getting the job done that I don't think too much about them!*

1 am a poor typist so my wrists and arms tire easily. I don't think my chair is set up correctly and don't know how it should be. I have never heard 'ergonomics' mentioned for academic staff despite the proliferation of computers!

1 personally think staff should be educated about this occupational hazard in this high tech era. One or two seminars on this topic would be most helpful and more importantly this University should set aside some money (easier said than done) to ensure these principles be implemented.

Within our School there is great emphasis on staff producing their own word-processing documents, memos, reports and so on. Whilst this has resulted in decreased hours for general staff, admin work particularly that related to word-processing has increased four fold and the likelihood of this changing in the near future is negligible.

Right arm was ruined a couple of years ago when doing a lot of data analysis. Now easily starts to twitch. What's the option – it's got to be done or I can't do my work.

I believe this survey is very appropriate to staff (particularly general) who are using technology (computers) on a long term basis.

Nice to know someone cares.

Some additional comments from post-graduate students were:

I don't think that an ergonomic course is required. Most people arrange things to suit themselves and that's the best way for them. Perhaps it's different for someone who has to work on a computer 10 hours a day. I just naturally take a break when I'm tired.

I think there is a need in use of computers as a technological tool as well as some input re ergonomics, however, I think that education regarding ergonomics could be made a general/public awareness issue eg. Posters on walls, leaflets in pigeonholes etc, rather than a course being designed for it. Use of computers, e-mail, fax, net etc., should be emphasised more as many under/post graduates leave Uni with no exposure to the potential use of those.

Every aspect of computer design from layout, size, program design, is aimed at enhancing the computers efficiency, not the humans. Who cares about a few sore backs or vision impairment so long as the end product is there. Humans are flexible – they'll adapt.

As a part time student employed elsewhere I find it more convenient to use my own computer. I frequently have neck and shoulder pains probably because I may spend two or three days constantly writing without sufficient breaks. Then *stop for a couple of weeks until it is necessary to complete another batch of paper-work.*

Summary of the Findings

Consistent with Study II, the findings for Study III showed the majority of respondents to be female, aged between 38 and 47 years. The average daily computer use mean of 3.3 hours was the same as for the Whyalla organisations in Study I, and less than the 4.3 hours reported by the Adelaide metropolitan area firms in Study II.

Very few respondents had received training in ergonomic computer use from the university. 92% reported never receiving such training compared to 76% and 72% respectively for respondents from the Whyalla and Adelaide metropolitan area organisations. Over half (56%) of the academic staff and post-graduate students surveyed believed they needed to spend more time in such training. A high non-response to this question suggests that training in ergonomics was probably something they placed low in importance and had not contemplated previously. Comments received indicated that staff and post-graduate students were not aware of what training, if any, was on offer and that students in particular were not provided with this information by the university.

The majority of academic staff and post-graduate students surveyed (57%) answered that they were not aware of the ergonomic principles relating to their computer use. This is considerably higher than for Study I (46%) and Study II (47%) and indicates less awareness within the university environment than in the other types of organisations surveyed. The primary source of ergonomic information for academic staff was in-house via university circulars and its Occupational Health and Safety department. This is consistent with Studies I and II. However, the post-graduate students generally received their information from the media and as part of their professional involvement. This knowledge was mainly applied in the selection, layout and adjustment of computer furniture and equipment. Application of ergonomic knowledge to posture and exercising when using the computer was rare.

It was clear that both staff and students organised for ‘survival’. Of the factors taken into consideration in organising their work day “urgencies, deadlines and priorities” dominated, particularly for academic staff. For both, availability and allocation of time were key factors. This is consistent with the findings in Studies I and II, where the majority of responses indicated that priorities and deadlines dominated the organisation of work.

Most respondents understood the importance of taking rest breaks away from the computer and knew that such breaks should be taken approximately every hour. In addition, 83% reported that they did take rest breaks, and they were aware of the need to stretch and exercise in the breaks and the appropriate things to do to relax the muscles and eyes. This is a better result than in Studies I and II, where a higher proportion of respondents believed rest breaks were relevant to computer use, but fewer reported actually taking them. However, it appears that the usefulness of attention to posture and of undertaking pause gymnastics when using the computer was not so well understood. 59% of respondents did not carry out pause gymnastics or exercise when using a computer, although this is better than Studies I and II, where

72% and 81% respectively did not exercise at the computer. The responses to the diagram questions indicate that the recommended postures were not well known.

The diagrams representing correct postures were recognised by no more than 30% of respondents; they generally failed to identify those factors in the scenarios that required ergonomic knowledge to be able to answer correctly. The average of correct responses was 41%, which is consistent with Studies I and II. It can be argued that this lack of knowledge and hence lack of application of ergonomics may have contributed to the neck and back problems experienced by 58% of respondents, particularly when a considerable proportion also reported using a computer for five or more hours per day. In Studies I and II, only 37% and 35% of respondents reported experiencing computer-related complaints of pain.

The main factors taken into consideration when choosing furniture and equipment were adjustability, placement, comfort and style, indicating an awareness of the importance of making adjustments to furniture and equipment, office layout, and being comfortable while working. There was a perception that there was a difference in knowledge and resources provided for general and academic staff, with academic staff more likely to be being required to use furniture not suited to the new technology. There was also acknowledgement that word processing and administrative functions were increasingly being undertaken by academic staff.

In relation to priority, 8% of respondents believed the ergonomic use of computers was given high priority by the university; 25% that it was given medium priority; and 50% that it was given low priority. The non-response rate of 17% was much higher than in

Studies I and II. In terms of how this priority was demonstrated, respondents indicated that the university generally provided ergonomic furniture and equipment for office staff and ‘good’ chairs in computer pools, but the furniture for academic staff was often not updated due to budget constraints. This is consistent with the findings in Study I, where lack of money was frequently given as a reason for the Whyalla organisations not implementing ergonomics. The perception of low priority is supported by the fact that 84% of academic staff and post-graduate students were unsure whether the university had a written policy in relation to the ergonomic use of computer technology. Most respondents (61%) believed ergonomics and computer use were not given sufficient priority within the university. This result was better than for Study I (66%) and Study II (70%), but the 30% non-response rate was considerably higher (Study I 8%; Study II 4%). 73% of respondents had not read material that included information relating to the ergonomic use of computers in the previous 12 months, indicating that this information was not readily available. This is consistent with Study I (73%) and Study II (74%), in which a large proportion of respondents had not read any such documents.

The general comments by the respondents were consistent with their answers to the specific questions. It appears that work pressures led to excessive computer use without rest breaks. Respondents generally indicated that there was not enough time to ensure computer work was carried out ergonomically. Others commented that they were poor typists, and that they “get busy, become absorbed in their work and forget” to apply ergonomics. A comment was also received questioning whether honest answers could be expected because of the “hideous” climate within the university.

Many respondents gave their best wishes for the study, indicating pleasure that the situation was being noticed and valued.

CHAPTER 5

FINDINGS: STUDY IV

Study IV investigated the effects of knowledge of and priority given to ergonomic principles relating to computer use and aspects of the psychosocial work environment on employee health and job satisfaction within the Whyalla organisations that had been surveyed once before, in Study I in 1994. As well as questions from the instrument used previously, the questionnaire included the Work Environment Scale (Moos 1986), the twelve-item General Health Questionnaire (GHQ-12) (Goldberg 1978), and a list of physical health complaints to which respondents replied how often in the past month they had experienced each symptom, similar to that developed from the work of Cheek and Miller (1983). A global index of job satisfaction based on the scale of Warr, Cook and Wall (1979) and a question about job security were also included.

Of the 196 questionnaires distributed, 40 were received from 15 private organisations and 57 from 19 public-sector organisations. A total of 37 questionnaires were received from small-sized organisations (where the number of employees was less than 10) and 60 questionnaires were received from medium–large-sized organisations (where the number of employees was greater than 10). Response rates ranged from 58% for the private-sector firms to 45% for public-sector organisations, with an average, based on 97 useable questionnaires returned, of 50% (Table 5.1). Consistent with Study I, the majority of respondents were female, non-managers and aged between 28 and 37 years (Table 5.2).

Table 5.1 Number of Questionnaires Returned and Response Rates for Type of Organisations (Private or Government) ordered by Size (Small and Medium–Large)

Type of Organisation	Max. Possible Response	Actual Response	Per cent Returned
Small Private (<= 10 employees)	35	22	63
Medium–Large Private (> 10 employees)	34	18	53
Small Government (<= 10 employees	47	15	32
Medium–Large Government (> 10 employees)	80	42	53
Total	196	97	50

Table 5.2 Number and Percentage of Respondents by Age, Gender and Position within Organisation

Variable	Category	Number	Per cent
Age	18–27 yrs	26	27
	28–37 yrs	29	30
	38–47 yrs	28	29
	48–57 yrs	10	10
	over 57 yrs	4	4
Gender	Male	27	28
	Female	70	72
Position	Manager	27	28
	Non–manager	66	68
	Non–responses	4	4

Thirty-five per cent of managers were from private organisations and 25% from public-sector organisations. Of the non-managers, 65% were from private firms and 75% from public-sector organisations. A comparison between gender and position indicated that 68% of males completing the questionnaire were managers and of the female respondents 15% were managers, and this association was highly significant statistically ($t = -5.816$, $df = 91$, $p < 0.01$).

The estimated hours of daily use of desktop computers ranged from 0 to 10 hours, with a mean of 4.07 hours (Figure 5.1). 40% of respondents used a computer for more than four hours a day.

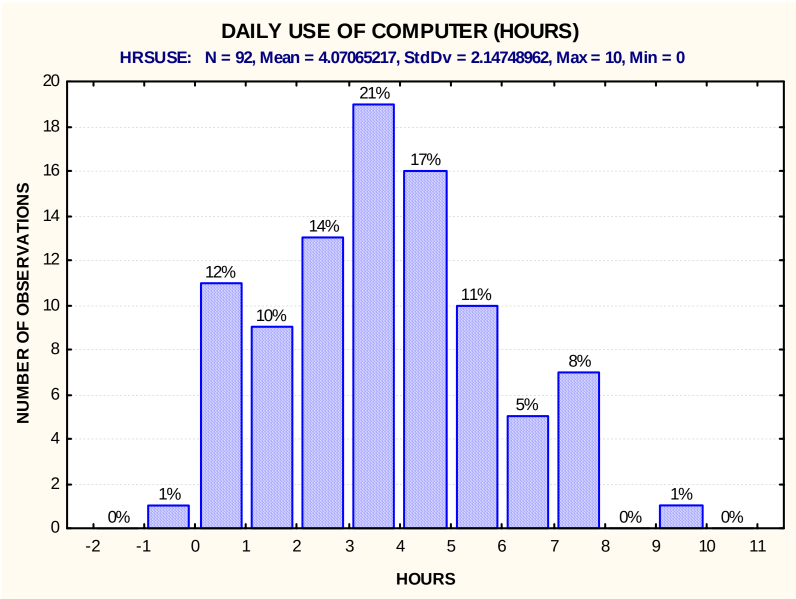

Figure 5.1 Hours of Daily Use of a Desktop Computer Reported by all Respondents

In public-sector organisations the range was 0.25 to 10 hours with a mean of 4.26 hours, and in private-sector organisations the range was 0 and 8 hours with a mean of 3.89 hours. When compared according to gender, the mean usage for females was 4.42 hours and for males, 3.24 hours and this difference was statistically significant ($t = -2.54$, $df = 90$, $p < 0.05$). There was also a statistically significant difference in hours of computer use by managers and non-mangers, with a mean of 2.50 hours for managers and of 4.75 hours for non-managers ($p < 0.01$). The error plot in Figure 5.2 shows the stark contrast.

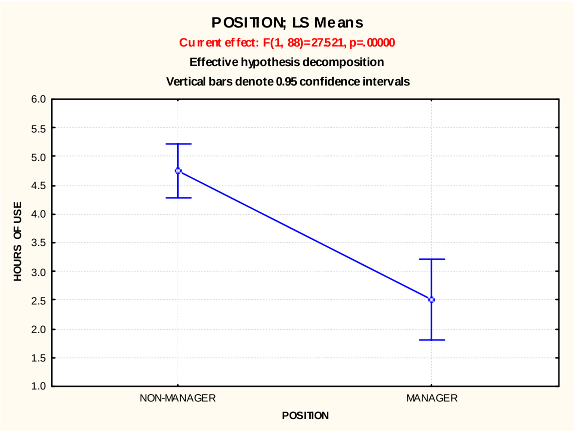

Figure 5.2 Hours of Daily Computer Use by Position

Regression analysis indicated that higher hours of use were associated with increased eyestrain, increased neck tension and increased migraine/headaches (see Table 4.19).

Findings Relating to Knowledge of Ergonomics

The majority of respondents (58%) indicated that they had learnt to operate a computer on the job (Table 5.3). However, only 11% of respondents had attended an educational program/training session provided by their organisation that included information on ergonomics and computer use in the previous 12 months and most respondents had never attended such training (Table 5.4).

Table 5.3 Number and Percentage of Responses Reporting Where Respondents had Learnt to Operate a Computer

Response Received	N	Per cent
On the job	56	58
Educational institution	36	37
Other	4	4
Non–responses	1	1
Total	97	100

Table 5.4 Number and Percentage of Respondents Reporting Attendance at Education/Training Sessions Provided by their Organisation

Frequency	N	Per cent
In the past 12 months	11	11
In the past 2 years	8	8
Over 2 years ago	13	14
Never	64	66
Non–responses	1	1
Total	97	100

The association between attendance at an educational program/training session and size of organisation was not statistically significant ($t = 1.628$, $df = 90$, $p > 0.05$) but respondents from government organisations (45%) were more likely to have attended than those from privately owned organisations (13%) and this was statistically significant ($t = –3.475$, $df = 93$, $p < 0.01$).

Most respondents did not believe they needed to spend more time in such training/update sessions (Table 5.5). These results contrast with the findings of Studies I, II and III, in which on average 57% of respondents believed they did need more time in ergonomic training/update sessions. Further, when asked whether they were aware of the ergonomic principles that relate to the use of computers, the majority of respondents (59%) indicated they were aware (Table 5.6).

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Table 5.5 Number and Percentage of Respondents Reporting whether they Believed they Needed More Time in Training/Update Sessions

Response	N	Per cent
Yes	45	46
No	51	53
Non–responses	1	1
Total	97	100

Table 5.6 Number and Percentage of Respondents Reporting whether they were Aware of the Principles of Ergonomics relating to the Use of Computers

Response	N	Per cent
Yes	57	59
No	36	37
Non–responses	4	4
Total	97	100

When awareness of ergonomic principles was compared according to respondent's position within the organisation, there was a statistically significant difference between managers and non-managers, with only 38% of managers reporting awareness of the ergonomic principles compared to 71% of non-managers (Chi Square = 8.4727, df = 1, $p < 0.01$) (Figure 5.3).

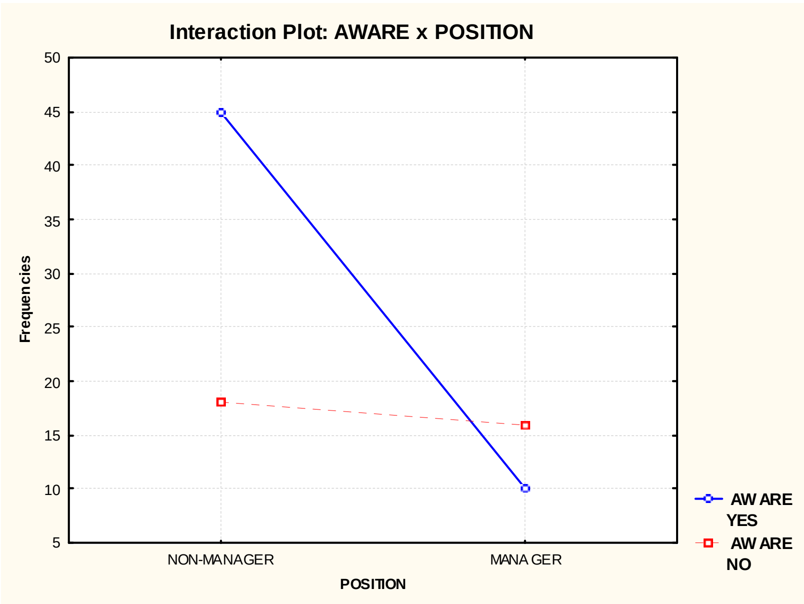


Figure 5.3 Number of Respondents Reporting Awareness of Ergonomic Principles by Position

Association between awareness of ergonomic principles and organisational size ($t = .070$, $df = 90$, $p > 0.05$) and organisational type was not statistically significant ($t = –.219$, $df = 93$, $p > 0.05$).

While 46% of respondents indicated that they had read documents that included information on ergonomics in relation to the use of computers in the preceding 12 months, the majority of respondents (54%) had not. However, 80% of respondents stated that they did take regular rest breaks away from the computer (Table 5.7).

Table 5.7 Number and Percentage of Respondents Reporting whether they Took Rest Breaks away from the Computer

Response	N	Per cent
Yes	78	80
No	14	15
Non–responses	5	5
Total	97	100

The answers received to the questions containing the scenarios designed to test ergonomic knowledge are presented in Figures 5.4 and 5.5. As in previous studies, respondents were asked to study each diagram and indicate whether or not accepted ergonomic principles were being applied in relation to sitting posture and positioning of the arms and wrists (Question 13), and the layout of equipment (Question 14). The average of correct answers for all scenarios by all respondents was 35%.

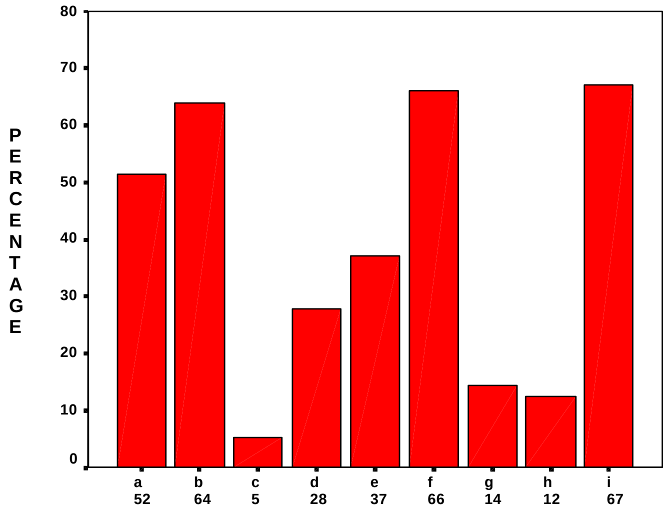


Figure 5.4 Percentage of Correct Answers to Scenarios Regarding Sitting Posture and Positioning of the Arms and Wrists (Survey Question Number 13 (a) to 13 (i))

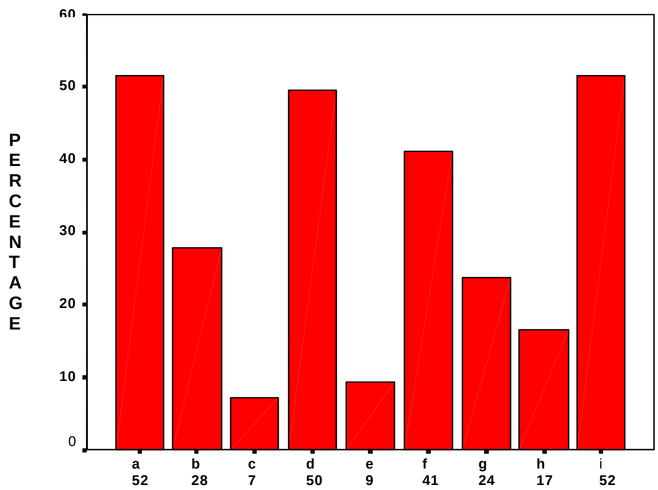
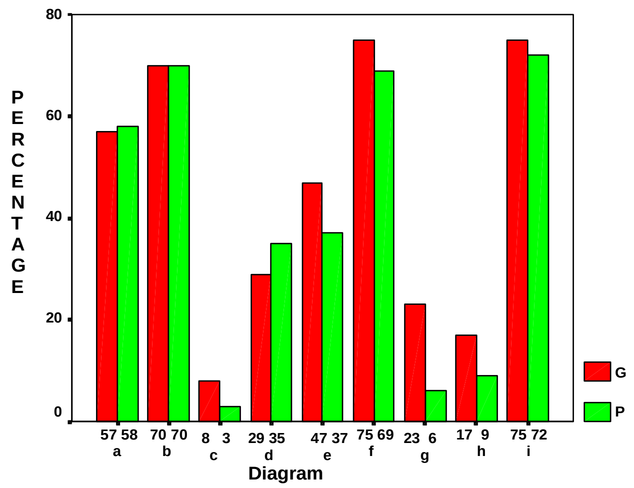


Figure 5.5 Percentage of Correct Answers to Scenarios Regarding Posture and the Layout of Equipment (Survey Question Number 14 (a) to 14 (i))

Respondents were most knowledgeable about diagrams (i), (f), (b) and (a) in Question 13. These diagrams show the computer operator sitting in a slouched position, not using the backrest of the chair; sitting with knees crossed; sitting on the front edge of the seat, not using the backrest of the chair; and sitting with knees bent high on a chair that is too low. In Question 14 respondents were most knowledgeable about diagrams (a), (i), and (d), which show the user sitting too far away from the VDU; sitting with neck bent too far forward to view the VDU; and sitting with the VDU positioned too high. It is reasonable to expect that each of these should be recognised by computer users as depicting poor posture and positioning. None of the diagrams in Question 13 or 14 was answered correctly by all respondents. Three scenarios in Question 13 – diagrams (c), (g) and (h), regarding sitting posture and positioning of the arms and wrists – and three from Question 14 – diagrams (c), (e), and (h), regarding posture and the layout of equipment – were correctly answered by less than 20% of respondents. In Question 13, diagrams (g) and (h) and in Question 14, diagrams (e) and (h) illustrated recommended practices and these were frequently not recognised.

An analysis of correct answers based on organisational structure suggested that respondents from government and private organisations had a similar knowledge of ergonomics. Correct responses were provided (average across all the scenarios) by 40% of respondents from government organisations and 39% from private organisations (Figures 5.6 and 5.7).



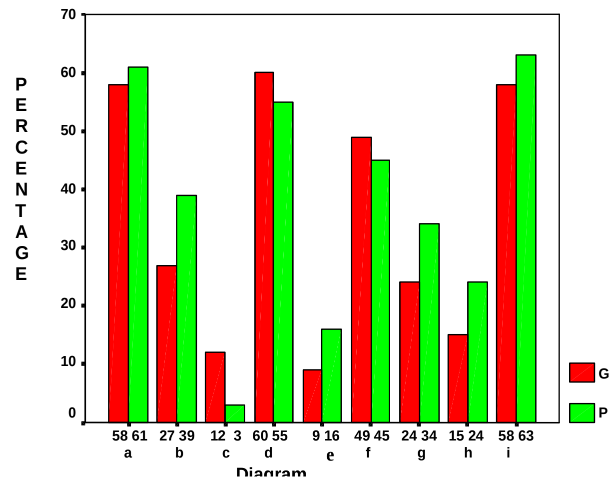
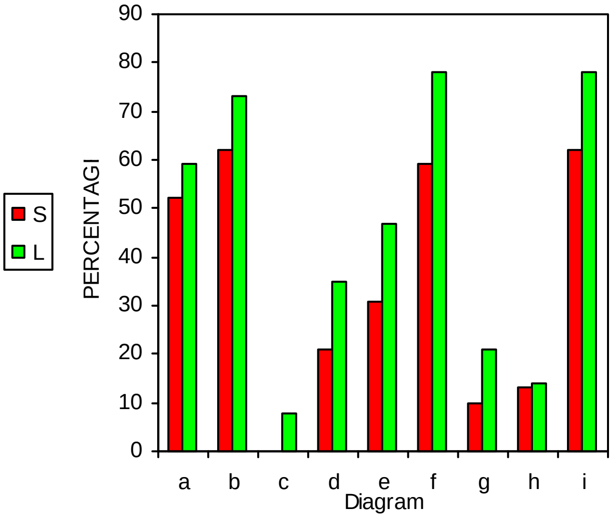


Figure 5.6 **Percentage of Correct Answers to Scenarios Regarding Sitting Posture and Positioning of the Arms and Wrists by Organisational Structure (Question Number 13 (a) to (i))**

Figure 5.7 **Percentage of Correct Answers to Scenarios Regarding Posture and the Layout of Equipment by Organisational Structure (Question Number 14 (a) to (i))**

The association between correct answers and type of organizational structure was tested but only question 13 (g) was statistically significant ($p < 0.05$). With respect to diagram (g), 23% of respondents from government organisations answered correctly, identifying the generally recommended “upright posture”, while 6% from private-sector firms answered correctly.

A comparison of correct responses by size of organisation showed that respondents from medium–large-sized organisations were more knowledgeable than those from small organisations. Correct answers were provided (average across all scenarios) by 41% of respondents from medium–large firms and 34% from small firms (Figures 5.8 and 5.9).



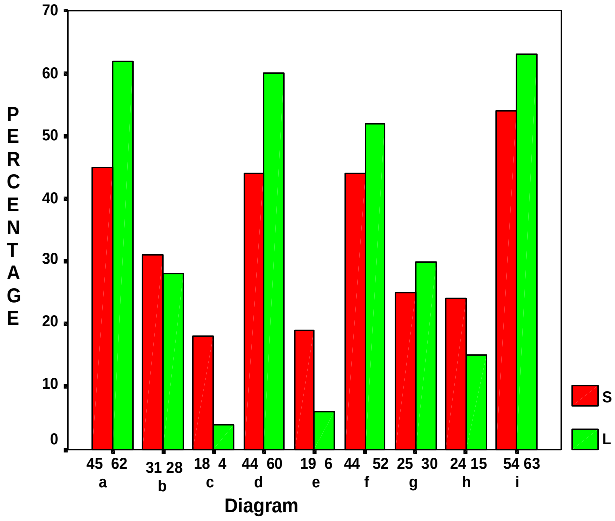
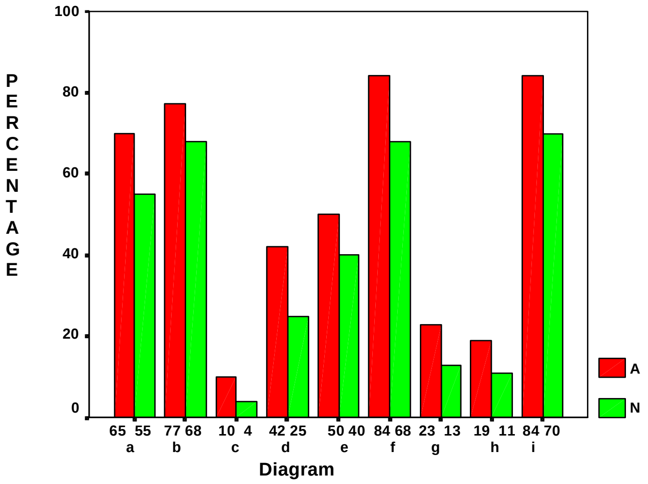


Figure 5.8 **Percentage of Correct Answers to Scenarios Regarding Posture and Positioning of the Arms and Wrists by Organisational Size (Question Number 13 (a) to (i))**

Figure 5.9 **Percentage of Correct Answers to Scenarios Regarding Posture and the Layout of Equipment by Organisational Size (Question Number 14 (a) to (i))**

A test for independence showed the association between correct answers and size of the organisation was statistically significant in relation to question 13 diagram (c) ($p < 0.05$). This diagram shows the chair seat cutting into the back of the operator's knees and was correctly identified by 8% of respondents from medium-large-sized organisations and none from small-sized firms.

The answers to the scenarios were also compared by attendance at an educational program/training session on ergonomic computer use provided by employers (Figures 5.10 and 5.11). Correct answers were given by 44% of respondents who had attended an educational program/training session, and by 37% of respondents who had not attended such a session.



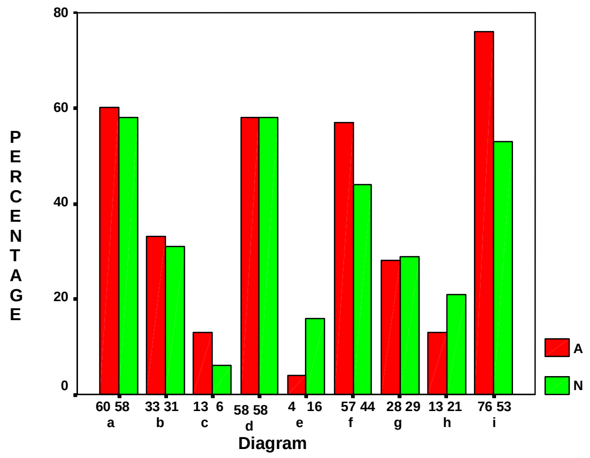
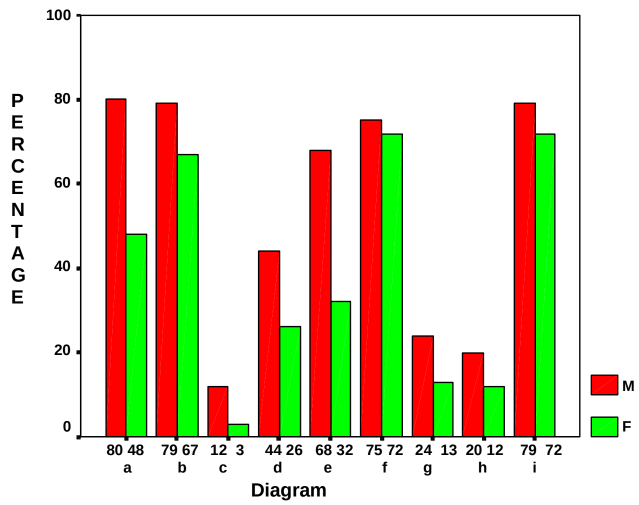


Figure 5.10 **Percentage of Correct Answers to Scenarios Regarding Sitting Posture and Positioning of the Arms and Wrists by Attendance at an Educational Program/Training Session (Question Number 13 (a) to (i))**

Figure 5.11 **Percentage of Correct Answers to Scenarios Regarding Posture and the Layout of Equipment by Attendance at an Educational Program/Training Session (Question Number 14 (a) to (i))**

Tests for association between correct answers and attendance at an educational program/training session were not statistically significant for any diagram ($p > 0.05$).

Comparison on the basis of gender indicated that males were more knowledgeable of the ergonomic principles than females (Figures 5.12 and 5.13). Contrary to expectations, considering most computer users were females, who spent more time using the computer, correct answers were received from 48% of male respondents and 36% of female respondents.



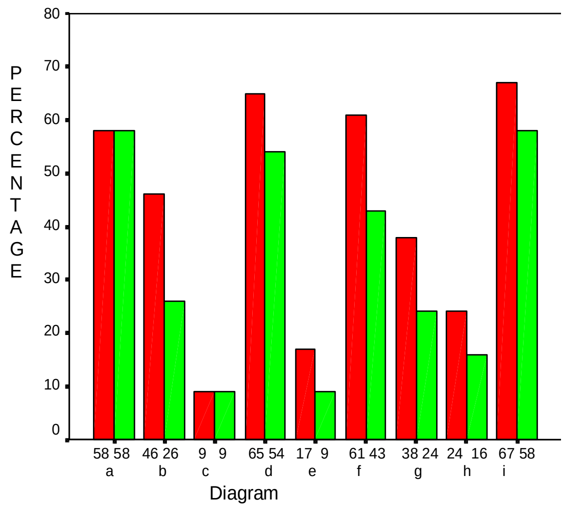
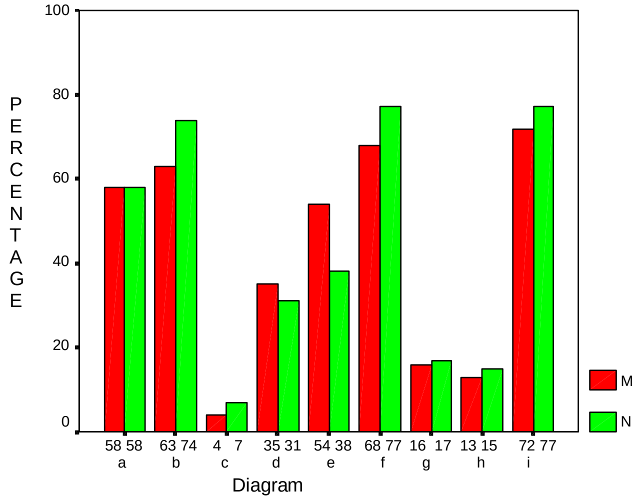


Figure 5.12 **Percentage of Correct Answers to Scenarios Regarding Sitting Posture and Positioning of the Arms and Wrists by Gender (Question Number 13 (a) to (i))**

Figure 5.13 **Percentage of Correct Answers to Scenarios Regarding Posture and the Layout of Equipment by Gender (Question Number 14 (a) to (i))**

When correct answers were tested for association with gender, the analysis indicated male respondents possessed significantly greater knowledge than did females on question 13 diagrams (a) and (e), which showed the chair positioned too low and the keyboard too far back from the edge of the desk ($p < 0.05$). With respect to diagram (a), 80% of males and 48% of females answered correctly. In relation to diagram (e), correct responses were received from 68% of male and 32% of female respondents.

A comparison was also made between the correct answers to the scenarios and the respondent's position in the organisation. Generally non-managers possessed a greater knowledge of the ergonomic principles than did managers (Figures5.14 and 5.15). Correct answers were received from 41% of respondents who were non-managers and from 36% of respondents who were managers.



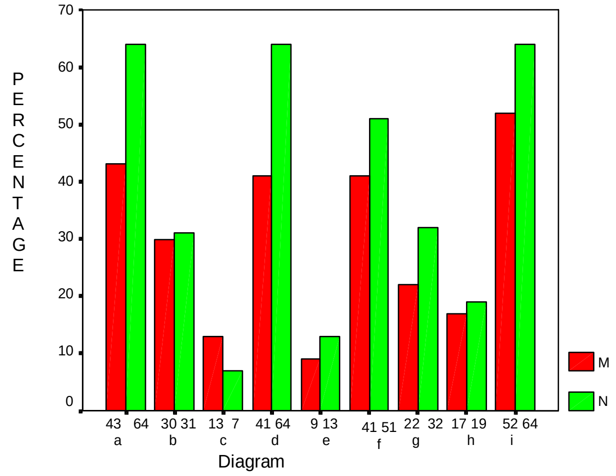


Figure 5.14 **Percentage of Correct Answers to Scenarios Regarding Sitting Posture and Positioning of the Arms and Wrists by Position (Question Number 13 (a) to (i))**

Figure 5.15 **Percentage of Correct Answers to Scenarios Regarding Posture and the Layout of Equipment by Position (Question Number 14 (a) to (i))**

Tests for association between correct answers and position within the organisation were not statistically significant for any diagram ($p > 0.05$). However, when tested with reported awareness of ergonomic principles there was significantly more awareness regarding question 13 diagrams (b), (c), (d), (f) and (i), showing the back not supported, chair seat cutting into the back of the knees, desk positioned too high, and operator sitting with legs crossed, and question 14 (a), (f), (g) and (i), showing VDU positioned too far away from operator, VDU positioned too high and too close to operator, VDU too close to operator, and VDU too low ($p < 0.05$).

Findings Relating to Priority given to Ergonomics

In relation to the priority given to ergonomic principles within the organisation, 41% of respondents believed that sufficient priority was given but most (51%) replied that they were not given sufficient priority. Responses to questions investigating formal organisational procedures related to ergonomics and the use of computers showed that the greatest proportion of respondents (39%) were unsure whether their organisation had a written policy on ergonomic computer use, indicating that this information was not readily available within organisations. A considerable proportion (29%) believed that the organisation did not have such a policy. Respondents who replied that there was no written policy were asked if the organisation was in the process of developing such a policy; a few (5%) stated that they were, but the large majority were unsure (41%) or did not respond (36%). Most employees (55%) were also unsure whether their organisation had a written policy regarding rehabilitation procedures for computer-related disorders and 20% said they did not. Again only a few (5%) indicated that the organisation was in the process of forming such a policy and most (41%) were unsure or left the question blank (39%).

When asked whether someone had been delegated the responsibility for ensuring employees followed appropriate ergonomic guidelines, 38% said that someone had been delegated within their organisation, but 50% stated that no-one had. Most employees knew that they were required to report computer-related disorders (58%); however, 10% replied that they were not required to report them, and a substantial proportion (29%) were unsure. While 39% indicated that their organisation recorded incidents of computer-related disorders, 19% said such records were not kept and 40% were unsure or did not respond. Table 5.8 summarises the responses to these questions.

Table 5.8 Responses to Questions Relating to the Priority Given to Ergonomics within the Organisation

Question	N	Yes %	No %	Unsure %	Non-response %
Written policy exists in organisation	97	30	29	39	2
Written policy being formed	97	5	18	41	36
Person delegated in organisation for ergonomics	97	38	50	–	12
Employees required to report computer-related disorders	97	58	10	29	3
Organisation keeps records on computer-related disorders	97	39	19	40	2
Organisation has written policy on rehabilitation of employees	97	20	20	55	5
Organisation in process of forming written policy on rehabilitation	97	5	15	41	39
Ergonomic principles given sufficient priority in organisation	97	41	51	–	8

When tested by type of organisation it was found that 11% of respondents from private-sector firms reported that their organisation had a written policy on procedures related to ergonomics and computer use compared to 43% from public-sector organisations and this was statistically significant (Chi Square = 17.6292, df = 2, $p < 0.01$) (Figure 5.16).

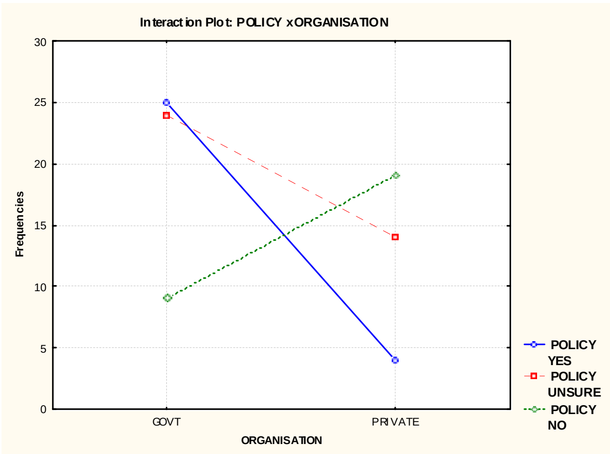


Figure 5.16 Number of Respondents Reporting Existence of Written Policy on Ergonomic Computer Use by Organisational Type

There was also a statistically significant difference between types of organisation in relation to whether the organisation had delegated responsibility for ensuring employees followed ergonomic practices, with 19% of respondents from private-sector firms and 57% from government organisations reporting such delegation (Chi Square = 11.0815, df = 1, $p < 0.01$) (Figure 5.17).

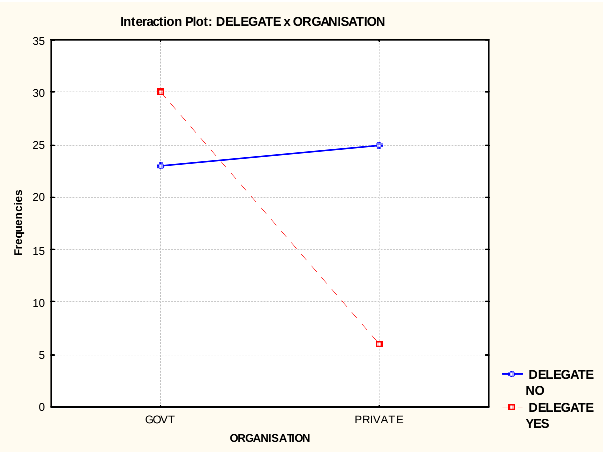


Figure 5.17 Number of Respondents Reporting whether Delegation of Responsibility for Ergonomic Work Practices by Organisational Type

There was again a statistically significant difference between types of organisation regarding emphasis placed on the importance of ergonomics, with 27% of respondents from private-sector firms reporting that their organisation placed emphasis on ergonomics compared to 72% from public-sector organisations (Chi Square = 16.1953, df = 1, $p < 0.01$) (Figure 5.18).

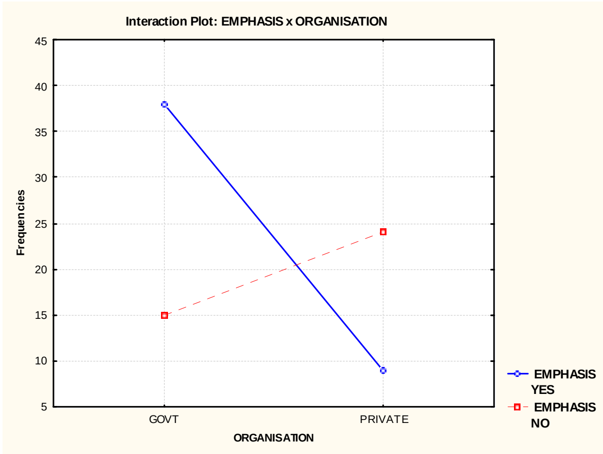
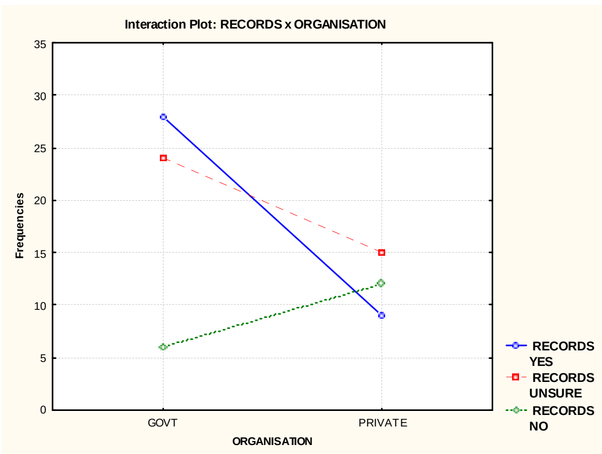


Figure 5.18 Number of Respondents Reporting whether Emphasis on Importance of Ergonomic Computer Use by Organisational Type

Only 25% of respondents from private-sector firms compared to 48% from government organisations reported that their organisation kept records of computer-related disorders and this was statistically significant (Chi Square = 9.1880, df = 2, $p < 0.05$) (Figure 5.19). Further, only 8% of respondents from private organisations compared to 30% from government organisations reported that their organisation had a written policy on procedures related to rehabilitation of employees affected by computer-related disorders and this was also statistically significant (Chi Square = 22.5362, df = 2, $p < 0.01$) (Figure 5.20).



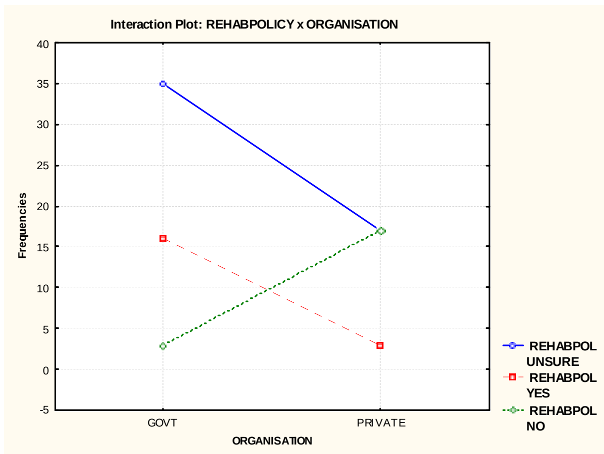


Figure 5.19 Number of Respondents Reporting whether Records Kept of Computer-Related Disorders by Organisational

Figure 5.20 Number of Respondents Reporting Existence of Written Rehabilitation Policy by Organisational Type

Psychosocial and Physical Health Aspects of Computer Use

The impact of psychosocial factors on work-related complaints manifesting as physical and/or psychological disorders was examined with the General Health Questionnaire (GHQ-12) and the Physical Health Symptoms Questionnaire. Results from the GHQ-12 suggest that overall the respondents were psychologically healthy (Tables 5.9 and 5.10).

Table 5.9 Results of the GHQ-12 for all Respondents

Item	Response	Per cent
Have you recently been able to concentrate on whatever you're doing? (G1)	Better than usual	2
	Same as usual	80
	Less than usual	8
	Much less than usual	6
Have you recently lost much sleep over worry? (G2)	Not at all	33
	No more than usual	46
	Rather more than usual	11
	Much more than usual	6
Have you recently felt that you are playing a useful part in things? (G3)	More than usual	18
	Same as usual	57
	Less so than usual	17
	Much less than usual	4
Have you recently felt capable of making decisions about things? (G4)	More than usual	14
	Same as usual	71
	Less so than usual	8
	Much less capable	2
Have you recently felt constantly under strain? (G5)	Not at all	16
	No more than usual	54
	Rather more than usual	20
	Much more than usual	7
Have you recently felt that you couldn't overcome your difficulties? (G6)	Not at all	43
	No more than usual	42
	Rather more than usual	6
	Much more than usual	4
Have you recently been able to enjoy your normal day-to-day activities? (G7)	More so than usual	3
	Same as usual	71
	Less so than usual	18
	Much less than usual	4
Have you recently been able to face up to your problems? (G8)	More so than usual	8
	Same as usual	75
	Less so than usual	9
	Much less than usual	2
Have you recently been feeling unhappy and depressed? (G9)	Not at all	35
	No more than usual	36
	Rather more than usual	18
	Much more than usual	6
Have you recently been losing confidence in yourself? (G10)	Not at all	53
	No more than usual	30

	Rather more than usual Much more than usual	9 3
Have you recently been thinking of yourself as a worthless person? (G11)	Not at all No more than usual Rather more than usual Much more than usual	71 19 2 3
Have you recently been feeling reasonably happy, all things considered? (G12)	More so than usual About the same as usual Less so than usual Much less than usual	10 65 14 2

Table 5.10 Results of the GHQ-12 Psychological Distress: All Respondents

Total	N	Min	Max	Mean	Std Dev
GHQ-12	87	5.00	32.25	10.22	5.48

When compared to other samples of South Australian public-sector workers (M = 12.25) and private-sector workers (M = 11.76) (Macklin and Dollard n.d.) these respondents showed relatively low levels of psychological distress. Comparison between GHQ-12 scores and position in the organisation showed no statistically significant differences in GHQ-12 scores in relation to whether the respondent was a manager or a non-manager. With respect to gender, females were more likely to score in the higher, more distressed range than males for items G7, relating to the ability to enjoy everyday activities ($t = –2.094$, $df = 91$, $p < 0.05$), and G9, regarding feelings of depression ($t = –2.009$, $df = 90$, $p < 0.05$), indicating that they had been enjoying their normal day-to-day activities less than usual and had been feeling unhappy and depressed more than usual. Respondents from public-sector organisations scored significantly higher than private-sector employees for item G2, which relates to losing sleep over worry ($t = 2.495$, $df = 91$, $p < 0.05$), and item G9, regarding feelings of depression ($t = 2.072$, $df = 89$, $p < 0.05$), suggesting that employees in government organisations were more likely to lose sleep over worry and feel unhappy and depressed. In relation to organisational size, respondents from the smaller organisations scored significantly higher on item G3, indicating that they felt a less useful part of the organisation than those from larger organisations ($t = 2.347$, $df = 86$, $p < 0.05$).

Factor analysis of the GHQ-12 responses conducted with Varimax rotation resulted in the emergence of three factors that accounted for 69.7% of the variation (Table 5.11).

Table 5.11 Rotated Factor Loadings Relating to GHQ-12

Item	Factor 1	Factor 2	Factor 3
G1	.175	.108	**.893**
G2	**.767**	–.158	.195
G3	–.018	**.671**	.469
G4	.147	**.790**	.101
G5	**.774**	.061	.377
G6	**.764**	.323	.030
G7	**.575**	.335	.429
G8	.345	**.506**	.434
G9	**.773**	.380	.074
G10	**.765**	.498	.048
G11	.503	**.673**	–.043
G12	**.642**	.445	.161

These components, which can be interpreted as 'general worry', 'worthiness' and 'attentiveness', contained the following items:

Factor 1 General worry
Have you recently lost much sleep over worry?
Have you recently felt constantly under strain?
Have you recently felt that you couldn't overcome your difficulties?
Have you recently been able to enjoy your normal day-to-day activities?
Have you recently been feeling unhappy and depressed?
Have you recently been losing confidence in yourself?
Have you recently been feeling reasonably happy, all things considered?

Factor 2 Worthiness
Have you recently felt that you are playing a useful part in things?
Have you recently felt capable of making decisions about things?
Have you recently been able to face up to your problems?
Have you recently been thinking of yourself as a worthless person?

Factor 3 Attentiveness
Have you recently been able to concentrate on whatever you're doing?

The results of the Physical Health Symptoms Questionnaire reporting symptoms experienced by respondents in the past month are shown in Table 5.12. Overall, respondents were physically healthy and not experiencing severe and consistent pain. The main areas of pain 'sometimes' experienced were eye strain (55%), muscular aches/pain in the shoulders (50%), lower back problems (43%), migraine and severe headache (42%), and neck tension (40%). Overall, the complaints most often identified were aches or pain in the shoulders, followed by eye strain and neck tension.

Table 5.12 Percentage of Respondents Reporting Physical Health Symptoms

Item	Never %	Sometimes %	Many Times %	Always %	Non–response %
Migraine/headache (HS1)	44	42	8	1	4
Eye strain (HS2)	35	55	7	0	3
Tics (HS3)	85	9	1	0	5
Elbow problems (HS4)	85	12	1	0	2
Upper back problems (HS5)	57	29	7	3	4
Lower back problems (HS6)	38	43	12	4	2
Wrist pain (HS7)	74	16	5	3	2
Arm problems (HS8)	80	13	4	0	2
Pain in fingers, thumbs (HS9)	81	11	5	0	2
Muscular aches/pain in Shoulders (HS10)	32	50	11	5	2
Grinding teeth (HS11)	73	12	5	3	4
Neck tension (HS12)	33	40	13	8	5

Comparison of health symptoms by gender showed that female respondents were significantly more likely to suffer headaches ($t = -2.499$, $df = 91$, $p < 0.05$), upper back problems ($t = -2.214$, $df = 91$, $P < 0.05$) and neck tension ($t = -3.214$, $df = 90$, $p < 0.05$) than were male respondents. Also, non-managers were significantly more likely to experience headaches ($t = -2.752$, df = 88, $p < 0.05$), eye tics ($t = -2.159$, df -= 87, $p < 0.05$), shoulder pain ($t = -3.048$, df = 90, $p < 0.05$) and neck tension ($t = -2.296$, df = 87, $p < 0.05$) than were managers. There were no statistically significant differences by type of organisation, reported awareness of ergonomic principles, emphasis by organisation on complying with ergonomic principles, or size of organisation. Interestingly, the most statistically significant differences occurred when physical symptoms experienced were tested by whether respondents took regular rest breaks. Respondents who did not take breaks away from the computer were more likely to experience eye strain ($t = -2.369$, df = 88, $p < 0.05$), elbow problems ($t = -3.857$, df = 89, $p < 0.05$), wrist pain ($t = -1.969$, df = 89, p 0.05), arm problems ($t = -5.719$, df = 89, $p < 0.05$), shoulder pain ($t = -3.042$, df = 89, $p < 0.05$) and neck tension ($t = -3.217$, df = 86, $p < 0.05$) than those who did take rest breaks.

The greatest proportion of respondents (36%) were ‘moderately satisfied’ with their jobs and overall job satisfaction was reasonably high when compared to samples such as South Australian psychologists ($M = 3.75$) and correctional officers ($M = 4.20$) (Dollard et al. 2000; Dollard et al.1992) but lower in comparison to other samples, of South Australian public-sector ($M = 5.08$) and private-sector ($M = 5.00$) workers (Macklin and Dollard n.d.) (Tables 5.13 and 5.14). While job satisfaction tended to be higher for female respondents and those working in management positions this was not statistically significant. Most respondents (67%) described their positions as not being under threat (Table 5.15).

Table 5.13 Number and Percentage of Respondents Reporting Job Satisfaction

Job satisfaction	N	Per cent
Extremely dissatisfied	5	5
Very dissatisfied	9	9.5
Moderately dissatisfied	9	9.5
Not sure	4	4
Moderately satisfied	35	36
Very satisfied	25	26
Extremely satisfied	6	6
Non-responses	4	4
Total	97	100

Table 5.14 Global Job Satisfaction: all Respondents

Total	N	Min	Max	Mean	Std Dev
Job satisfaction	93	1	7	4.66	1.61

Table 5.15 Number and Percentage of Respondents Reporting Job Security

Job Secure	N	Per cent
Yes	65	67
No	25	26
Non–responses	7	7
Total	97	100

Responses to the Work Environment Scale (Moos 1986) were collated to form four subscales: peer cohesion, supervisor support, work pressure and control, as summarised in Table 5.16.

Table 5.16 Responses Regarding the Work Environment

Statement	True %	False %	Non–responses %
Peer cohesion			
People go out of their way to help a new staff member feel comfortable.	81	13	5
The atmosphere is somewhat impersonal.	70	23	7
People take a personal interest in each other.	69	25	6
Staff rarely do things together after work.	35	60	5
People are generally frank about how they feel.	67	25	8
Staff often each lunch together.	39	55	6
Staff who differ greatly from the others in the organisation don't get on well.	43	46	10
Staff often talk to each other about their personal problems.	65	26	9
Often people make trouble by talking behind others' backs	41	50	9
Supervisor support			
Supervisors tend to talk down to staff members.	74	20	6
Supervisors usually compliment staff who are doing something well.	63	31	6
Supervisors tend to discourage criticisms from staff.	57	35	8
Supervisors usually give full credit to ideas contributed by staff.	57	33	10
Supervisors often criticise staff over minor things.	63	28	9
Staff generally feel free to ask for a raise.	10	75	14
Supervisors expect far too much from staff.	67	24	9
Staff discuss their personal problems with supervisors.	37	50	13
Supervisors really stand up for their people.	55	30	16
Work pressure			
There is constant pressure to keep working.	62	32	6
There always seems to be an urgency about everything.	49	45	6
People cannot afford to relax.	41	54	5
Nobody works too hard.	77	17	6
There is no time pressure.	77	14	9
It is very hard to keep up with your workload.	40	51	9
You can take it easy and still get your work done.	56	33	11
There are always deadlines to be met.	75	16	9
People often have to work overtime to get their work done	35	55	10
Control			
Few staff have important responsibilities.	24	69	7
Staff have a great deal of freedom to do as they like.	49	43	8
Staff are encouraged to make their own decisions.	74	19	7

People can use their own initiative to do things.	76	17	7
Supervisors encourage staff to rely on themselves when a problem arises.	51	38	11
Staff generally do not try to be unique and different	60	28	12
Staff are encouraged to learn things even if they are not directly related to the job.	64	27	9
Staff function fairly independently of supervisors.	73	14	12
Supervisors meet with staff regularly to discuss their future work goals.	51	39	10

In relation to 'peer cohesion', most respondents believed people in their workplace went out of their way to help others (81%), took a personal interest in each other (69%), were frank about how they felt (67%) and talked to each other about personal problems (65%). Although most thought the work atmosphere was somewhat impersonal, they tended to share after-work activities. In relation to 'supervisor support', the majority of respondents felt their supervisors talked down to them (74%), expected far too much from them (67%) and criticised them over minor things (63%). However, most also said supervisors usually complimented staff when they did something well (63%) and gave full credit to ideas contributed by staff (57%). Most respondents did not tend to discuss their personal problems with supervisors (50%) and did not feel free to ask for a raise (75%). In terms of 'work pressure', while many respondents replied there were always deadlines to be met (75%), a constant pressure to keep working (63%) and an urgency about everything (49%), most were able to relax at work (54%), and said that nobody worked too hard (77%), that there was no time pressure (77%) and that they did not have to work overtime to get their work done. In relation to 'control' over work, most staff were able to use their initiative (76%), were encouraged to make their own decisions (74%) and functioned fairly independently of supervisors (73%). They were given important responsibilities and encouraged to rely on themselves when a problem arose. They were also encouraged to learn and met regularly with supervisors to discuss their future work goals.

A factor analysis using the twelve 'ergonomic' variables (Part B of the survey instrument) gave three factors that accounted for 62% of the variance. These were rotated using Varimax to give the loadings shown in Table 5.17.

Table 5.17 Rotated Factor Loadings Relating to Ergonomics and Work Environment

Variable	Factor 1	Factor 2	Factor 3
Attended	.49653	.48071	.04650
Aware	.12649	**.74527**	.04686
Breaks	–.00641	–.02128	**.79600**
Delegate	.38135	.14850	**.70927**
Emphasis	.51236	.32051	**.63697**
Moretime	.24639	**–.81764**	–.15041
Policy	**.56455**	.31746	.27439
Read	.41339	.56925	.17827
Records	**.74825**	.12214	.21393
Rehabpol	**.67117**	.11853	.28845
Report	**.81211**	–.00962	–.01568
Suffpri	.35510	.75870	–.00052

The first grouping corresponds to organisational procedures regarding ergonomic policies and practice and contained items relating to whether employees were required to report incidents of computer-related disorders and whether the organisation kept records of these, whether the organisation had a written policy on procedures related to rehabilitation of employees affected by computer related disorders, and whether they had a written policy on ergonomic computer use. The second group related to ergonomic education and contained items regarding whether the individual believed they needed to spend more time in ergonomic training, whether sufficient priority was given to ergonomics, whether they were aware of the ergonomic principles relevant to computer use, and whether they had read material on ergonomics and computer use in the preceding 12 months. The third group reflected both individual and organisational characteristics and contained items regarding whether the individual took regular rest breaks away from the computer, and whether the organisation had delegated responsibility for ergonomic computer use and emphasised the importance of keeping ergonomic work practices in mind when using a computer.

These items were grouped together to form the new variables Group1, Group 2 and Group 3, which were entered hierarchically into a multiple linear regression. The biographic variables (Age, Gender, Position, Organisation size, Organisation type and Hours of daily use) were entered in one block; the ergonomic variables, together with a composite variable representing the answers from the two questions containing the diagrams, were entered in a second block; and a third block included the composite variables for responses to the four subscales of the Work Environment Scale (peer cohesion, supervisor support, work pressure and control), and the variable regarding job security. These blocks were examined against the aggregated GHQ-12 scores, job satisfaction, and the aggregated physical health symptoms.

Group 2 items, regarding ergonomic education, showed statistically significant associations with GHQ-12 scores ($t = 2.066$, $p < 0.05$), suggesting that the less the ergonomic information available to employees the higher the psychological distress. There was a positive relationship between work pressure ($t = 2.217$, $p < 0.05$) and GHQ-12 scores, indicating that when job demands increased there was greater psychological distress. There was also a negative relationship between peer cohesion and GHQ-12 scores ($t = –2.076$, $p < 0.05$), suggesting that as peer cohesiveness increased scores on the GHQ-12 decreased, reflecting improved psychological wellbeing.

When job satisfaction was compared with Group 1, Group 2 and Group 3 (the factor analysis groupings) and the aggregated scores of the diagram questions, the result was statistically significant, suggesting that job satisfaction increased when computer users had higher levels of ergonomic knowledge ($t = 3.14$, $p < 0.01$). Job satisfaction was also higher in private-sector organisations than in public-sector ones ($t = 2.06$, $p < 0.05$). When job satisfaction compared with the Work Environment subscales (work pressure, peer cohesiveness, supervisor support, control) and job security the result was also statistically significant, indicating that job satisfaction increased with increased job security ($t = 2.91$, $p < 0.01$).

When the Physical Health Symptoms Questionnaire items were entered as the dependent variable the only statistically significant result was for work pressure ($t = .267$, $p < 0.05$), suggesting that as job demands increased, physical health problems also increased.

A further factor analysis was conducted using the items from the Physical Health Symptoms Questionnaire and three factors were extracted that accounted for 57% of the variance. These factors were rotated using oblique rotations[48] to give the loadings shown in Table 5.18.

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[48] With the oblique rotation method, factor rotation is computed so that the extracted factors are correlated (Hair et al. 1995, p. 366).

Table 5.18 Rotated Factor Loadings Relating to Physical Health Symptoms

Item	Factor 1	Factor 2	Factor 3
HS12 Neck tension	**.868**		
HS5 Upper back problems	**.615**		
HS10 Muscular aches/pain in shoulders	**.593**		
HS1 Migraine/severe headache	**.548**		
HS11 Grinding teeth	.465		
HS6 Lower back problems	.448		
HS2 Eye strain			
HS4 Elbow problems		**.861**	
HS8 Arms problems		**.731**	
HS9 Pain in fingers, thumbs			**.678**
HS7 Wrist pain			**.559**
HS3 Tics			.474

The first factor related to upper body symptoms such as neck tension, upper back problems, shoulder pain and severe headaches; the second factor related to the arms, and contained the items elbow problems and arm problems; and the third factor related to the hands, and contained the items pain in fingers and thumbs and wrist pain. When these three physical health factors were used in the multiple regression analysis statistically significant results were obtained for all three: upper body symptoms were significantly associated with work pressure ($t = 2.45$, $p < 0.05$), arm symptoms with age and job security ($t = 3.24$, $p< 0.01$; $t = 2.08$, $p < 0.05$)), and hand symptoms with ergonomic education and knowledge ($t = –2.252$, $p < 0.05$; $t = –2.285$, $p < 0.05$).

The hours spent daily on a computer were also related to health symptoms. A ridge regression analysis, with an 81.3% explanation of the variance, showed that higher hours of computer use were associated with increased eye strain (HS2), neck tension (HS12) and migraine/severe headaches (HS1) (Table 5.19).

Table 5.19 Ridge Regression Summary regarding Hours of Daily Computer Use and Physical Health Symptoms

N=80	Ridge Regression Summary for Dependent Variable: HRSUSE (JANET_PHD R= .90142985 R²= .81257577 Adjusted R²= .77950091 F(12,68)=24.568 p<0.0000 Std.Error of estimate: 2.1658					
	Beta	Std.Err. of Beta	B	Std.Err. of B	t(68)	p-level
HS1	0.260669	0.129004	0.698508	0.345689	2.02062	0.047259
HS2	0.326807	0.146942	0.831321	0.373786	2.22406	0.029469
HS3	0.137609	0.146039	0.536405	0.569265	0.94228	0.349387
HS4	0.215036	0.164589	0.816631	0.625052	1.30650	0.195784
HS5	0.036054	0.129915	0.100048	0.360511	0.27752	0.782225
HS6	0.071895	0.136080	0.167110	0.316296	0.52833	0.598988
HS7	-0.156560	0.136666	-0.472297	0.412282	-1.14557	0.255989
HS8	-0.087770	0.154494	-0.312788	0.550574	-0.56811	0.571830
HS9	0.062018	0.148687	0.219382	0.525968	0.41710	0.677918
HS10	-0.081818	0.163165	-0.184409	0.367756	-0.50144	0.617679
HS11	-0.230219	0.121314	-0.734917	0.387264	-1.89772	0.061979
HS12	0.354240	0.157549	0.771269	0.343023	2.24844	0.027793

Summary of the Findings

The formal characteristics of respondents to this survey were in line with those from the earlier study in the same setting: female (72%), aged between 28 and 37 years (30%), in a non-managerial role (68%), from a government organisation (60%) and working in a medium–large-sized organisation (62%). Male respondents were significantly more likely to hold management positions than the females. 57% of respondents used a computer for four or more hours per day, with the mean daily use being approximately four hours. Usage was significantly higher within public-sector organisations, and among females and non-managers. As the hours of daily use of a computer increased so did the incidence of eye strain, neck tension and migraine/severe headaches.

While 58% of respondents learnt to use a computer on the job, the majority had not received training in ergonomics from their employer (66%). Only 11% had attended a training session provided by their organisation that included information on ergonomic computer use in the preceding 12 months. Respondents from public-sector organisations were more likely to attend than those from privately owned firms. However, contrary to the findings in Studies I, II and III, most respondents did not believe they needed to spend more time in such training (53%). In addition, the majority of respondents (59%) stated that they were aware of the ergonomic principles relating to computer use; however, a considerable proportion (37%) answered that they were not aware and this was cause for concern. In particular, many people in management positions were not aware, suggesting an inability to control this area of risk. Over half (54%) had not read any material related to ergonomics and the use of computers in the preceding 12 months. However, most respondents were aware of the importance of rest breaks and a high percentage (80%) took regular breaks away from their computer work.

The responses to the scenarios designed to elicit knowledge of ergonomic principles relevant to computer use suggest that computer users had limited knowledge of appropriate ergonomic practices. The average of correct answers for all scenarios was only 35%. In particular the ‘upright posture’, with thighs and arms level or angled slightly downwards, was rarely recognised as an accepted posture. Those who had attended ergonomic training sessions, male workers, non-managers and respondents from medium–large-sized organisations showed the highest level of ergonomic knowledge in relation to the diagrams. Private and public-sector employees had similar knowledge.

Many respondents were unsure whether their organisation had written policies and procedures regarding the use of computers (39%), whether their organisation kept records of computer-related disorders (40%) or whether their organisation had a policy concerning rehabilitation of employees affected by computer use (55%), suggesting that this information was not readily available within the organisations. The majority of respondents replied that their organisation did not have a designated person responsible for ergonomic practice (50%), but most also stated that the organisation did emphasise the importance of adhering to ergonomic work practices (50%) and required that incidents of computer-related disorders were reported (58%). Private-sector firms were less likely to place emphasis on the importance of ergonomic computer use, were less likely to have delegated to a person responsibility for ensuring that ergonomic work practices were followed. They were also less likely to have a written policy on ergonomic computer use, less likely to keep records of computer-related disorders, and less likely to have a policy on procedures related to the rehabilitation of employees affected by computer-related disorders, than public-sector organisations. 51% of respondents believed ergonomic computer use was not given sufficient priority within their organisation.

Overall, respondents were psychologically healthy. Psychological distress as measured by the GHQ-12 was linked to ergonomic education, suggesting that the less ergonomic information there was available the more workers experienced psychological distress. Psychological wellbeing was also linked with job demands and peer cohesion: when job demands were high, levels of psychological distress were also high and when peer cohesion was low, levels of psychological distress were high.

Most respondents were satisfied with their jobs. Job satisfaction was higher for those computer users with greater ergonomic knowledge. Job satisfaction was also higher for people who worked in a private-sector organisation, and those who perceived that their position had high job security. The majority of respondents (67%) described their positions as not being under threat. The psychosocial work environment was generally supportive. Supervisor support was strong, although many people felt that too much was expected of them and that they were talked down to. Peers went out of their way to help others, took a personal interest in each other and often shared after-work activities. Respondents had autonomy over their work and were generally able to make their own decisions and work independently of their supervisors. The workload was generally manageable and, although there were always deadlines and a constant pressure to keep working, most respondents said nobody worked too hard, there was no time pressure, and that they did not need to work overtime in order to complete their work.

Muscular aches and pain in the shoulders, eye strain and neck tension were the physical health symptoms experienced most frequently by the respondents. Females were more likely to suffer health problems than males, and non-managers more likely than managers. Job demands were positively associated with upper body symptoms such as neck tension, upper back problems, aches/pain in shoulders and severe headaches, and age and job security were linked to arm and elbow problems. Ergonomic education and knowledge were associated with pain in the fingers, thumbs and wrists, indicating that low levels of ergonomic knowledge were linked to hand and wrist problems. Physical health symptoms were lowest among people who took regular rest breaks from computer use. Respondents who did not take rest breaks suffered more eye strain, elbow problems, arm problems, wrist pain, shoulder pain and neck tension than those who did take breaks.

CHAPTER 6

FINDINGS: STUDY V

Studies I and *II* investigated the knowledge of and priority given to ergonomic principles in relation to computer use within organisations located in the regional city of Whyalla and in the Adelaide metropolitan area to enable a city–country comparison of the findings. *Study III* extended this research within a large South Australian university to determine the extent of knowledge of ergonomics and the priority ergonomic computer use was given by academic staff, post-graduate students and the institution. *Study IV* revisited the Whyalla organisations that had participated in Study I to examine relationships between ergonomic knowledge and practice, aspects of the psychosocial work environment, and the mental and physical health of the managers and computer operators previously surveyed.

Study V, carried out in 1998, compared data collected in Study IV with those of Study I, carried out in 1994. The location (Whyalla) and the organisations remained the same. The study aimed to determine the nature and extent of any change in knowledge of and priority given to ergonomic computer use over the four-year period, in formally comparable settings. Comparison was made using the biographical data about age, gender, position, type and size of organisation, daily computer use, and where the respondent had learnt to use a computer; the twelve ergonomic questions regarding awareness of ergonomic principles, attendance at training, taking of rest breaks, organisational policies and procedures and perceived priority; and the two questions containing the scenarios relating to posture and positioning of the body and computer-related furniture and equipment.

Ninety-seven questionnaires from Study IV and 111 from Study I came from common organisations. While the organisations surveyed were the same in Study V, responses to a question asking whether the *Ergonomics and Computer Technology* survey instrument used in Study I had been completed in 1994 revealed that most Study V respondents had not answered the ergonomics questionnaire previously. It is reasonable to assume, therefore, that any change in response or performance as a result of the previous study was more likely to have occurred via the organisations' becoming more conscious of the importance of applying ergonomics to computer use rather than its impact on the individuals involved at the time.

A profile of the respondents is given in Table 6.1. In both periods the majority of respondents were female, aged between 28 and 37 years and working in a non-management position within a public-sector organisation. However, there was a 12% drop in respondents from public-sector organisations over the period (private 25%, public 72% 1994; private 39%, public 60% 1998), probably consistent with the accelerating shift to a private/corporate emphasis in the political economy.

Table 6.1 Percentage of Respondents by Age, Gender and Position within Organisation

Variable	Category	1994		1998	
		N	%	N	%
Position	Manager	35	32	27	28
	Non-manager	73	66	66	68
Age	18–27 years	27	24	26	27
	28–37	36	32	29	30
	38–47	33	30	28	29
	48–57	14	13	10	10
	Over 57 years	1	1	4	4
Gender	Male	38	34	27	28
	Female	71	64	70	72

Most managers came from private-sector organisations (private 37%, public 32% 1994; private 35%, public 25% 1998). There were 11% more male managers and 5% fewer female managers (male 57%, female 20% 1994; male 68%, female 15% 1998), and this association between gender and position was statistically significant in both periods ($p < 0.01$).

There had been a clear, though not large, increase in hours spent at the keyboard. In 1994 daily computer use ranged up to 7.5 hours; by 1998 it ranged as high as 10 hours and the mean had risen nearly 12% to 4.07 hours. Computer use was greater in medium–large-sized and public-sector organisations and among females and non-managers: mean use within medium–large-sized firms had increased by 17% (to 4.47 hours) and in small-sized organisations by 4% (to 3.27 hours); it had increased by 12% (to 4.26 hours) in public-sector organisations and by a substantial 33% (to 3.89 hours) in private-sector organisations. Mean use by male respondents had also increased substantially (24%) but from a lower base (2.61 hours 1994; 3.24 hours 1998); use by females was up by 6% (to 4.42 hours). Computer use of managers was similar at the two times (2.49 hours 1994; 2.50 hours 1998) and for non-managers had increased

14% (to 4.75 hours). In both periods the difference in computer use between managers and non-managers was statistically significant ($p < 0.05$).

Higher proportions of respondents were using a computer for four or more hours per day. In 1998, 63% of respondents used a computer for four or more hours per day compared to 49% in 1994, an increase of 14%. Table 6.2 gives the details for each category.

Table 6.2 Number and Percentage of Respondents using a Computer for Four or More Hours Daily

	1994		1998	
Category	**N**	**%**	**N**	**%**
Small-sized firm	11	42	14	45
Medium–large-sized firm	43	53	39	67
Private-sector organisation	10	37	20	54
Public-sector organisation	42	53	35	65
Manager	8	23	5	19
Non-manager	45	63	49	78
Male	11	30	9	33
Female	42	60	46	71

Table 6.2 shows the large difference in extended use between managers and non-managers and between male and female computer users in each period and also the increased use by non-managers and females over the four years. In 1994, 39% of respondents experienced a work-related complaint of pain in some part of the body. Those who used a computer for four or more hours a day were more than twice as likely to report pain worth complaining about (69%) than those with less than four hours use (31%). The highest percentage of complaints of pain came from females using computers for six hours per day (79%), who were aged between 28 and 37 years (44%), who worked in a non-management position (79%), within a medium–large (73%) public-sector organisation (77%). In 1998, 55% of respondents reported that

they had suffered health symptoms in the preceding month. In particular, females and non-managers were significantly more likely to experience headaches and neck tension than males and those working in management positions. Higher hours of computer use were significantly associated with increased eye strain, neck tension and severe headaches ($p < 0.05$).[48]

Findings Relating to Knowledge of Ergonomics

A definition of ergonomics and the aspects of work to which ergonomics can be applied was given in the questionnaire and respondents were asked whether they were aware of the ergonomic principles that related to the use of computers. The replies indicated a 16% improvement in reported awareness over the period 1994-98 (Table 6.3).

Table 6.3 Number and Percentage of Respondents Reporting whether they were Aware of the Principles of Ergonomics relating to the Use of Computers

	1994		1998	
Response	**N**	**%**	**N**	**%**
Yes	48	43	57	59
No	62	56	36	37
Non-responses	1	1	4	4
Total	111	100	97	100

Females were more likely to report awareness than males but over the period the greatest increase in reported awareness was among male respondents (males 35%, females 49% 1994; males 52%, females 62% 1998). In 1994, managers were more

[48] Refer Chapter 5 Study IV Table 5.19.

likely to report awareness than non-managers, but a 30% increase in reported awareness among non-managers reversed this in 1998 (managers 49%, non-managers 41% 1994; managers 38%, non-managers 71% 1998). The reported awareness of respondents from small and medium–large-sized organisations was similar in each period, with the largest increase being within small-sized firms (small 40%, medium–large 44% 1994; small 58% and medium–large 59% 1998). In relation to organisational type, the largest increase in reported awareness (19%) was among respondents from government organisations (private 41%, public 45% 1994; private 54%, public 64% 1998).

There was only a small increase (8%) in the proportion of respondents attending an education/training session provided by their organisation that included information on ergonomics relating to computer use (Table 6.4). It is noteworthy that, while the majority of respondents learnt to use a computer on the job, two-thirds had not attended training provided by their employer and almost half did not appear interested in doing so. The percentage of respondents who believed they needed to spend more time in such education/training decreased 13%, from 59% to 46%, over the period, reflecting the increase in reported awareness (Table 6.5).

Table 6.4 Number and Percentage of Respondents Reporting Attendance at Education/Training Sessions Provided by their Organisation

	1994		1998	
Response	**N**	**%**	**N**	**%**
In the past 12 months	7	6	11	11
In the past 2 years	8	7	8	8
Over 2 years ago	13	12	13	14
Never	81	73	64	66
Non-responses	2	2	1	1
Total	111	100	97	100

Table 6.5 Number and Percentage of Respondents Reporting whether they Believed they Needed More Time in Training/Update Sessions

Response	1994		1998	
	N	%	N	%
Yes	66	59	45	46
No	24	22	51	53
Non-responses	21	19	1	1
Total	111	100	97	100

People working in small-sized and private-sector firms and in management positions were less likely to receive training in ergonomic computer use from their organisation than those working in larger and public-sector organisations and non-management positions. Lack of attendance within both small and medium–large-sized organisations had decreased by approximately 10% (small 84%, medium–large 72% 1994; small 73%, medium–large 63% 1998) and within government organisations by 15%, but there was a slight increase within privately owned firms (private 85%, public 70% 1994; private 87%, public 55% 1998). There was a 12% drop in males and non-managers who had never attended training (males 75%, females 73% 1994; males 63%, females 68% 1998) but managers who had never attended had risen slightly (managers 65%, non-managers 78% 1994; managers 67%, non-managers 66% 1998).

It is noteworthy that a considerably lower proportion of people reported that they had learnt to use a computer on the job (75% 1994; 58% 1998). In 1998, 37% of respondents learnt at an educational institution, increasing the likelihood that their computer training would have included instruction in ergonomics, whereas in 1994 only 20% had learnt their computing skills in an educational institution (Table 6.6).

Table 6.6 Number and Percentage of Responses Reporting Where Respondents had Learnt to Operate a Computer

Response received	1994 N	1994 %	1998 N	1998 %
On the job	83	75	56	58
Educational institution	22	20	36	37
Other	5	4	4	4
Non-responses	1	1	1	1
Total	111	100	97	100

Although again the majority of respondents had not read any documents that included information relating to ergonomics and computer use in the preceding 12 months, there was a 16% increase over the period in those who had (Table 6.7). There was also a 10% increase in respondents who took rest breaks away from the computer (Table 6.8). However, although a favourable 80% of respondents reported taking rest breaks, 15% reported not taking breaks even though it s generally recommended that they be taken every 50–60 minutes when doing computer work.

Table 6.7 Number and Percentage of Respondents Reporting whether they had Read Documents on Ergonomic Computer Use

Response	1994 N	1994 %	1998 N	1998 %
Yes	34	30	45	46
No	74	67	52	54
Non-responses	3	3	0	0
Total	111	100	97	100

Table 6.8 Number and Percentage of Respondents Reporting whether they Take Rest Breaks away from Computer

Response	1994 N	1994 %	1998 N	1998 %
Yes	78	70	78	80
No	26	24	14	15
Non-responses	7	6	5	5
Total	111	100	97	100

Respondents not taking rest breaks away from the computer were generally from privately owned organisations (private 31%, public 24% 1994; private 21%, public 12% 1998). In 1994, the greatest proportion of people not taking breaks were from small-sized rather than larger organisations (small 39%, medium–large 21%) but in 1998 this had reversed (small 10%, medium–large 16%). Particularly in 1998, people not taking breaks were more likely to be non-managers (manager 21%, non-manager 28% 1994; manager 8%, non-manager 19% 1998) and female (male 27%, female 25% 1994; male 12%, female 17% 1998). 1998 data showed that respondents who did not take rest breaks away from their computer work were significantly more likely to suffer more eye strain, neck tension, and wrist, arm and shoulder problems than those who did.

The percentage of correct answers to the two questions containing the various scenarios related to sitting posture, positioning of the arms and wrists, and the layout of equipment are presented in Figures 6.1 and 6.2 for each period. The average percentage of correct answers for all scenarios was similar (36% 1994; 35% 1998) and generally indicated a low level of knowledge of the relevant ergonomic principles.

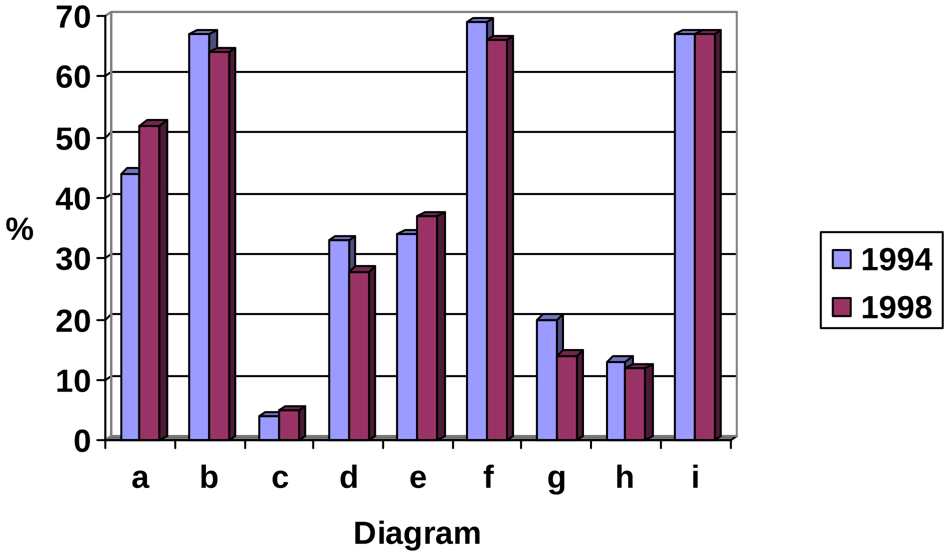

Figure 6.1 Percentage of Correct Answers to Scenarios Regarding Sitting Posture and Positioning of the Arms and Wrists

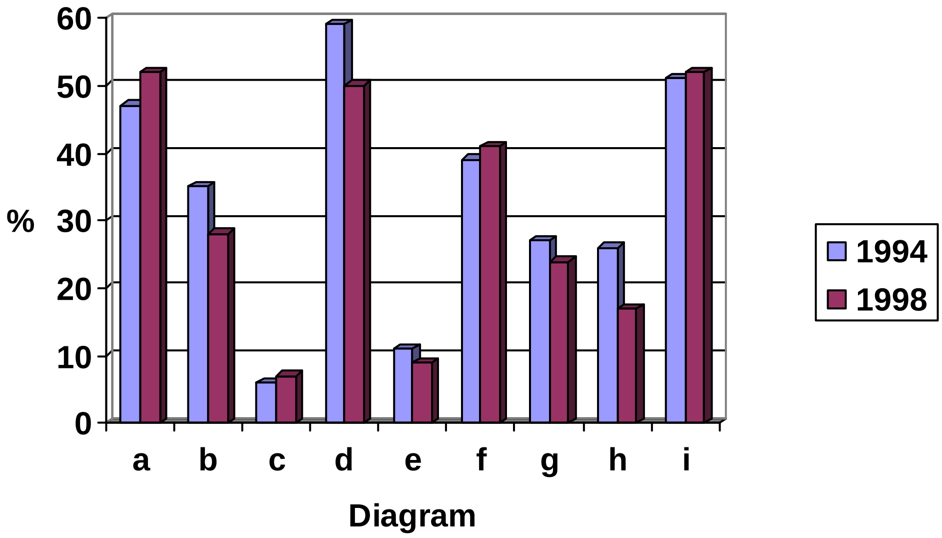

Figure 6.2 Percentage of Correct Answers to Scenarios Regarding Posture and the Layout of Equipment

In both periods only those diagrams clearly depicting poor positioning were correctly identified by half or more respondents, suggesting that ergonomic principles were still not well known or understood. There was an improvement on diagram (a) in both questions, which show the user sitting too low and too far away from the screen. However, there were fewer correct answers on diagram (g) in the first question, which represents the generally recommended ‘upright posture’, and on diagrams (b), (d) and (h) in the second question, which show the document holder positioned too high, the VDU too high and the generally recommended ‘upright posture’ respectively, suggesting a lack of awareness of the ergonomic principles.

While in 1994 correct answers were more likely to be provided by respondents from privately owned organisations (private 50%, public 42%), in 1998 the proportions from both types of organisation were similar (private 39%, public 40%), with a considerable reduction (11%) in correct answers from people within private-sector firms (Figures 6.3 and 6.4).

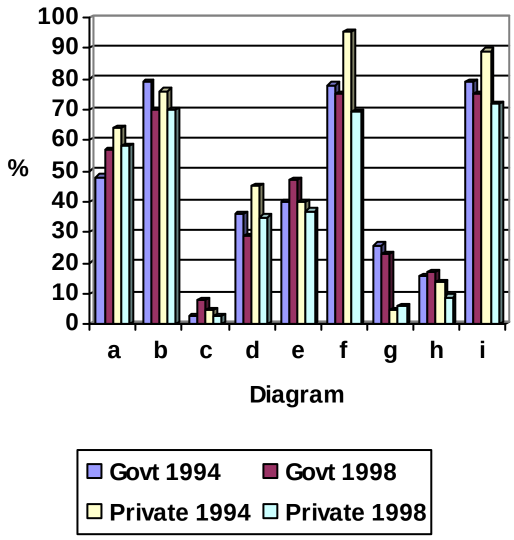

Figure 6.3 Percentage of Correct Answers to Scenarios Regarding Sitting Posture and Positioning of the Arms and Wrists by Organisational Structure

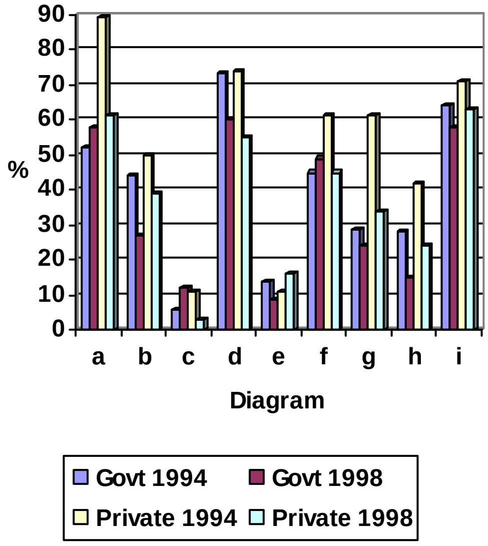

Figure 6.4 Percentage of Correct Answers to Scenarios Regarding Posture and Layout of Equipment by Organisational Structure

In 1994 a higher percentage of correct answers were received from respondents in small-sized firms (small 52%, medium–large 42%) but in 1998 an 18% drop in correct answers from respondents in small-sized firms reversed this situation (small 34%, medium–large 41%) (Figures 6.5 and 6.6).

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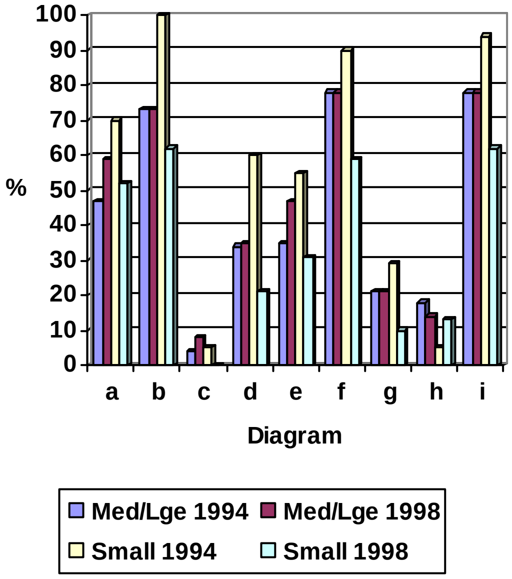


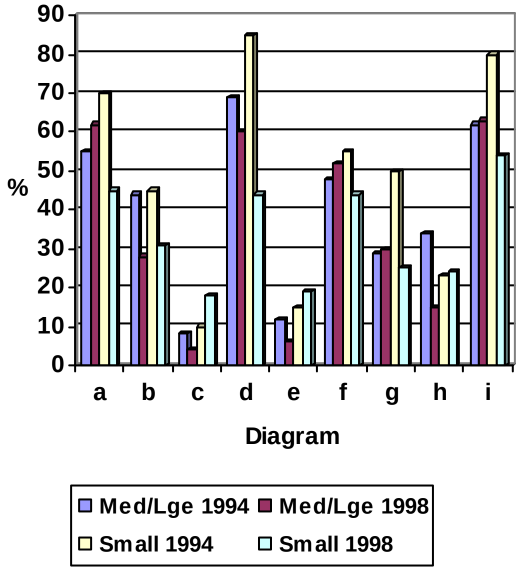
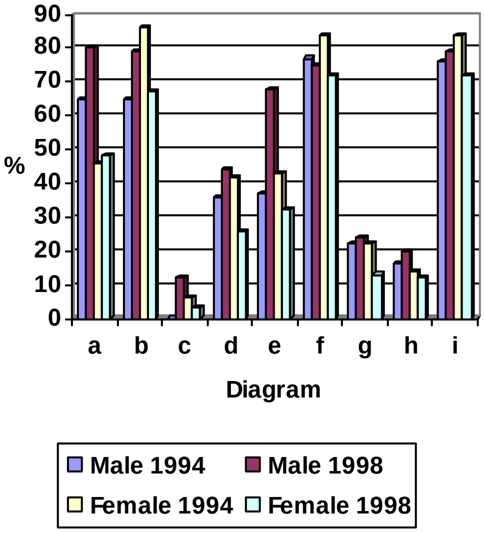


Figure 6.5 **Percentage of Correct Answers to Scenarios Regarding Sitting Posture and Positioning of the Arms and Wrists by Organisational Size**

Figure 6.6 **Percentage of Correct Answers to Scenarios Regarding Posture and Layout of Equipment by Organisational Size**

In 1994 male and female respondents had similar knowledge (44%) but in 1998 a greater proportion of males answered correctly (males 48%, females 36%) (Figures 6.7 and 6.8).



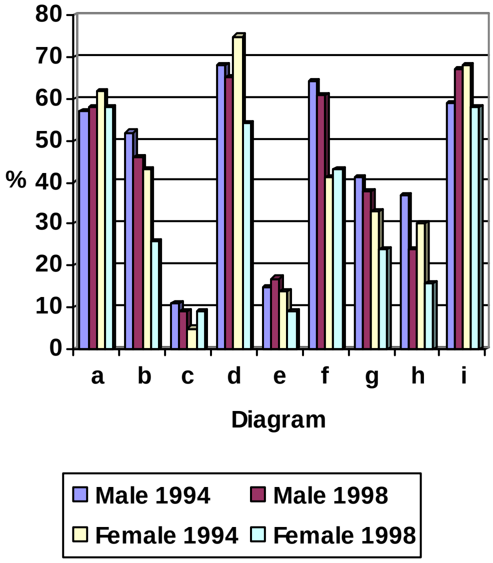


Figure 6.7 **Percentage of Correct Answers to Scenarios Regarding Sitting Posture and Positioning of the Arms and Wrists by Gender**

Figure 6.8 **Percentage of Correct Answers to Scenarios Regarding Posture and Layout of Equipment by Gender**

Ergonomic knowledge was higher among people working in non-management positions. While previously, a slightly higher proportion of managers answered correctly, a 10% decrease in correct answers from managers reversed this in 1998 (managers 46%, non-managers 43% 1994; managers 36%, non-managers 41% 1998) (Figures 6.9 and 6.10).

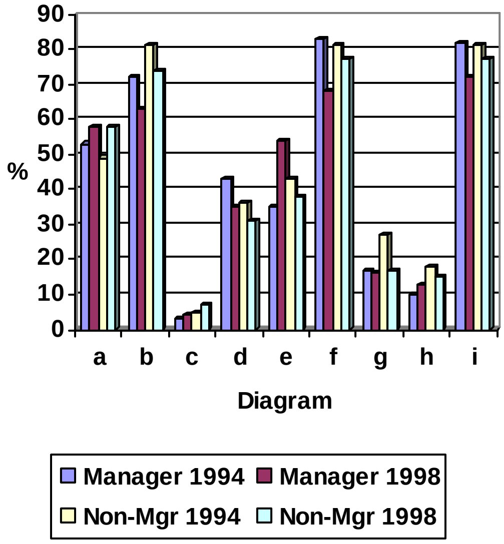


Figure 6.9 **Percentage of Correct Answers to Scenarios Regarding Sitting Posture and Positioning of the Arms and Wrists by Position**

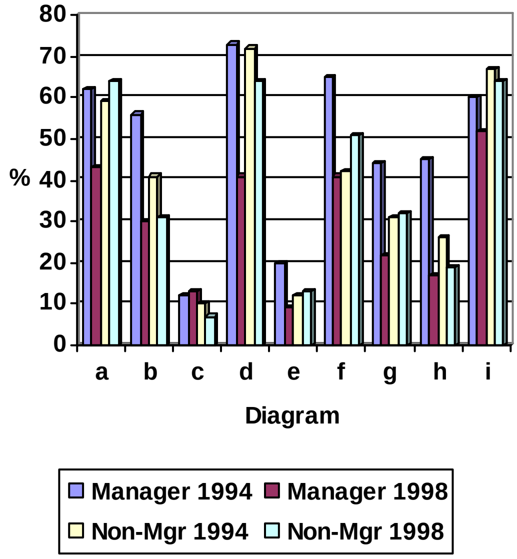


Figure 6.10 **Percentage of Correct Answers to Scenarios Regarding Posture and Layout of Equipment by Position**

Findings Relating to Priority given to Ergonomics

Respondents reporting that their organisation had a written policy on procedures related to ergonomics and computer use increased considerably over the period, from 19% to 30% (Table 6.9). However, almost an equal proportion replied that their organisation did not have such a policy and many continued to be unsure.

Table 6.9 **Number and Percentage of Respondents Reporting whether their Organisation had a Written Policy on Ergonomics and the Use of Computers**

	1994		1998	
Response	**N**	**%**	**N**	**%**
Yes	21	19	29	30
No	44	40	28	29
Unsure	46	41	38	39
Non-responses	0	0	2	2
Total	111	100	97	100

Public-sector organisations were more likely to have a policy on ergonomic computer use than privately owned firms and in both periods this was statistically significant ($p < 0.05$). Over the period there was a 19% increase in respondents from government organisations who reported that their organisation had a written policy (private 7%, public 24% 1994; private 11%, public 43% 1998). There was also a 13% increase in respondents from medium–large-sized firms who believed their organisation had a written policy on ergonomic computer use (small 23%, medium–large 18% 1994; small 27%, medium–large 31% 1998).

Other questions designed to assess institutional priority given to ergonomic computer use asked whether respondents were required to report to their organisation incidents of computer-related disorders, whether their organisation kept records of such incidents, and whether the organisation had a written policy on procedures related to rehabilitation of employees affected by computer-related disorders. In 1998 a lower proportion of respondents reported that they were required to report computer-related disorders (66% 1994; 58% 1998) and a high 29% were unsure (Table 6.10).

Table 6.10 Number and Percentage of Responses Reporting Whether Computer Users were Required to Report Incidents of Computer-Related Disorders

	1994		**1998**	
Response	**N**	**%**	**N**	**%**
Yes	73	66	56	58
No	5	4	10	10
Unsure	31	28	28	29
Non-responses	2	2	3	3
Total	111	100	97	100

While in 1994 a considerably higher proportion of respondents from medium–large organisations than from small ones replied that they were required to report computer-related disorders, a 9% decrease within medium–large firms gave similar results in 1998 (small 54%, medium–large 71% 1994; small 59%, medium–large 62% 1998). Public-sector organisations continued to perform better than privately owned ones (private 52%, public 71% 1994; private 49%, public 66% 1998).

There was also a decrease in the percentage of respondents (43% 1994; 39% 1998) who reported that their organisation kept records of computer-related disorders, and a high 40% in both periods continued to be unsure (Table 6.11).

Table 6.11 Number and Percentage of Responses Reporting Whether Organisation Kept Records Relating to Computer-Related Disorders

	1994		1998	
Response	**N**	**%**	**N**	**%**
Yes	48	43	38	39
No	17	15	18	19
Unsure	44	40	39	40
Non-responses	2	2	2	2
Total	111	100	97	100

Although there was a 10% improvement within privately owned firms, public-sector organisations continued to be more likely to keep records of computer-related disorders than private ones (private 15%, public 53% 1994; private 25%, public 48% 1998) and this was statistically significant in both periods ($p < 0.01$). There was a 17% improvement within small-sized organisations but again a 9% decrease for medium–large-sized organisations (small 27%, medium–large 50% 1994; small 44%, medium–large 41% 1998).

There was also a small decrease in respondents reporting that their organisation had a written policy on procedures related to rehabilitation of employees affected by computer-related disorders, and a similar high percentage remained unsure (Table 6.12).

Table 6.12 Number and Percentage of Responses Reporting whether their Organisation had a Written Policy on Rehabilitation of Employees Affected by Computer-Related Disorders

	1994		1998	
Response	**N**	**%**	**N**	**%**
Yes	26	23	19	19
No	22	20	20	21
Unsure	60	54	53	55
Non-response	3	3	5	5
Total	111	100	97	100

While there was a slight improvement within privately owned firms, public-sector organisations continued to be more likely to have such a policy than private ones (private 4%, public 31% 1994; private 8%, public 30%) and this was statistically significant in both periods ($p < 0.01$). Medium–large-sized firms continued to be more likely to have a rehabilitation policy than small-sized firms, with little change over the period (small 15%, medium–large 27% 1994; small 13%, medium–large 27% 1998).

The percentage of respondents who believed their organisation emphasised the importance of keeping ergonomic work practices in mind when using computers increased 18% from 32% in 1994 to 50% in 1998 (Table 6.13).

Table 6.13 Number and Percentage of Respondents Reporting whether their Organisation Stressed the Importance of Ergonomic Work Practices

Response	1994		1998	
	N	**%**	**N**	**%**
Yes	35	32	48	50
No	72	65	39	40
Non-responses	4	3	10	10
Total	111	100	97	100

Public-sector organisations were more likely to place emphasis on ergonomic work practices than private-sector ones and in 1998 this difference was statistically significant ($p < 0.01$). The percentage of respondents from public-sector organisations who reported that their organisation placed emphasis on ergonomics had doubled over the period (private 21%, public 36% 1994; private 27%, public 72% 1998). This change was also reflected in relation to organisational size, with twice the proportion of respondents from medium–large-sized firms in 1998 reporting that their organisation stressed the importance of keeping ergonomic work practices in mind than in 1994 (small 35%, medium–large 32% 1994; small 40%, medium–large 64% 1998).

The proportion of respondents reporting that their organisation had specified a person responsible for ensuring that employees followed ergonomic practices also increased (11%) (Table 6.14).

Table 6.14 Number and Percentage of Responses Reporting whether a Person had been Delegated Responsibility for Ensuring Ergonomic Practices were Followed

Response	1994		1998	
	N	**%**	**N**	**%**
Yes	30	27	37	38
No	71	64	48	50
Non-response	10	9	12	12
Total	111	100	97	100

Public-sector organisations were more likely to have delegated responsibility for ensuring employees followed ergonomic practices than private-sector firms (private 12%, public 36% 1994; private 19%, public 57% 1998) and in 1998 this difference was also statistically significant ($p < 0.01$). Over the period there was a 21% increase in respondents from public-sector organisations who reported that their organisation had someone charged with responsibility for ensuring ergonomic computer use. Medium–large-sized firms continued to be more likely to have delegated responsibility than small-sized firms, with a 21% increase also in reporting from medium–large firms (small 18%, medium–large 33% 1994; small 24%, medium–large 54% 1998). In 1998 the association between delegation of responsibility and size of organisation was statistically significant ($p < 0.01$).

As reported in Table 6.15, the percentage of respondents who believed ergonomics were given sufficient priority within their organisation increased by 14% to 41% over the four years. This improvement aligns with the fact that higher percentages of organisations had a written policy on ergonomic computer use, placed emphasis on the importance of ergonomic work practices when using a computer, and had delegated a person responsible for ensuring ergonomic work practices were followed, suggesting that more priority was being placed on ergonomic computer use. However, it is noteworthy that over half still believed ergonomics were not being given sufficient priority.

Table 6.15 Number and Percentage of Respondents reporting whether Ergonomic Principles related to Computer Use were given Sufficient Priority within their Organisation

Response	1994		1998	
	N	%	N	%
Yes	30	27	40	41
No	71	64	49	51
Non-responses	10	9	8	8
Total	111	100	97	100

In both periods males were more likely than females to believe sufficient priority was given to ergonomic computer use (males 35%, females 27% 1994; males 54%, females 41% 1998), which is possibly in accordance with males being more likely to take rest breaks and to spend less than half the time working at a computer than female respondents. Priority reported by males had increased by 19% and by females, 14% over the period. Managers were more likely to believe sufficient priority was given than non-managers in 1994, but a 19% increase in non-managers reporting sufficient priority reversed this in 1998 (managers 35%, non-managers 27% 1994; managers 42%, non-managers 46% 1998). There was a similar increase in reported priority among small and medium–large-sized firms (14% and 17% respectively) and at both times respondents from medium–large-sized firms were more likely to believe sufficient priority was given to ergonomics than those from small firms (small 27%, medium–large 30% 1994; small 41%, medium–large 47% 1998). In 1994, a similar proportion of people from private and public-sector organisations believed ergonomics was given sufficient priority but in 1998 there was a 21% increase in those from public-sector firms reporting sufficient priority (private 32%, public 30% 1994; private 31%, public 51% 1998).

Summary of the Findings

As in the previous studies, the majority of respondents were females, aged between 28 and 37 years, working within a public-sector organisation in a non-management position. Over the four-year period the notable changes in profile were an increase in the proportion of female respondents and those from private-sector firms. Also, the proportion of male respondents who were managers had increased while that of female respondents who were managers had decreased.

By 1998 computer users were spending more time working at their computer. Daily computer use had increased by approximately 12%, with the greatest increases within private-sector and medium–large-sized firms and among females and non-managers. 63% of respondents used a computer for four or more hours per day compared to 49% in 1994; and in 1998 a clear majority of those using a computer for extended periods were non-managers and female. The increased hours of daily computer use were linked to increased health problems such as eye strain, neck tension and severe headaches, which often result from the non-application of ergonomics.

There was a marked change in reported awareness of ergonomics over the period, with 59% of respondents in 1998 replying that they were aware of ergonomic principles relating to computer use. This was a 16% improvement as previously the majority of respondents answered that they were not aware. There was a considerable increase in reported awareness within public-sector and small-sized organisations. The findings also highlighted a change in the difference in reported awareness between managers and non-managers over the period, with reported awareness among managers decreasing by 1% and among non-managers, increasing by 30%. While at both times a greater proportion of female respondents reported being aware of the ergonomic principles, the largest increase in reported awareness over the period was among male respondents.

Although in both years most respondents learnt how to use a computer on the job, there was only a small reduction (7%) in people who had never attended an education/training session on ergonomic computer use provided by their organisation. However, in accordance with the increase in reported awareness, there was also a decrease (13%) in respondents who believed they needed to spend more time in such training. In addition, there was a 17% increase in people who had learnt to operate a computer in an educational institution, increasing the likelihood of ergonomic instruction via the institution and, although the majority had not read any documents containing information on ergonomics and computer use in the preceding 12 months, there was a 15% increase in the proportion who had, further supporting the reply by the majority that more training in ergonomics was not required. It is noteworthy that the proportion of respondents from public-sector organisations who replied that they had never attended ergonomic training provided by their employer decreased by 15% over the period. On the other hand, a high 46% of respondents still believed they needed more time in training/update sessions related to ergonomics and computer use.

The percentage of correct answers to the scenarios relating to posture and positioning of the arms and wrists and the layout of equipment had not improved (36% 1994; 35% 1998) and indicated that the majority of respondents still had limited knowledge of the appropriate ergonomic practices. Male respondents and those in non-management positions and from medium–large-sized firms performed best. Respondents from private-sector and public-sector organisations had similar knowledge. Correct answers from managers, small-sized and private-sector firms decreased by 10% or more over the period; those from female respondents decreased by 8%.

There was an understanding of the need to take rest breaks away from the computer and a 10% increase in respondents who reported taking such breaks. The majority of people not taking breaks were female and non-managers from medium–large, private-sector organisations, possibly due to the lower priority ergonomics was given within private-sector firms and a higher load of computer-related work for female, non-manager employees.

Although the majority of respondents (51%) still believed insufficient priority was given to ergonomic principles related to computer use within their organisation, a greater proportion perceived that sufficient priority was given. There was a favourable increase (18%) in the proportion of respondents who replied that their organisation emphasised the importance of keeping ergonomic work practices in mind when using a computer, particularly within medium–large-sized and public-sector organisations, where those reporting favourably had doubled (medium–large 32%, public 36% 1994; medium–large 64%, public 72% 1998). There was also an increase in reports that a person had been delegated responsibility for ensuring that ergonomic work practices were followed and that the organisation had a written policy on ergonomic computer use – again, particularly within medium–large and public-sector organisations.

On the other hand, there was a decrease in the proportion of people who replied that they were required to report incidents of computer-related disorders (66% 1994; 58%

1998) and many were unsure (28% 1994; 29% 1998). Also, a smaller proportion of people believed their organisation kept records of computer-related disorders (43% 1994; 39% 1998) and fewer believed their organisation had a policy on the rehabilitation of employees affected by computer-related disorders (23% 1994; 19% 1998). While there was some slight improvement within small-sized and private-sector firms they continued to have a lesser result in these areas than medium–large-sized public-sector organisations.

Generally the large percentages of ‘unsure’ responses to questions seeking to determine whether organisations had written policies on ergonomic procedures (41% 1994; 39% 1998) and the rehabilitation of employees affected by computer-related disorders (54% 1994; 55% 1998) indicated that, even if these documents existed, they were rarely discussed and were not readily available to or accessed by computer users. The high proportions of ‘unsure’ responses to questions asking whether respondents were required to report incidents of computer-related disorders and whether the organisation kept records of such disorders also indicated that these matters were not often talked about. It is disturbing to find that, within private-sector firms in particular, a large proportion of respondents either did not believe their organisation had or were unaware whether their organisation had, a written policy on ergonomic computer use, records of computer-related disorders, or a written policy on rehabilitation of employees affected by computer-related disorders. Private-sector firms also appeared to place less emphasis on ergonomic work practices and to delegate responsibility for ensuring ergonomic computer use than public-sector organisations.

Respondents in 1998 did report greater awareness of ergonomics, attendance at ergonomic education/training sessions, reading of ergonomic material, and practice of taking rest breaks. They also indicated an increase in emphasis on ergonomic work practices, and an increase in perception of priority given to them within organisations. However, the findings in Study V also suggest that managers and computer operators within organisations still required more information about the firm's policies in relation to ergonomics and computer use and more training in ergonomic procedures to increase their knowledge and application of ergonomic computer use if they were to work productively in a safe, healthy environment. The differences between types of organisation remained, with private-sector firms – compared with public-sector ones – having significantly fewer policies, records and procedures related to ergonomic computer use.

CHAPTER 7

FINDINGS: STUDY VI

Study VI extended the concepts introduced in Study IV by taking up such matters as personality and attitude to compliance, and the impact of any health problems, as it gave further attention to the importance of knowledge of, priority given to and the work environment in relation to the application of ergonomics to computer use. As shown in Figure 7.1, the study sought to determine the influence of ergonomic knowledge, personality and attitude to Risk-taking, and cultural factors of the work environment, on the application of ergonomic principles and, in turn, on the psychological and physical health of managers and other computer operators.

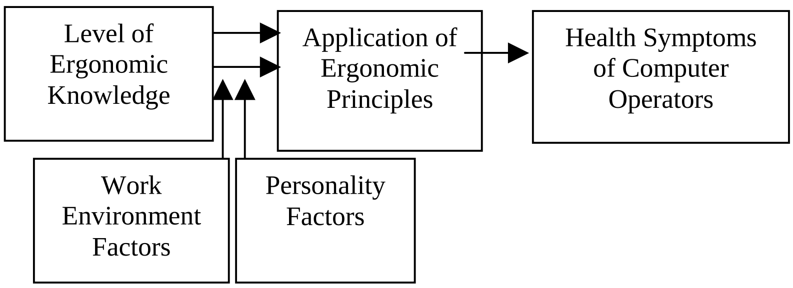


Figure 7.1 Theoretical Model of the Relationships between Ergonomic Knowledge, the Application of Ergonomic Knowledge and Health Symptoms

Additional questions seeking further data about the individuals and their jobs were included in the questionnaire. Other questions were omitted, more specifically related to the priority ergonomic computer use was given by the organisation, such as whether it had written policies on ergonomics, kept records of computer-related disorders and placed emphasis on the importance of ergonomic work practices.

Study VI was conducted within one large private-sector organisation. 50 questionnaires were distributed via the firm's internal mail system and 39 useable questionnaires were returned, giving a response rate of 78%. Table 7.1 provides a profile of the respondents, indicating their age, gender, position within the organisation and highest level of educational qualifications. The majority were males, aged between 26 and 35 years, who had university-level education, and worked in a non-management position.

Table 7.1 Number and Percentage of Respondents by Age, Gender, Position within Organisation and Educational Qualifications

Variable	Category	Number	Per cent
Age	16–25 years	1	3
	26–35	12	31
	36–45	10	25
	46–55	11	28
	Over 55 years	5	13
Gender	Male	27	69
	Female	12	31
Position	Manager	9	23
	Non-manager	29	74
Education	Secondary	12	31
	DTAFE	4	10
	University	23	59

A comparison between gender and position of respondents showed that 33% of males were managers and none of the females were managers and this was statistically significant (Chi Square = 5.977, df = 2, $p < 0.05$). 89% of managers and 48% of non-managers, and 63% of males and 50% of females had university-level education. 92% of those in the 25–35 year age bracket had attended university.

The number of years that respondents had been working in their current position ranged from 3 months to 28 years 9 months, with a mean time of 6 years 8 months.

The majority (51%) worked between 38 and 40 hours per week; 23% worked between 44 and 46 hours and 18% worked more than 46 hours per week. Of those who worked more than 40 hours per week, 59% were male and 17% female, and 67% were managers and 38% non-managers; of those who worked more than 46 hours per week, 22% were male, 8% female, 11% were managers and 17% non-managers.

Other biographical information, regarding whether the person wore spectacles and whether these were bifocals, their physical fitness, and perceptions of their current position within the organisation, is summarised in Table 7.2. Most respondents wore glasses, and believed they had healthy levels of fitness and good jobs that were secure and adequately remunerated.

Table 7.2 Reporting of Respondents in Relation to Wearing Glasses, Fitness Levels, and Perceptions of their Position within the Organisation

Variable	Category	N	Per cent
Glasses	Yes	22	56
Bifocals	Yes	8	21
Fitness level	Low	3	8
	Medium	22	56
	High	11	28
Position security	Insecure	13	33
	Secure	23	59
	Very secure	3	8
Position payment	Low paid	4	10
	Adequately paid	29	74
	Highly paid	6	15
Position prestige	Low prestige	5	13
	Medium prestige	28	72
	High prestige	6	15

In the 26–35 age bracket only 17% wore glasses and none had bifocals. Most people (73%) who wore glasses were aged between 46 and 55 years. 46% of those with glasses wore bifocals. More males (59%) than females (50%) wore glasses and had bifocals (males 22%; females 17%). More non-mangers (59%) than managers (44%) wore glasses but more managers than non-managers had bifocals (managers 33%, non-managers 14%). A greater proportion of people who wore glasses reported neck tension and aches or pain in the shoulders than those who did not (Table 7.3).

Table 7.3 Percentage of Respondents Wearing Glasses who Reported Neck and Shoulder Problems

	Glasses		Bifocals	
Symptom	**Yes**	**No**	**Yes**	**No**
Neck tension	77%	63%	88%	68%
Aches or pain in shoulders	91%	50%	88%	74%

85% of respondents reported that their fitness levels were medium or high, with the majority (56%) having ‘medium’ fitness. 63% of males and 42% of females reported they had a medium fitness level. Less than 10% of respondents believed they had ‘low’ levels of fitness. 91% of people aged between 46 and 55 years and 100% of managers and 83% of non-managers replied that they had medium or high fitness levels. The majority of respondents (59%) also reported that they exercised for 30 minutes or more at least 3–4 days per week, which is beneficial for both physical and psychological health. 75% of females and 52% of males, and 78% of managers and 52% of non-managers exercised 3–4 or more days per week. However, 21% of respondents exercised less than once a week.

Although for some there was doubt about the security of their position, overall the respondents had positive perceptions of their work. The same proportion of males and females (67%), and 78% of managers and 62% of non-managers, believed their position was ‘secure’ or ‘very secure’. All the females and 85% of the males, and all the managers and 90% of non-managers, thought their position was ‘adequately’ or ‘highly’ paid. 89% of males and 83% of females, and 89% of managers and 86% of non-managers, believed their position had ‘medium’ or ‘high’ prestige.

The mean daily use of computers was 5.47 hours, with a range of 1.5–10 hours per day at work, and 0–5 hours at home. The greatest proportion of respondents reported that they used the computer for 5 hours per day at work; 72% of respondents had average daily computer use above 4 hours (4 hours is the maximum hours of daily use recommended). In addition, 19% of males and 42% of females, and 35% of non-managers (managers 0%) used a computer for 2 or more hours each day at home. The mean daily use for female computer operators was 6.00 hours and for male operators 5.24 hours; the mean for managers was 3.78 hours and for non-managers 6.02 hours.

By far the majority of respondents reported that they had learnt to use a computer on the job (69%), with only 18% reporting that they had learnt via an educational institution. More males (85%) than females (33%) learnt on the job and this was statistically significant (Chi Square 10.664, df = 2, $p < 0.05$). Also, 89% of managers and 66% of non-managers learnt to use a computer at work.

Findings in Relation to Ergonomic Knowledge and Behaviour

Respondents were again provided with the definition of ergonomics from Australian Standard AS1837 (1976, p. 6) and informed that ergonomics could be applied to aspects of the work environment, seating, workstation and job design. They were then asked if they were aware of the ergonomic principles that related to the use of computers. The majority of respondents replied that they were aware of the ergonomic principles (Table 7.4).

Table 7.4 Number and Percentage of Respondents Reporting whether they were Aware of the Principles of Ergonomics relating to the Use of Computers

Response	**N**	**Per cent**
Yes	24	62
No	15	38
Non-responses	0	0
Total	39	100

While not statistically significant, a higher percentage of respondents who worked in a management position, were female, had TAFE-level education and had learnt to operate a computer in an educational institution reported being aware of the recommended adjustments and layouts. Respondents who had learnt their computer skills at home were least likely to be aware.

Respondents were also asked whether they had attended an educational program/training session provided by their organisation that included information on ergonomics and computer use and how much time had been spent in such sessions in the previous 12 months. Consistent with the previous studies, the majority had not attended such training provided by their organisation (Table 7.5).

Table 7.5 Number and Percentage of Respondents Reporting Attendance at Education/Training Sessions Provided by their Organisation

Frequency	N	Per cent
In the past 12 months	1	3
In the past 2 years	2	5
Over 2 years ago	9	23
Never	27	69
Non-responses	0	0
Total	39	100

A comparison of attendance with gender and position showed that a higher proportion of females and people working in a management position had received training in ergonomics but this was not statistically significant ($p > 0.05$).

Respondents who had attended training/update sessions in relation to ergonomics and the use of computers provided by the organisation in the preceding 12 months were asked how much time had been spent in such training. The only respondent who reported attending training indicated that the time spent was one hour. Most respondents believed they needed to spend more time in such training (Table 7.6). The large majority of respondents had not read any material that included information on ergonomics and computer use in the preceding 12 months (Table 7.7).

Table 7.6 Number and Percentage of Respondents Reporting whether they Believed they Needed More Time in Training/Update Sessions

Response	N	Per cent
Yes	21	54
No	16	41
Non-responses	2	5
Total	39	100

Table 7.7 Number and Percentage of Respondents Reporting whether they had Read Documents on Ergonomic Computer Use

Response	N	Per cent
Yes	4	10
No	35	90
Non-responses	0	0
Total	39	100

A test for association between gender and having read material on ergonomic computer use showed that a higher proportion of female than male respondents had read ergonomic material and this was statistically significant (Chi Square = 4.093, df = 1, $p < 0.05$). A similar proportion of managers and non-managers had read such material but this was not statistically significant ($p > 0.05$).

The two questions containing scenarios in relation to sitting posture and positioning of the arms and wrists and the layout of equipment were again included in the questionnaire but in an updated form, using photographs rather than drawn diagrams. An additional scenario relating to mouse use was added as the incidence of mouse use had increased considerably and related health problems were of concern. Respondents were asked to study each photograph, indicate whether accepted ergonomic principles were being applied and give the reason for their answer. A total of nineteen photographs were included. The average of correct answers received across all scenarios was 50%. While higher than in Studies I to V (35%, 42%, 41%, 35%, 36% respectively), indicating an improvement in the understanding of ergonomic computer use, this result still suggests inadequate knowledge. Figures 7.2 and 7.3 show the correct answers received.

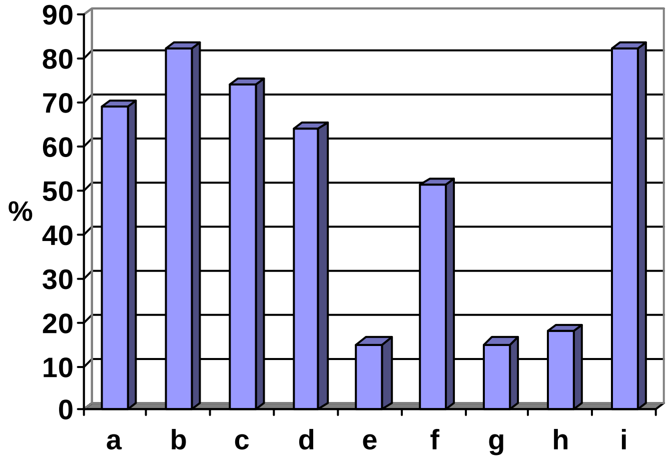


Figure 7.2 Percentage of Correct Answers to Scenarios Regarding Sitting Posture and Positioning of the Arms and Wrists

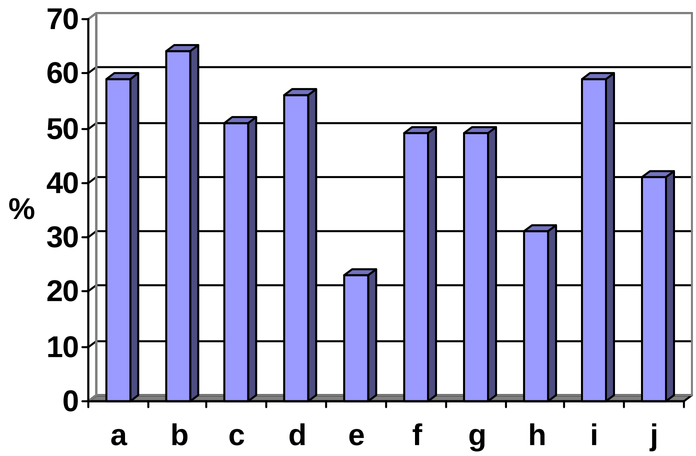


Figure 7.3 Percentage of Correct Answers to Scenarios Regarding Posture and the Layout of Equipment

In the first question respondents were most knowledgeable about scenarios (b), (i) and (c), which showed the computer operator not using the backrest, sitting on the front edge of the chair with back not supported, and sitting in a slouched position with back not supported and the seat of the chair cutting into the backs of the knees.

(b) (i) (c)

Figure 7.4 Diagrams (b), (i) and (c) Survey Question Number 12

The majority of respondents also answered scenarios (a), (d) and (f) correctly. These showed the operator using a chair that is positioned too low, reaching up to the keyboard, and crossing ankles under the chair. Again, each of these three scenarios should be easily recognised by computer users as depicting poor posture, and none of the photographs were answered correctly by all respondents. Scenario (e), showing the operator sitting with a rounded back and arms lying along the desk with wrists flexed back, and scenarios (g) and (h), showing the recommended ‘upright posture’, were answered correctly by less than 20% of respondents.

As indicated in Figure 7.3, in relation to posture and the layout of equipment, respondents were most knowledgeable about (b), (a) and (i). Scenario (b) shows the computer operator looking upwards towards a document holder that was positioned too high, scenario (a) shows the operator sitting too far away from the VDU and in scenario (i) the VDU is positioned too low.

(b) (a) (i)

Figure 7.5 Diagrams (b), (a) and (i) Survey Question Number 13

Overall, a greater proportion of males (55%) than females (39%) (Figures 7.6 and 7.7), and a greater proportion of managers (61%) than non-managers (46%) (Figures 7.8 and 7.9), answered correctly.

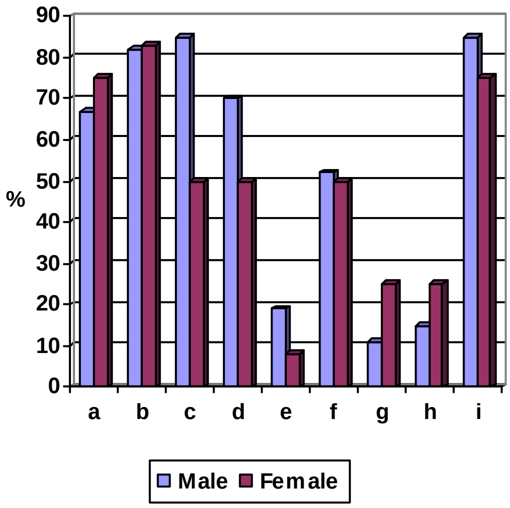


Figure 7.6 Percentage of Correct Answers to Scenarios Regarding Sitting Posture and Positioning of the Arms and Wrists by Gender

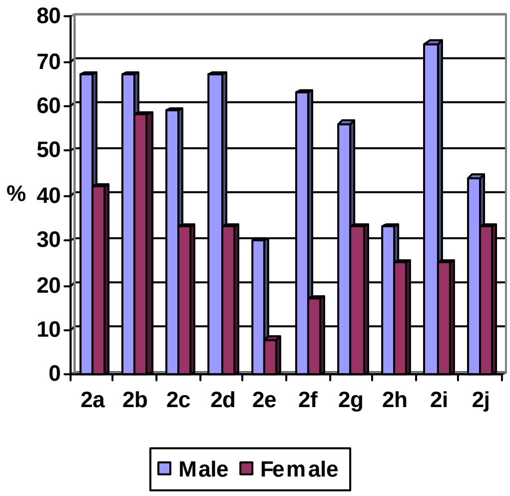
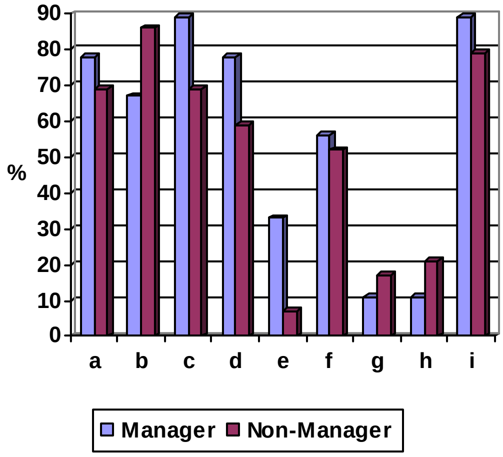


Figure7.7 Percentage of Correct Answers to Scenarios Regarding Posture and Layout of Equipment by Gender



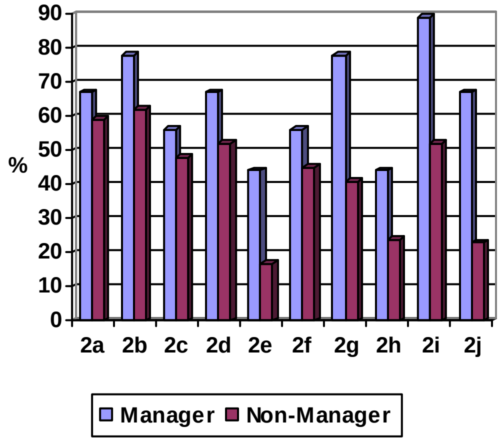


Figure 7.8 Percentage of Correct Answers to Scenarios Regarding Sitting Posture and Positioning of the Arms and Wrists by Position

Figure7.9 Percentage of Correct Answers to Scenarios Regarding Posture and Layout of Equipment by Position

When asked whether they applied ergonomic principles relevant to the use of computers to their work situation the majority (54%) replied that they did not. 33% of people in a management position said they applied ergonomics compared to 52% in a non-management position. The greatest proportion of respondents (33%) gave the reason for their non-application as 'Not aware of the ergonomic principles'. Others forgot (8%), had no health symptoms so did not bother (8%), were too busy (5%), or thought it unimportant (3%). Of the respondents reporting that they did apply ergonomic principles to their work, the highest proportion (28%) indicated that they did so because they knew they should, 10% because they had experienced health problems, and 5% because it was expected by the organisation.

Respondents were asked how they applied their knowledge of ergonomics to their work situation. The greatest proportion indicated that ergonomics was applied to considerations of workstation layout and in making adjustments to the computer furniture and equipment. However, only 23% of respondents answered this question, indicating that many were unsure. The responses received are summarised in Table7.8.

Table 7.8 Responses Reporting how Respondents Applied their Knowledge of Ergonomics to their Work Situation

How Knowledge was Applied	N*
In layout and adjustments to furniture and equipment	7
In seating, 5-legged chair, back support	2
Using computer for short period, taking breaks from computer work	2
Glare reduction on computer screen	2
In posture	1
By stretching	1

*** N** indicates the number of times the item was identified.

87% of respondents reported that they did not believe ergonomic principles in relation to the use of computers were being given sufficient priority within their organisation. When asked to elaborate many people took the opportunity to add their comments. The comments received indicated that, while the issue of safety was important within the organisation, ergonomic principles were “not reinforced compared to other issues” and employees were generally “not aware of any training” and had “not visibly seen anything to support or educate”. The following comments are representative of those received:

Safety is a top priority –- not ergonomics.

Safety efforts concentrate more on physically active jobs.

Rarely mentioned, too busy focussing on other safety and production issues.

Only when there is a complaint or injury.

It is an assumption, I believe, that all workers should know their limitations and when they should take a break – some do/some don't.

I believe ergonomics are viewed as too difficult to properly control within my organisation.

Documentation would be available from OH&S Dept if I had thought to ask for it. Ergonomic desks are expensive, training is expensive. When people get educated they can cost the company.

Company encourages people to do back and neck exercises during breaks away from computer work.

Information is available when you ask. Can get ergonomic assessments carried out when you ask.

Ergonomic type furniture not provided, chair only provided.

These comments suggest that, while safety was regarded as an important issue within the organisation, the ergonomic use of computers was not considered to be part of the safety at work issue. The inference is that safety in relation to production was important but in relation to computer use it was largely forgotten. Respondents indicated that ergonomic information and guidance was available from their occupational health and safety department but they had to remember to ask for it, suggesting that it was not given much emphasis within their organisation.

92% of respondents replied that they took rest breaks away from the computer and, when asked how often the breaks should be taken, the greatest proportion (36%) reported taking a break approximately every one hour, which is the recommended length of time (PSA Inc 1990, p. 9). However, 20% of respondents took breaks after two or more hours, which is of concern as such prolonged computer use without a break could result in health problems. To indicate their understanding of the relevance of rest breaks away from the computer, respondents were asked what activities they usually undertook during these breaks. There was a high response rate to this question, with almost every person listing activities that were ergonomically sound. Most respondents recognised the need to get up and walk around. Table 7.9 summarises the responses received.

Table 7.9 Activities Respondents Believed could be Undertaken in Rest Breaks

Activity	**N***
Walk, go outside to the plant	25
Drink/toilet/cigarette, meal break	15
Social chats, conversation	7
Stretching, exercise	4
Photocopying, filing	4
Writing, reading, other clerical duties	4
Meetings, work discussions	3
Standing	2
Look into distance	1

*** N** indicates the number of times the item was identified.

Respondents were also asked whether they took micro-breaks, or rest pauses, when using the computer. The majority (54%) replied that they did take micro-breaks. However, a high 72% reported that they never carried out pause gymnastics or exercise when using a computer and 33% reported that they 'rarely' stopped and rested their eyes with long distance viewing when doing computer work. While not statistically significant ($p > 0.05$), of those respondents not taking rest breaks, micro-breaks, carrying out pause gymnastics or resting their eyes, many reported being ergonomically aware.

Log-binomial regression analysis was conducted to determine the impact of respondents' ergonomic knowledge on their application of ergonomic principles to computer use. In the final multivariate model,[48] variables related to gender and reported awareness of ergonomics were statistically significant ($p < 0.05$) but the variable 'Diagpost', for the scenarios regarding posture and the layout of equipment, was not, indicating no association with the application of ergonomics. The relative risk for gender showed that females were 1.7 times more likely to apply ergonomics than males; the relative risk for awareness indicated that respondents who replied that they were aware of the ergonomic principles were 8.5 times more likely to apply ergonomics than those who said they were not (Table 7.10). Interestingly, whether respondents had read material on ergonomics in the preceding 12 months, and the correct answers to the two questions containing the scenarios designed to test knowledge of ergonomics, did not have a p-value less than 0.2 in the univariate analyses and, therefore, were not included in the final model, indicating they did not affect whether ergonomic principles were applied.

Table 7.10 Ergonomic Knowledge and Application of Ergonomics

Variable	**Relative Risk**	**Confidence Limits**		**P-value**
Gender (females vs males)	1.7635	1.1124	2.7957	0.0158
Awareness (yes vs no)	8.5436	1.1796	61.8790	0.0337
Diagpost	1.1179	0.9500	1.3153	0.1794

48 Univariate analysis uses a single dependent measure, whereas multivariate analysis uses multiple variables in a single relationship or set of relationships (Hair et al. 1995, p. 2).

Findings Relating to Compliance

Questions were asked to determine whether respondents were compliant or non-compliant only in relation to the application of ergonomics to computer use, or whether they were generally compliant or non-compliant in their behaviour relative to health promotion advice.

92% of respondents replied that they were aware that exposure to the sun could cause health problems such as skin cancer. In addition, the highest proportion never sun-baked (61%) and frequently wore a hat (33%), sunscreen (31%) and appropriate clothing (41%) when going outdoors into the sun. 97% replied that they were aware that smoking cigarettes could cause health problems such as lung cancer and heart disease and the large majority (90%) did not smoke cigarettes. Of the three respondents who did, one never smoked indoors at home, one did so occasionally, and the other did so very frequently. The number of cigarettes smoked was reported as 6, 25 and 43 per day. 95% of respondents were aware that excessive drinking of alcohol could cause health problems and most reported that they rarely or never drank more than the recommended amount (70%), very frequently had two alcohol free days each week (69%), and that they never drove a motor vehicle (72%) and never operated machinery or undertook activities in potentially hazardous situations (92%) after having had more than the recommended number of alcoholic drinks. The details provided in Table 7.11 suggest that the respondents were generally compliant in their behaviour.

Table 7.11 Compliance Scale: Responses relating to Sun Exposure, Smoking Cigarettes and Drinking Alcohol

Question	N	Never %	Rarely %	Occasion-ally %	Fre-quently %	Very fre-quently %	Miss-ing %
How often do you sun bake?	39	61	31	5	0	0	3
How often do you wear a hat when you go out into the sun?	39	5	15	21	33	23	3
How often do you use a sunscreen regularly when outdoors?	39	8	18	23	31	18	3
How often do you cover up with appropriate clothing when you go into the sun?	39	0	10	15	41	31	3
How often to you smoke cigarettes?	39	90	0	3	0	5	1
How often do you smoke cigarettes indoors at home?	39	92	0	3	0	3	3
How often have you tried to give up smoking cigarettes?	39	87	5	0	0	3	5
How often do you drink more than the recommended standard alcoholic drinks per day?	39	26	44	26	0	3	3
How often do you have at least two alcohol free days each week?	39	8	5	3	13	69	3
How often would you drive a motor vehicle after having had more than the recommended number of alcoholic drinks?	39	72	21	5	0	0	3
How often would you operate machinery or undertake activities in potentially hazardous situations after having had more than the recommended number of standard drinks?	39	92	3	3	0	0	3
How often have you tried to significantly reduce drinking alcohol?	39	62	23	8	0	3	5

However, 36% of respondents continued to sun-bake, 26% never or rarely used sunscreen regularly when going outdoors and 20% never or rarely wore a hat when going out into the sun. It is also noteworthy that, even though only ‘rarely’ and ‘occasionally’, some reported driving a motor vehicle and operating machinery or undertaking other potentially hazardous activities after having had more than the recommended number of standard drinks (four per day for men and two per day for women), each of which ignores safety warnings and creates a potentially life-threatening situation.

Analysis[49] used to compare responses to the questions in the compliance scale with reported application of ergonomic principles showed that no compliance scale item was significantly related to reported application of ergonomics at the 0.05 level, indicating that there was no association between the respondents' compliance in other areas of health promotion and their compliance in relation to the application of ergonomics to their computer work.

Factor analysis conducted on the compliance scale using Varimax rotation yielded four underlying components that accounted for approximately 71% of the total variation (Table 7.12).

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[49] Fisher's exact test was used to determine any association between the two categorical variables.

Table 7.12 Rotated Factor Loadings Relating to Compliance Scale

Variable	Factor 1	Factor 2	Factor 3	Factor 4
SUNBAKE	.333	**.598**	–.226	9.815E-02
WEARHAT	–.483	–.339	6.863E–02	.361
SUNSCREN	–.268	–.250	–.137	**.804**
CLOTHING	–.459	**–.730**	–.175	1.465E-02
SMOKE	**.839**	.318	–1.071E-02	–3.297E-02
SMOKEIND	**.954**	1.619E-03	4.505E-02	1.035E-02
GIVEUPSM	–3.504E-02	**.812**	3.134E-02	–.122
DRINKMOR	–5.364E-02	.124	**.592**	.455
ALCFREED	.214	.135	2.162E-02	**.602**
ALCDRIVE	.220	–8.820E-02	**.773**	–.172
ALCMACH	–.173	7.588E-02	**.729**	2.897E-02
ALCREDUC	–.109	–6.163E-02	–1.448E-02	–1.953E-02

These factors contained items related to smoking habits, prevention of health problems, risk-taking activity, and health precautions, as follows:

Factor 1 Smoking habits
How often do you smoke cigarettes?
How often do you smoke cigarettes indoors at home?

Factor 2 Prevention
How often do you sun-bake?
How often do you cover up with appropriate clothing when you go into the sun?
How often have you tried to give up smoking cigarettes?

Factor 3 Risk-taking
How often do you drink more than the recommended standard alcoholic drinks per day?
How often would you drive a motor vehicle after having had more than the recommended number of alcoholic drinks?
How often would you operate machinery or undertake activities in potentially hazardous situations after having had more than the recommended number of standard drinks?

Factor 4 Health precautions
How often do you use a sunscreen regularly when outdoors?
How often do you have at least two alcohol free days each week?

The Quick Scales questionnaire (Brebner 1998) was used to determine whether there was a personality factor relevant to the respondent's attitude to risk-taking and compliant or non-compliant behaviour. It contained five subscales, measuring extroversion, emotionality, openness, conscientiousness and agreeableness, that correlate highly with those in other personality tests such as Costa and McCrae's (1992) NEO PI-R personality inventory. The subscale of extroversion seeks to determine whether the person is friendly, outgoing, self-confident, energetic, adventurous and spontaneous, or aloof and withdrawn. Emotionality (neuroticism) relates to whether the person is anxious, impatient, pessimistic, defensive and moody, or confident, contented, clear thinking and efficient. The subscale of openness assesses receptiveness to new ideas and experiences by measuring whether the person is imaginative, spontaneous, insightful, idealistic and inventive, or mild, conservative and cautious. Agreeableness relates to whether the person is trusting, sympathetic and tolerant, or autocratic, selfish, argumentative, impatient and wary. The conscientiousness subscale measures whether the person is organised, efficient, thorough, methodical and persistent, or confused, careless, distractible, lazy, absent-minded, impatient and impulsive.

For this study the main areas of interest were the measures of agreeableness and conscientiousness as they contained facets such as compliance, competence, order, dutifulness, self-discipline and deliberation, which are qualities that could indicate a person's attitude to applying ergonomic principles to their computer use. The responses to each of the five subscales are given in Table7.13, with the highest percentages of responses highlighted. Descriptive statistics for all respondents are shown in Table 7.14 and comparative means provided in Table 7.15.

Table 7.13 Responses Relating to the Personality factors of Extroversion, Emotionality, Openness, Conscientiousness and Agreeableness

Question	Not at all %	Slightly %	Less than most %	Moder-ately %	More than most %	Very much so %	Extre-mely %
Extroversion							
How lively, outgoing and extraverted are you?	3	5	18	**44**	23	8	0
How much do you prefer meeting people rather than reading, studying, or being at home?	3	8	21	**33**	21	13	3
How sociable, friendly and relaxed are you with other people?	3	3	18	**33**	33	8	3
How active, quick and responsive are you?	0	0	3	31	**51**	5	10
How easily can you tell jokes or give your opinion when you are the centre of attention?	5	3	28	**33**	13	18	0
How much do you like being at large, noisy parties with lots of people you've never met?	**28**	15	23	18	8	8	0
Emotionality							
Do you get anxious, worried or frightened?	3	23	10	**36**	28	0	0
Do you often feel moody, low spirited and negative about yourself?	5	**31**	23	23	15	3	0
Do you feel lonely, unhappy, or a bit left out of activities you would like to be part of?	21	**23**	**23**	15	15	0	3
Are you an easily affected, sensitive person whose feelings are easily hurt?	5	5	**26**	**26**	23	10	5
Do other people make you flustered, take you for granted or try to push you around?	13	15	26	**28**	13	5	0
Do you have difficulty deciding, reacting to or coping with, unexpected turns of events that demand an immediate response?	15	26	15	**36**	3	5	0
Openness							
Do you easily accept new ideas, different values, or views of what is aesthetically pleasing?	3	0	18	26	**36**	18	0
How imaginative, intellectually enquiring, and interested to try new things are you?	0	3	13	21	26	**36**	3
How open-minded, flexible in your attitudes, and interested in other cultures are you?	0	3	18	23	**28**	26	3
How easily moved, and affected by or sensitive to beautiful things are you?	0	8	15	**36**	26	13	0

Question	Not at all %	Slightly %	Less than most %	Moder-ately %	More than most %	Very much so %	Extre-mely %
How often do you want to go to new places, join new groups or try novel forms of recreation?	5	5	26	**36**	13	10	5
How often do you imagine having new experiences, or things you would like to happen, or events involving you that probably will not turn out like that?	3	15	18	**49**	13	3	0
Conscientiousness							
How often do you make sure you know what to expect, what will need to be done and how to be sure you get something right?	0	0	5	18	36	**39**	3
How often are you organised, well prepared and ready for most situations?	0	5	5	**33**	26	26	5
How often you are conscientious, careful and trustworthy?	0	0	3	10	18	**51**	18
How often do you feel motivated, looking to achieve some goal, or working to high standards?	0	0	5	18	**33**	26	15
How often do you put things in order of importance and pace your efforts in order to finish what you start?	0	5	5	**28**	**28**	26	8
Do you plan ahead, consider all the possibilities and think what the best outcome would be?	0	8	5	23	23	**39**	3
Agreeableness							
Do you think most people are honest, well-meaning and can be trusted?	5	3	10	13	**54**	15	0
How often are you careful not to be too direct or blunt in case the truth hurts someone?	3	15	8	23	**28**	21	3
How often do you consider other peoples wishes, feelings or their need for help?	0	0	5	15	**33**	31	15
How difficult do you find it is to be a little bit deceitful to manipulate things for your own ends?	0	0	8	**31**	28	21	13
Are you mostly modest, and somewhat retiring rather than telling others of your successes?	0	0	15	26	23	**36**	0
How often do you feel sorry for and willing to help someone who is poor, very old or disabled?	0	0	13	**33**	26	23	5

Table 7.14 The Quick Scales Personality Results: All Respondents

Factor Total	N	Min	Max	Mean	Std Dev
Extroversion	39	11	35	24.13	5.25
Emotionality	39	10	32	20.13	5.81
Openness	38	18	34	25.68	4.09
Conscientiousness	38	16	40	30.68	4.98
Agreeableness	39	20	36	28.74	3.28

Table 7.15 The Quick Scales: Means and Medians*

Factor	N	Mean	Median
Extroversion	1800	26.66	27
Emotionality	1800	20.23	20
Openness	1800	28.44	28
Conscientiousness	1800	28.81	29
Agreeableness	1800	27.03	2

* From Brebner 2001

The highest proportion of respondents rated themselves as being moderately outgoing and more active and social than most. However, they did not enjoy being the centre of attention and did not like large noisy parties. Although generally sensitive people, they were only moderately anxious and were unlikely to feel moody or negative about themselves. They did not feel lonely, unhappy or left out of things, other people did not make them flustered and they were able to cope with unexpected turns of events. The greatest proportion believed they accepted new ideas easily, were open-minded and flexible in their attitudes, and interested to try new things. They were only 'moderately' keen to go to new places or join new groups and to imagine having new experiences that probably would not turn out as anticipated.

In relation to conscientiousness, the replies indicated that the greatest proportion were very conscientious, careful and trustworthy. They were also likely to plan ahead and consider all the possibilities to ensure the best outcomes. It was very likely that they would make sure they knew what to expect and be motivated to achieve their goals and work to high standards. In relation to agreeableness, the majority thought most people were honest and well-meaning. Many respondents reported that they were modest and retiring and would find it difficult to be deceitful or manipulative; they would take care to consider other people's wishes, not to hurt their feelings, and to help someone if required.

The data in Tables 7.13 and 7.14 appear to confirm that the respondents were generally compliant in nature. There were higher scores on the conscientiousness and agreeableness subscales, indicating that the respondents tended to be efficient, organised people who were methodical and thorough in their approach and not lazy, impatient, absent-minded or careless. This appears to be supported by the fact that the personal quality of 'impulsiveness', which may be relevant to the non-application of ergonomics, is a facet of the emotionality scale, which scored lowest. In comparison to other samples (as provided in Table 7.15), the respondents also scored higher on conscientiousness and agreeableness. The results were similar regarding emotionality and for whatever reason lower on extroversion and openness. Overall, therefore, the responses to the personality scale indicate that the respondents were more likely than not to apply ergonomic principles to their work if they were aware of them.

Log-binomial regression analysis was conducted to determine the importance of personality in whether respondents applied ergonomic principles to their computer work. The final multivariate model included the personality factors extroversion and agreeableness and was adjusted for gender and reported awareness of ergonomics. The personality factor agreeableness was statistically significant at the 0.05 level. The variable Totala, representing the agreeableness scale, was categorised into a high score and a low score to allow easy interpretation. The relative risk indicates that respondents who scored high on agreeableness were 1.7 times more likely to apply ergonomics than those with a low score. The analysis, therefore, indicated that the personality facet of agreeableness did have an impact on whether or not the respondents applied ergonomic principles to their computer work (Table 7.16).

Table 7.16 Personality and Application of Ergonomics

Variable	Relative Risk	Confidence Limits		P-value
Gender (females vs males)	1.7236	1.1095	2.6774	0.0154
Aware (yes vs no)	8.0949	1.1992	54.6451	0.0318
Totale	1.0291	0.9863	1.0738	0.1855
Totala (high vs low)	1.7376	1.0541	2.8642	0.0303

A confirmatory factor analysis[50] showed that the factors extroversion and conscientiousness were highly correlated, as revealed in the structural equation model in Figure 7.10. The comparative fit index was close to unity, suggesting a good fit (CFI = 0.951).

[50] Confirmatory factor analysis using structural equation modeling is a technique used to validate scales for measuring specific constructs and provides a test of the goodness-of-fit for the proposed confirmatory factor solution (Hair et al. 1995, p. 646).

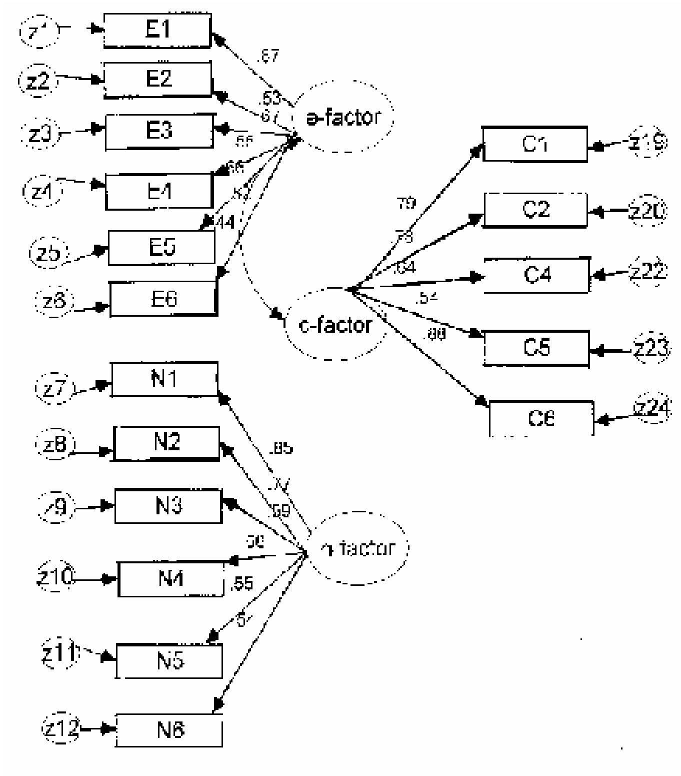

Figure 7.10 The Quick Scales: Structural Equation Model[51]

Findings in Relation to Psychological Wellbeing and Job Satisfaction

Goldberg's (1978) General Health Questionnaire (GHQ-12) was used to assess the mental health of respondents. Respondents were required to indicate how they had felt over the previous two weeks in answer to the twelve questions given in Table 7.17. The responses suggested that the majority of respondents were generally feeling happy and not experiencing psychological distress (Table 7.17). However, 38% were feeling more under strain and 43% less able to concentrate than usual. More than one-quarter had lost sleep over worry and had been feeling unhappy and depressed and less able to enjoy their day-to-day activities. The descriptive results for all respondents are shown in Table 7.18. When compared to the mean scores for psychological distress found in

[51] The subscales were coded neuroticism (N) for the emotionality subscale, extroversion (E), openness (O), conscientiousness (C) and agreeableness (A).

other studies of various occupations, the psychological distress is relatively high, as can be seen from the data by Dollard et al. (2000) provided in Table 7.19.

Table 7.17 GHQ-12 Responses from the Majority of Respondents

Question	Response	Per cent
1. Have you recently been able to concentrate on whatever you're doing?	Better than usual	3
	Same as usual	**54**
	Less than usual	43
	Much less than usual	0
2. Have you recently lost much sleep over worry?	Not at all	33
	No more than usual	**41**
	Rather more than usual	18
	Much more than usual	8
3. Have you recently felt that you are playing a useful part in things?	More than usual	15
	Same as usual	**64**
	Less so than usual	16
	Much less than usual	5
4. Have you recently felt capable of making decisions about things?	More than usual	15
	Same as usual	**77**
	Less so than usual	5
	Much less capable	0
5. Have you recently felt constantly under strain?	Not at all	10
	No more than usual	**51**
	Rather more than usual	33
	Much more than usual	5
6. Have you recently felt that you couldn't overcome your difficulties?	Not at all	**44**
	No more than usual	36
	Rather more than usual	15
	Much more than usual	5
7. Have you recently been able to enjoy your normal day-to-day activities?	More so than usual	5
	Same as usual	**67**
	Less so than usual	28
	Much less than usual	0
8. Have you recently been able to face up to your problems?	More so than usual	15
	Same as usual	**74**
	Less so than usual	10
	Much less than usual	0
9. Have you recently been feeling unhappy and depressed?	Not at all	**36**
	No more than usual	**36**
	Rather more than usual	23
	Much more than usual	5
10. Have you recently been losing confidence in yourself?	Not at all	**49**
	No more than usual	39
	Rather more than usual	10
	Much more than usual	3
11. Have you recently been thinking of yourself as a worthless person?	Not at all	**74**
	No more than usual	18
	Rather more than usual	5
	Much more than usual	3
12. Have you recently been feeling reasonably happy, all things considered?	More so than usual	8
	About the same as usual	**67**
	Less so than usual	21
	Much less than usual	3

Table 7.18 Results of the GHQ-12 Psychological Distress: All Respondents

Total	N	Min	Max	Mean	Std Dev
GHQ-12	37	6.00	28.00	12.08	5.34

Table 7.19 GHQ-12 scores from other Studies: Means and Standard Deviations*

	M	SD	N	α
Second Year Undergraduate University Students (Cotton, Dollard, De Jonge and Lewig 1999)	15.98	9.70	140	.86
NZ Prison Officers (Voges et al. 1982)	12.50	5.50	332	
SA Public Sector Workers (Macklin and Dollard n.d.)	12.25	5.77	84	.89
SA Uni. Staff (Jarrett and Winefield 1995)	12.20	5.90	1961	
SA Correctional Officers (Dollard et al. 1992)	12.18	7.22	414	.93
Community Support Workers (Dollard et al. 2000)	11.90	–	71	
SA Private Sector Workers (Macklin and Dollard n.d.)	11.76	6.29	143	.91
Social Workers (Dollard et al. 2000)	11.70	–	244	
Administrative/Clerical Workers (Dollard et al. 2000)	11.60	–	156	
SA Human Service Workers (Dollard et al. 2000)	11.53	5.83	798	.90
SA Nurses (Dollard 1996)	11.49	5.71	106	.91
British Uni. Staff (Daniels and Guppy 1992)	11.30	4.70	221	
SA Clerical Admin (O'Mara 1991)	11.25	5.20	176	
Youth Workers(Dollard et al. 2000)	11.23	–	140	
Financial Counselors (Dollard et al. 2000)	11.21	–	42	
Psychologists (Dollard et al. 2000)	11.14	–	7	
Project Workers (Dollard et al. 2000)	11.11	–	54	
Managers (Dollard et al. 2000)	10.84	–	43	
Young South Australians (Winefield et al. 1993)	10.70	5.20	8998	
Psychiatric Nurses (Janman et al. 1988)	10.30	50	349	
Young Australians (Graetz 1991)	10.10	50	970	
British Teachers (Parkes 1990)	9.13	5.21	157	
Executives (Dollard et al. 2000)	8.00	–	3	

* From Dollard et al. (2000)

Factor analysis conducted on the GHQ-12 responses using Varimax rotation resulted in the emergence of two factors, named 'general worry' and 'decisiveness', which contained the following items:

Factor 1 General worry

G1 Have you recently been able to concentrate on whatever you're doing?
G2 Have you recently lost much sleep over worry?
G3 Have you recently felt that you are playing a useful part in things?
G9 Have you recently been feeling unhappy and depressed?
G5 Have you recently felt constantly under strain?
G6 Have you recently felt that you couldn't overcome your difficulties?

G7 Have you recently been able to enjoy your normal day-to-day activities?
G10 Have you recently been losing confidence in yourself?
G12 Have you recently been feeling reasonably happy, all things considered?

Factor 2 Decisiveness
G8 Have you recently been able to face up to your problems?
G4 Have you recently felt capable of making decisions about things?

Confirmatory factor analysis confirmed these factors. There was a statistically significant correlation between the two factors as shown in the structural equation model (Figure 7.11). The Chi Square score (Chi Square = 53.284, df = 41, p = 0.095), and the general fit index (GFI) and comparative fit index (CFI), which were both close to unity, suggested a very good fit (GFI = 0.812, CFI = 0.909).[52]

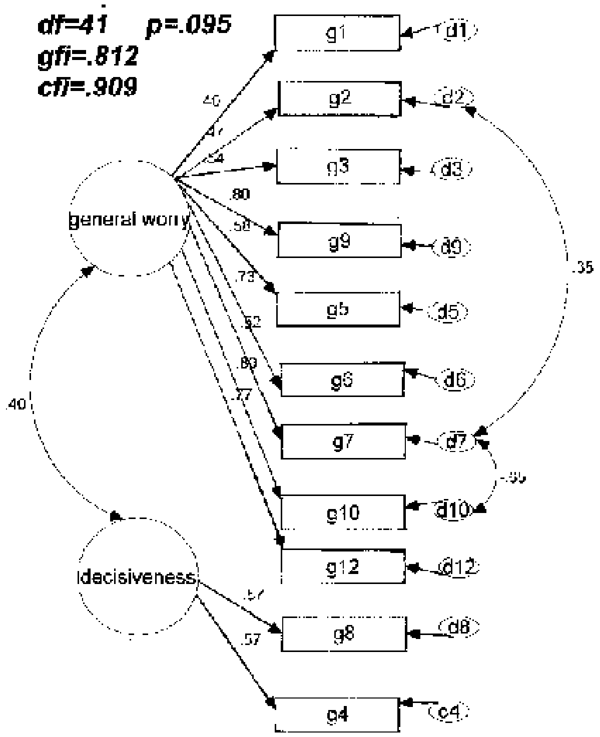

Figure 7.11 GHQ-12: Structural Equation Model

GHQ-12 responses were tested for association with gender and position using independent samples *t*-test but the results were not statistically significant for any item ($p > 0.05$).

Job satisfaction was measured by using the final question from the scale of Warr, Cook and Wall (1979), which asked respondents to indicate on a seven-point scale how satisfied or dissatisfied they felt with their present job. The majority of respondents reported that they were ‘moderately satisfied’ with their present job, although 31% indicated some dissatisfaction (Table 7.20). The descriptive statistics for all respondents are given in Table 7.21.

Table 7.20 Number and Percentage of Respondents Reporting Job Satisfaction

Response	N	Per cent
Extremely dissatisfied	3	8
Very dissatisfied	2	5
Moderately dissatisfied	7	18
Not sure	1	3
Moderately satisfied	14	36
Very satisfied	11	28
Extremely satisfied	0	0
Non-responses	1	3
Total	39	100

Table 7.21 Global Job Satisfaction Results: All Respondents

Total	N	Min	Max	Mean	Std Dev
Job satisfaction	38	1	6	4.42	1.59

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[52] The general fit index (GFI) measures the relative amount of variance and co-variance accounted for by the model. The comparative fit index (CFI) measures the reduction in the amount of misfit between the target model and a baseline model.

The mean score for job satisfaction indicated that overall workers were reasonably satisfied although the level of satisfaction was lower in comparison to many of the samples shown in Table 7.22 (Dollard et al. 2000).

Table 7.22 Global Job Satisfaction from other Studies: Means and Standard Deviations*

	M	SD	N
Second Year Undergraduate University Students (Cotton et al. 1999).	3.50	.99	175
Psychologists (Dollard et al. 2000)	3.75	–	7
Correctional Officers (South Australian) (Dollard and Winefield 1992)	4.20	1.60	416
Social Workers (Dollard et al. 2000)	4.66	–	244
Project Workers (Dollard et al. 2000)	4.75	–	54
Youth Workers (Dollard et al. 2000)	4.79	–	140
Community Support Workers (Dollard et al. 2000)	4.81	–	71
SA Human Service Workers (Dollard et al. 2000)	4.84	1.37	806
Administrative/Clerical Workers (Dollard et al. 2000)	4.96	–	156
SA Private Sector Workers (Macklin and Dollard 2000)	5.00	1.36	143
SA Public Sector Workers (Macklin and Dollard 2000)	5.08	1.10	84
Managers (Dollard et al. 2000)	56	–	43
Nurses (South Australian) (Dollard 1996)	58	1.10	102
Financial Counselors (Dollard et al. 2000)	5.24	–	42
British Blue Collar Male Workers (Warr, Cook, and Wall 1979)	5.24	1.46	200
Executives (Dollard et al. 2000)	6.33	–	3

* From Dollard et al. (2000)

Job satisfaction tended to be similar for managers and non-managers and higher among male workers than female but this was not statistically significant ($p > 0.05$).

Findings Relating to Physical Health Symptoms

A self-administered questionnaire based on the Physical Health Questionnaire used by Morrison et al. (1992), developed from the work of Cheek and Miller (1983), was used to assess physical health. The Physical Health Questionnaire was adapted to include items specifically related to the health symptoms associated with computer use, and items that were not relevant were omitted. For example, items such as ‘dry, irritated eyes’, ‘increased sensitivity of eyes to light’, ‘difficulty in turning door knobs or taps’, ‘waking during the night with pain or numbness in hands’, and ‘aches or pain in shoulders’ were included, and items such as ‘kidney trouble’, ‘hearing problems’ and ‘hay fever’ were left out. Respondents indicated how often they had suffered from a range of 24 physical health problems in the previous month by circling the appropriate number on a five-point scale ranging from ‘never’ to ‘very frequently’. Table 7.23 summarises the responses received.

Table 7.23 Percentage of Respondents Reporting Physical Health Symptoms

Item	Never %	Rarely %	Occasion-ally %	Fre-quently %	Very Fre-quently %
1. Headaches	18	36	28	10	5
2. Eye strain	21	31	31`	8	8
3. Blurred vision	39	23	26	5	3
4. Dry, irritated eyes	21	8	18	8	8
5. Difficulty in turning the pages of a book	80	15	3	.	.
6. Difficulty in turning door knobs or taps	87	10	.	.	.
7. Cold hands while entering data	77	8	13	.	.
8. Waking during the night with pain or numbness in hands	74	18	5	.	.
9. Increased sensitivity of eyes to light	44	41	8	3	3
10. Elbow problems	82	8	5	.	.
11. Upper back problems	49	21	18	5	3
12. Lower back problems	28	15	33	13	5
13. Wrist pain	59	31	5	.	.
14. Arm problems	67	18	10	.	.
15. Pain in the hands	69	23	3	.	.
16. Pain in fingers, thumbs	72	21	3	.	.
17. Swollen ankles	85	8	3	3	.
18. Pain in the foot or toes	80	13	5	.	.
19. Pain down the legs	59	18	18	3	
20. Aches /pain in shoulders	26	31	31	8	3
21. Eye tics	77	13	8	.	.
22. Grinding teeth	69	15	8	3	.
23. Shooting pains in jaws and into ears	85	13	.	.	.
24. Neck tension	28	18	31	10	10

. indicates non-response

The results suggest that generally the respondents were physically healthy and not experiencing severe or consistent pain. However, one-third reported that they suffered lower back problems ‘occasionally’ and 31% occasionally suffered aches or pain in the shoulders, neck tension, and eye strain. Headaches and blurred vision were suffered ‘occasionally’ by 28% and 26% respectively. Overall, the main health symptoms suffered by respondents appeared to be related to lower back problems, neck tension, headaches, aches or pain in the shoulders and eye problems.

Factor analysis carried out on the Physical Health Symptoms scale yielded three factors named head, hands and back, which contained the following items as confirmed by confirmatory factor analysis and indicated in the structural equation model in Figure 7.12:

Factor 1 Head
Headaches
Eye Strain
Blurred vision
Neck Tension

Factor 2 Hands
Arms problems
Wrist pain
Pain in the hands
Pain in fingers or thumbs

Factor 3 Back
Upper back problems
Lower back problems

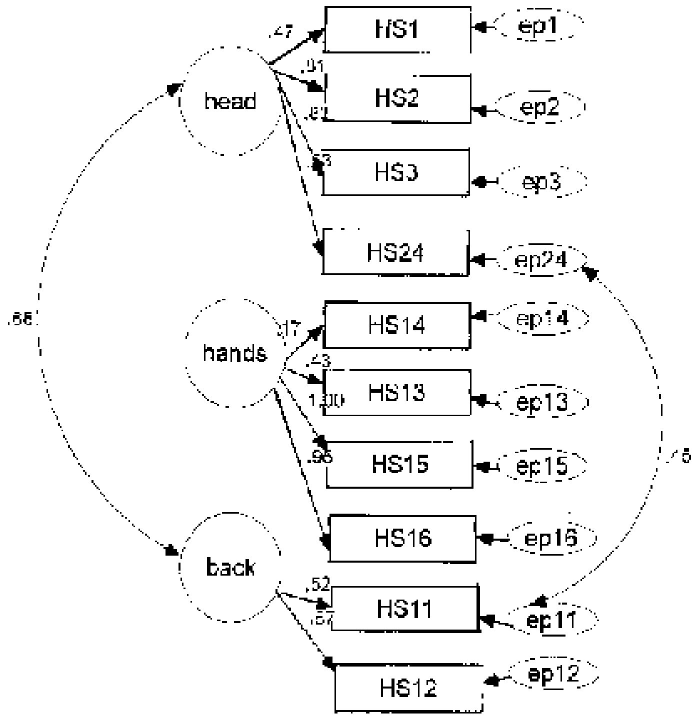

Figure 7.12 Physical Health Symptoms: Structural Equation Model

The structural equation model (Chi Square = 47.231, df = 34, p = 0.065) appears to be a good fit (GFI = 0.819 and CFI = 0.918). The correlation of 0.68 is statistically significant, suggesting a definite relationship between 'head' and 'back'. The variable 'hands' has no statistically significant correlation with the other two factors.

Linear regression analysis was conducted to determine the impact of personality on physical health symptoms. The final model included the variables 'Totaln', representing the emotionality/neuroticism personality scale, and 'Pospay', representing the remuneration of the respondent's position, and was adjusted for fitness levels. The emotionality personality scale was not statistically significant, indicating that there was no association between personality factors and physical health (Table 7.24).

Table 7.24 Physical Health Symptoms and Personality

Variable	Estimate	Confidence Limits		P-value
Fitness – low	0.1437	–0.5443	0.8319	0.6609
Fitness – medium	0.0975	–0.4549	0.6499	0.7107
Fitness – high	0.0303	–0.5395	0.6002	0.9107
Fitness – very high	0.0000	.	.	.
Pospay – low	–0.6294	–1.0887	–0.1702	0.0108
Pospay – adequate	–0.3894	–0.6776	–0.1012	0.0117
Pospay – highly	0.0000	.	.	.
Totaln	0.0087	–0.0085	0.0259	0.2972

. indicates non-response

Regression analysis was used to determine the impact of ergonomic knowledge on physical health symptoms. The final multivariate model included the variables ‘Diagpost’, ‘Fitness’ and ‘Pospay’, representing the scenarios regarding posture and the layout of equipment, reported physical fitness levels, and the remuneration levels of the respondent’s position. However, no variables related to ergonomic knowledge had a p-value of less than 0.2 in the univariate analysis and, therefore, were not included in the final model, indicating there was no association between knowledge of ergonomic principles and the physical health symptoms reported by respondents ($p > 0.05$) (Table 7.25).

Table 7.25 Physical Health Symptoms and Ergonomic Knowledge

Variable	Estimate	Confidence Limits		P-value
Diagpost	–0.0037	–0.0889	0.0814	0.9259
Fitness – Low	0.2332	–0.4909	0.9575	0.5009
Fitness – Medium	0.1683	–0.4091	0.7458	0.5418
Fitness – High	0.0474	–0.5811	0.6760	0.8737
Fitness – Very High	0.0000	.	.	.
Pospay – Low	–0.6401	–1.2270	–0.0532	0.0347
Pospay – Adequate	–0.3938	–0.7128	–0.0749	0.0191
Pospay – Highly	0.0000	.	.	.

. indicates non-response

Respondents were provided with a list of twelve parts of the body and asked to rate the extent to which they believed the symptoms they suffered in each part of the body were related to their present work or, alternatively, to other factors unrelated to their present work on a scale of 1 (solely related to present work) to 5 (solely related to non-work activities). Symptoms of the neck, eyes and shoulders were those most often identified as work-related. Problems with legs, ankles/feet, arms and lower back were most often reported as being related to factors other than the present work. When asked whether they had reported the symptoms identified as work-related to their organisation the majority said they had not, with only 10% replying that they had reported the problem to their organisation.

In a question developed from the Nordic Questionnaire for the analysis of musculoskeletal symptoms (NMQ) (Kuorinka et al. 1987), respondents were asked to indicate whether they had ever hurt parts of their body in an accident unrelated to work. While for each item the majority answered that they had not hurt themselves in an accident outside of work a quarter or more indicated that they had, with legs, ankles/feet and lower back being the main parts identified (Table 7.26). This aligns with the reporting that problems with legs, ankles/feet and lower back were generally not work-related, but not in relation to arm problems.

Table 7.26 Percentage of Respondents Reporting whether Part of Body had been Hurt in an Accident Unrelated to Work

Part of Body	N	Yes %	No %	Missing %
Head	39	15	82	3
Eyes	39	25	72	3
Neck	39	31	66	3
Shoulders	39	28	69	3
Arms	39	18	79	3
Wrists	39	25	72	3
Hands	39	25	72	3
Legs	39	38	59	3
Elbows	39	15	80	5
Ankles/Feet	39	38	59	3
Lower Back	39	36	61	3
Upper Back	39	18	77	5

Respondents were also asked how many hours of out-of-work time they spent in activities such as watching television, playing computer games, embroidery, knitting, writing or reading for extended periods and playing sports such as tennis and squash that involved the same muscles that they used while at work. Activities on which they spent one or more hours were watching television (73%), reading (46%), playing sport (28%), writing (23%) and computer games (15%). The main activities on which respondents spent two or more hours per day after work were television viewing (62%) and reading (23%). For many respondents, therefore, these after-work activities, additional to an average daily computer use of 5.47 hours at work, may be contributing to the headaches, shoulder pain, neck tension, lower back and eye problems experienced.

A question also asked whether pain or discomfort in various parts of the body had prevented the respondent from doing normal activities in the previous 12 months, at work and out-of-work, and the length of time they had been so prevented. The responses received are shown in Table 7.27.

Table 7.27 Percentage of Respondents Prevented from doing Normal Activities and the Number of Days involved

Part of Body	N	At Work Yes %	At Work No %	At Work Missing %	Out of Work Yes %	Out of Work No %	Out of Work Missing %	No. of Days
Head	39	13	79	8	15	80	5	21
Eyes	39	0	92	8	0	95	5	0
Neck	39	0	90	10	5	90	5	7
Shoulders	39	3	87	10	10	85	5	43
Arms	39	0	92	8	0	95	5	0
Wrists	39	0	92	8	0	95	5	0
Hands	39	0	92	8	0	95	5	0
Legs	39	5	87	8	10.	85	5	350
Ankles/feet	39	2	90	8	8	87	5	51
Elbows	39	0	92	8	0	95	5	0
Lower back	39	10	82	8	15	80	5	113
Upper back	39	2	90	8	5	90	5	105

As can be seen from Table 7.27, pain or discomfort did not prevent the majority of respondents from doing normal activities at work. Headaches (13%) and lower back pain (10%) were the main health problems that hindered normal work activities. These two symptoms are commonly related to computer work as a result of sitting incorrectly or for prolonged periods while using the computer and VDU. Increased incidences of headaches (15%) and lower back pain (15%), together with pain in the shoulders and legs (10% each), were identified as preventing normal activities at home. Pain in the legs and lower and upper back resulted in the largest number of days away from normal activities. When asked to elaborate in relation to this question, respondents reported mainly problems with headaches outside of work hours. Some comments received were:

Frequent headaches on Saturday afternoon (no, not related to drinking)

Headaches usually caused by lack of sleep/excess work…

Pain prevents me from playing sports or help around the house on weekends

These comments indicate that, for some, while they may be able to perform well at work, the symptoms impact on them after hours, disrupting their normal out-of-work activities.

To ascertain the severity and impact of the complaints of pain, respondents were asked to indicate how many times they had consulted a professional such as a doctor, optometrist, physiotherapist, chiropractor or similar person in the previous 12 months due to pain or discomfort in various parts of the body, and whether they had had to change jobs or duties and needed time off work because of the problem. Tables 7.28 and 7.29 report the responses received.

Table 7.28 Percentage of Respondents Consulting a Health Professional and Number of Consultations

		Consultation				
Part of Body	**N**	**Yes %**	**No %**	**Missing %**	**N**	**No. of Visits**
Head	39	10	85	5	4	11
Eyes	39	21	74	5	8	15
Neck	39	26	69	5	10	48
Shoulders	39	21	74	5	8	49
Arms	39	0	95	5	0	0
Elbows	39	3	92	5	1	6
Wrists	39	3	92	5	1	1
Hands	39	3	92	5	1	1
Legs	39	13	82	5	4	17
Ankles/feet	39	10	85	5	4	8
Lower back	39	28	67	5	10	64
Upper back	39	21	74	5	7	58

Table 7.29 Percentage of Respondents Changing Jobs/Duties and Number of Work Days Lost

Part of Body	N	Changed Duties Yes %	No %	Missing %	N	No. of Days Lost
Head	39	0	95	5	2	5
Eyes	39	0	95	5	0	0
Neck	39	0	95	5	0	0
Shoulders	39	0	95	5	0	0
Arms	39	0	95	5	0	0
Elbows	39	0	95	5	0	0
Wrists	39	0	95	5	0	0
Hands	39	0	95	5	0	0
Legs	39	0	95	5	1	10
Ankles/feet	39	5	90	5	2	18
Lower back	39	3	92	5	1	5
Upper back	39	0	95	5	0	0

The data in Table 7.28 show that the majority of respondents did not consult a health professional due to pain or discomfort in the preceding 12 months. However, these responses highlighted that back, neck, shoulder and eye disorders were the main reasons for consultation for between 21% and 28% of respondents. Most visits to a health professional were related to lower back pain, which can be caused by sitting incorrectly or for prolonged periods without adequate movement, as can be associated with computer work. Upper back, shoulder and neck complaints, which are also linked to computer work, were the reasons for most other visits. On average each person reporting a problem consulted a professional five times, although the number of visits ranged to 14. The highest number of visits per person related to upper back complaints. Problems with ankles and feet, legs, lower back and headaches were the causes of lost working days. However, health complaints did not impact substantially on work duties or work days lost. Of the 8% replying that they needed to change jobs or duties, 5% had returned to their original duties and 3% did not respond. 15% of respondents took time off work due to their disorders for an average of six days.

Findings in relation to the Work Environment

A scale developed in the style of the Work Environment Scale (Moos 1986) was used to assess aspects of the cultural work environment. The statements in the work environment measure used were devised to investigate the situation in relation to factors such as task variation, job flexibility, utilisation of skills, involvement in decision-making, job demands and control over work, to allow an assessment of the influence that the work environment may have had on the application of ergonomics to computer use. Respondents were required to rate each statement about their workplace on a scale from 1 (never) to 5 (very frequently) (Table 7.30).

Table 7.30 Percentage of Responses Regarding the Work Environment

Statement	**Never %**	**Rarely %**	**Occasionally %**	**Frequently %**	**Very Frequently %**	**Missing %**
1. Staff are encouraged to apply ergonomics to their work.	18	**41**	28	10	0	3
2. Staff are able to use their initiative in organising their work.	0	0	8	**54**	36	3
3. Staff skills are under-utilised.	3	13	**62**	15	5	3
4. There is scope to be flexible when organising your work day.	0	3	10	**51**	33	3
5. There are problems catching up on work when returning from leave.	5	8	**39**	**33**	13	3
6. The work is interesting.	3	5	28	**51**	10	3
7. There is a variation of tasks.	0	5	23	**51**	18	3
8. The application of ergonomics to computer use is monitored by a person within the organisation.	**62**	28	5	3	0	3
9. Work demands are excessive.	5	18	**41**	21	13	3
10. Staff input into decision-making is valued.	0	13	**41**	**41**	3	3
11. New staff receive appropriate induction on the organisation's policy on ergonomics and computer use.	**46**	31	13	5	3	3

Statement	Never %	Rarely %	Occas-ionally %	Fre-quently %	Very Fre-quently %	Miss-ing %
12. Staff are consulted when decisions are to be made about their work.	3	18	31	**36**	10	3
13. Urgencies and deadlines dominate the organisation of work	0	3	23	**46**	26	3
14. Staff are encouraged to take rest breaks away from the computer.	21	**39**	28	8	0	5
15. Staff are given too much to do.	0	21	**51**	23	3	3
16. The workload does not allow rest breaks away from the computer.	8	**49**	26	13	3	3
17. Staff are given the responsibilities required to complete their tasks.	0	0	13	**72**	13	3
18. Staff have adequate control over the order in which tasks are completed.	0	3	21	**54**	21	3
19. The rate of work is too fast.	0	39	**44**	13	3	3
20. The work is narrow and monotonous.	13	**44**	26	10	3	5
21. Staff find supervision supportive.	0	15	28	**46**	8	3
22. There is a friendly spirit of cooperation between co-workers.	0	3	21	**56**	18	3
23. Ergonomic furniture and equipment are available for use.	15	10	33	**36**	3	3
24. Staff are provided with software that reminds/trains in the application of ergonomic principles.	**69**	18	10	0	0	3
25. People often have to work overtime to get their work done.	13	23	**41**	18	3	3

These results indicate that the job tasks of most of the computer users were interesting and varied, and rarely narrow and monotonous. Staff were generally able to use their initiative in organising their work, and there was scope to be flexible when planning the work day. Although the majority believed their skills were occasionally under-utilised, computer users were usually given the responsibilities required to complete their tasks, and adequate control over the order in which tasks were completed. The greatest proportion of respondents was frequently consulted when decisions were to be made about their work, and their input to decision making frequently valued.

Supervision was generally supportive and the majority reported a friendly spirit of cooperation existed between co-workers.

However, new staff rarely (the majority replied ‘never’) received appropriate induction on the organisation’s policy on ergonomics and computer use and the application of ergonomics was generally not monitored within the organisation. Computer users were rarely encouraged to apply ergonomics to their work or take rest breaks away from the computer. They were generally not provided with software that reminded/trained in the application of ergonomic principles to computer use. However, ergonomic furniture and equipment was usually provided.

Some staff were occasionally given too much to do, and for some the rate of work was too fast, and people had to work overtime to get their work done. There were frequently problems catching up on work when returning from leave. Urgencies and deadlines dominated the organisation of work for the majority of respondents and, for the greatest proportion of respondents, work demands were occasionally excessive. However, it was rare that workload demands did not allow rest breaks away from the computer.

Factor analysis in relation to the work environment scale yielded three factors, confirmed by confirmatory factor analysis as shown in the structural equation model in Figure 6.11. The first factor contained items related to staff issues; the second related to work demands; and the third related to ergonomics, as follows:

Factor 1 Staff issues
Staff find supervision supportive
Staff have adequate control over the order in which tasks are completed

Staff are given the responsibilities required to complete their tasks
Staff are consulted when decisions are to be made about their work
Staff input into decision-making is valued

Factor 2 Work demands
Staff are given too much to do
The rate of work is too fast
Work demands are excessive

Factor 3 Ergonomic factor
The application of ergonomics to computer use is monitored by a person within the organisation
New staff receive appropriate induction on the organisation's policy on ergonomics and computer use
Staff are provided with software that reminds/trains in the application of ergonomic principles

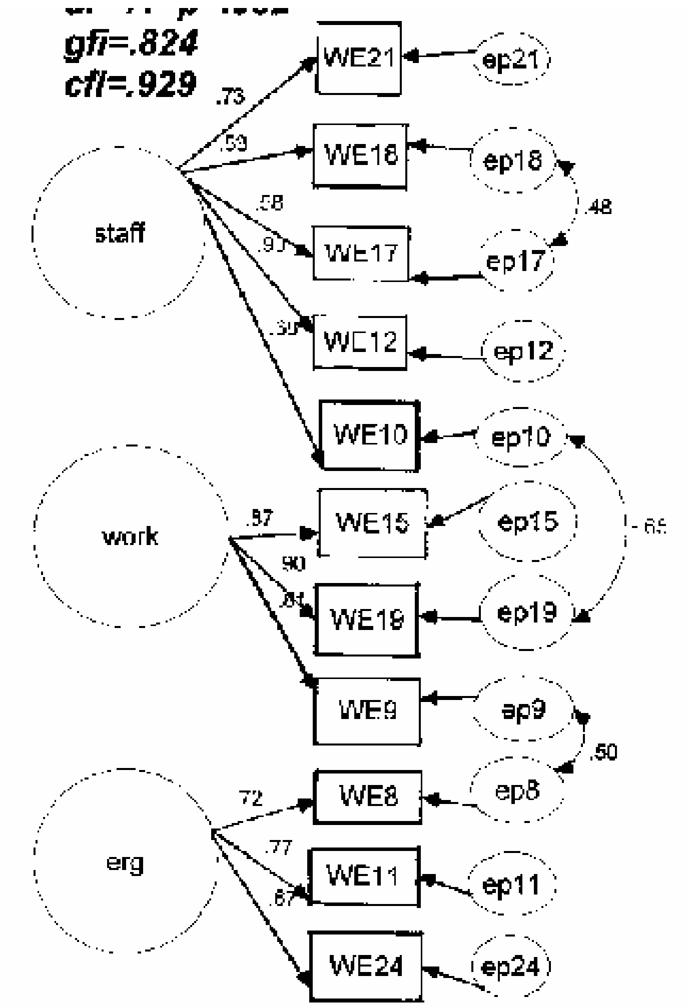

Figure 7.13 Work Environment Scale: Structural Equation Model

The model appears to be a good fit. There is no statistically significant correlation between the three factors; each can be looked at independently of the other two (Chi Square = 54.162, df = 41, $p > 0.05$).

Univariate analysis was conducted with the items in the work environment scale to determine the impact of factors within the cultural work environment on both the application by respondents of ergonomic principles to their computer work and the physical health symptoms experienced by respondents, but in each case no item had a p-value less than 0.2 and, therefore, no multivariate model was applied. The results of the analysis indicated that cultural work environment factors were not predicting whether or not respondents applied ergonomic principles to their computer work or whether they experienced physical health symptoms.

The final question in the survey instrument asked for ‘any other information’ but it was generally left blank and did not provide any useful or relevant additional information.

Summary of the Findings

The majority of respondents in this study were also non-managers, aged between 26 and 35 years, but male whereas in Studies I to V the greater proportion had been female. They had university-level education and settled jobs, having been in their current position for an average of 6.7 years. Most worked between 38 and40 hours per week, although a substantial 41% worked for more than 40 hours per week, which could impact on their health. Most respondents regarded their position as being secure, adequately paid and as having a medium level of prestige. These are positive factors as poor perceptions of work can have adverse affects on employee health. Most respondents exercised regularly and believed they had medium to high fitness levels – factors also beneficial to health as exercise and being fit can reduce the incidence and severity of musculoskeletal aches and pains. The majority of respondents wore glasses and of these 46% were bifocals. Wearing glasses, particularly bifocals, is relevant to computer use as it impacts on the viewing habits of the user. A person who cannot read the screen easily will tend to lean forward to view the screen and with bifocals tip the head upwards to read through the bottom section of the lens. Both of these habits can put strain on the neck and shoulder muscles and it was found in this study that people who wore glasses experienced more aches and pain in the shoulders, and those with bifocals more neck tension, than those who did not wear glasses or bifocals.

The average daily use of computers was substantial at 5.5 hours, and almost half (49%) worked at their computer for six or more hours per day. This is an extended amount of time in terms of the four hours maximum generally recommended and potentially risky to the health of the user, who could experience eye problems, headaches, musculoskeletal and other disorders as a result. A study of more than 25,000 clerical workers by Nakazawa et al. (2002) found not only that physical symptoms increased with higher daily computer use but also that mental symptoms and sleep disorders were higher when VDUs were used for more than five hours per day. His findings confirmed the relationships between VDU use and health symptoms suggested by previous researchers such as Rossignol et al. (1987), Lindstrom (1991), Bernard et al. (1994) and Polanyi et al. (1997).

69% of respondents had learnt to use a computer on the job, and 69% had never attended an educational program/training session provided by their organisation that included information on ergonomics in relation to computer use. 90% of respondents had not read any documents that included information on ergonomics and the use of computers in the preceding 12 months. 87% of respondents did not believe ergonomic principles relating to computer use were given sufficient priority within their organisation. More than half believed they needed to spend more time in ergonomic training.

On the other hand, 62% of respondents reported that they were aware of the ergonomic principles that relate to computer use. However, only 46% of respondents replied that they applied ergonomic principles to their work situation and of those who did not apply ergonomics, 33% reported the reason as being ‘not aware of the ergonomic principles’. Very few respondents (5%) replied that they did not apply ergonomics to their work because they were ‘too busy’. People who applied ergonomics to their computer work generally did so because ‘they knew that they should’. Only 5% replied that they applied ergonomics because ‘it is expected by the organisation’. 10% replied that they applied ergonomic principles because they had experienced health problems. Of the 23% of respondents answering how they applied the ergonomic knowledge gained in training to their work most said in the layout of, and adjustments made to, furniture and equipment, particularly in positioning the keyboard and VDU and adjusting the chair.

92% of respondents reported taking rest breaks away from the computer, although only 36% did so approximately every hour, with most others working for two or more hours before resting. Most were also aware of the appropriate activities to be undertaken during rest breaks, in particular the need to get up and go for a walk. The majority also reported taking regular micro-breaks when using a computer. However, most did not do pause gymnastics or exercise and 46% rarely or never stopped to rest their eyes with long distance viewing when doing computer work.

The responses to the scenarios designed to test ergonomic knowledge indicated that the respondents were unaware of the specific detail in relation to the recommended posture and layout and adjustments of computer furniture and equipment. While most respondents replied that they were aware of the ergonomic principles related to computer use, and this was demonstrated in their understanding of the need to consider workstation layout and making adjustments to furniture and equipment, the need for micro-breaks, rest breaks and exercise, and an appreciation of the type of activities suitable to be undertaken during rest breaks when using computers, their answers to the scenarios did not confirm this reported awareness. The majority of respondents did not recognise the poor posture of laying the arms along the desk and flexing the wrists up to the keyboard or even the recommended postures where the body is well supported by the adjusted chair, the legs and feet are positioned to act as stabilisers, and arms and wrists are level, positioned either at right angles or greater to the body. Approximately half of the respondents were unaware of when the VDU was positioned too close or too high, and that reaching up to use the mouse was not recommended.

A large majority of respondents reported being aware that sun-baking, smoking cigarettes and drinking excessive amounts of alcohol could cause health problems. When queried regarding the generally recommended ‘principles’ relating to each of these activities it was shown that overall the sample was compliant in nature. Nearly all of the respondents did not smoke cigarettes and of those who did most did not smoke indoors. Most rarely had more than the recommended number of standard alcoholic drinks per day, had at least two alcohol-free days each week and would not drive a motor vehicle after having more than the recommended number of drinks. Respondents were least compliant in the area of sun-baking. Although most never sun-baked, 36% did, and while most covered up with appropriate clothing, a considerable proportion never or rarely wore a hat or used sunscreen regularly when outdoors even though it is recommended.

Responses to the personality scale indicated that the respondents were generally conscientious, methodical, trustworthy people who were not disorganised, impatient, lazy or careless in their approach. These qualities also suggested that the computer users were likely to be compliant. This was confirmed by statistical analysis that showed respondents who scored high on the Quick Scales agreeableness facet, which contains the item ‘compliance’, were more likely to apply ergonomic principles to their computer work (refer Table 7.16).

Most respondents were not experiencing psychological health problems. However, 43% had not been able to concentrate as well as usual and many had been feeling constantly under strain and less able to enjoy their normal daily activities. Many respondents had also lost sleep over worry and were more unhappy and depressed than usual. The majority of respondents were contented in their job although a third were unsure or dissatisfied and job satisfaction was lower than that of many other samples.

However, the job satisfaction experienced by respondents generally aligned with their positive perceptions of the security, remuneration and prestige of their position.

Physical health symptoms were experienced ‘frequently’ or ‘very frequently’ by 47% of respondents. The most common complaints were lower back problems, aches or pain in the shoulders, neck tension, headaches and eye problems. All of these symptoms have been linked to the use of computers and can be relieved by the regular application of appropriate ergonomics. Problems with legs, ankles/feet, arms and lower back were generally identified as not being related to the respondents’ present work and it appears that leg, ankle/feet and lower back symptoms in particular were likely to be the result of an accident unrelated to work. It is reasonable to expect that the extended time spent by many respondents in out-of-work activities such as watching television and reading also contributed to the headaches and eye and lower back problems experienced.

The physical health symptoms suffered by respondents did not stop the large majority from carrying out their work. Headaches and lower back pain, cited by less than 15%, were the main reasons people were prevented from doing their normal work activities. However, it appears that, while some people may have been able to continue to do their tasks at work, symptoms impacted on their ability to perform normally out of work. For some, headaches, lower back pain and pain in the shoulders and legs prevented normal activities at home. The longest lengths of time people were prevented from doing their normal activities in the preceding 12 months were related to leg and back problems, which were seemingly as a result of an accident unrelated to work. Problems with ankles/feet (5%) and lower back (3%) resulted in a small number of respondents changing their jobs or duties at work in the preceding 12 months, and most of these reported that they had returned to their original duties. Leg, ankle/feet and lower back problems and headaches each caused between 1 and 10 days' loss of work, again seemingly as a result of an accident unrelated to work. The most common complaints, which caused between 21% and 28% of respondents to consult a health professional, were back, neck, shoulder and eye problems. Respondents consulting a health professional had between 1 and 14 visits in the preceding 12 months. The highest number of visits per person was for lower and upper back and shoulder problems followed by and neck complaints, symptoms often associated with computer work.

Examination of the work environment revealed a generally supportive workplace where people were able to use their initiative and were given the responsibilities required to complete their tasks together with adequate control over the order in which they were completed. They were able to be flexible when organising their work day and there was a friendly spirit of cooperation between co-workers. Occasionally their skills were under-utilised but the respondents were generally consulted when decisions were to be made about their work and their input to decision-making was valued.

Respondents found their work interesting; there was a variation of tasks and it was rarely narrow and monotonous. It was also revealed that the respondents often believed they were given too much to do, the rate of work was too fast and work demands were excessive. Most reported having to work overtime to get their work done, and problems catching up on work when returning from leave. Urgencies and deadlines frequently dominated the organisation of work. Staff were never or rarely given appropriate induction on the organisation's policy on ergonomics and computer use or provided with software that reminded/trained in the application of ergonomic principles. Although ergonomic furniture and equipment were generally available for use, most respondents were rarely or never encouraged to apply ergonomics to their work and reported that the application of ergonomics was never monitored by a person within the organisation. The majority answered that they were rarely or never encouraged to take rest breaks away from the computer even though most believed the workload would allow such breaks. These latter findings align with the respondents' earlier reports that ergonomic principles related to computer use were not given sufficient priority within their organisation.

CHAPTER 8

CONCLUSIONS

In this final chapter, an overview of the findings of each study will be discussed together with their implications. This is followed by a discussion of past and recent developments in the field of ergonomic computer use, leading to some concluding remarks about the gap between the theory and practice of ergonomics and how this may be closed.

Collective Significance of the Empirical Studies

My thesis, that the ergonomic principles relevant to computer use are generally not known or considered sufficiently important within organisations, is the product of my reflection on the six inter-related field studies that investigated the knowledge and application of ergonomic principles in relation to the use of computers. In answering the research questions posed in each of these studies (as outlined in Chapter 2) the following conclusions are made -

Studies I and II

Computer operators, managers and non-managers, within organisations located in both the regional city of Whyalla and the Adelaide metropolitan area possessed a low level of knowledge of ergonomic principles in relation to the use of desktop keyboard-operated computer technology.

Low priority was given to ergonomics in relation to computer use within both the regional and capial city organisations.

Study III

University academic staff and post-graduate students also had a low level of knowledge of ergonomic principles in relation to computer use.

Low priority was given to ergonomics in relation to computer use by academic staff, post-graduate students, and the university.

Study IV

Computer users with greater levels of ergonomic knowledge demonstrated higher job satisfaction and fewer health-problem symptoms, particularly in relation to the hands and wrists.

Ergonomic knowledge and aspects of the psychosocial work environment were variously associated with job satisfaction, psychological wellbeing and physical health symptoms.

Study V

Little change had occurred in the knowledge of ergonomic principles relating to computer use among managers and computer operators within the organisations surveyed in 1994 and 1998.

There was a small improvement in the priority given by organisations to ergonomics relating to computer use over the period 1994 - 1998.

Study VI

Respondents had a compliant attitude towards risk-taking generally and possessed personal qualities that suggested it was probable they would apply ergonomics to their computer work.

Ergonomic knowledge was more important than personality and the cultural work environment in determining behaviour in relation to the application of ergonomics to computer use.

Ergonomic knowledge, personality and the cultural work environment were not found to be statistically significant in determining health symptoms.

Studies I and *II* focused on the knowledge of and priority given to ergonomics and computer use within various private and public-sector organisations located in regional and city areas. The results of Study II showed the level of ergonomic knowledge within the city firms was as low as that within the firms located in the country. Knowledge of ergonomics and the priority it was given were not generally affected by gender, position or organisational size. However, there was a statistically significant difference in relation to organisational type, with people working in public-sector organisations being more aware of ergonomic practices and giving higher priority to procedures related to ergonomic computer use than privately owned organisations.

Limited ergonomic knowledge was demonstrated in the responses about taking rest breaks and the factors considered in organising the work day. Only one-third gave ergonomically sound answers such as varying tasks and spacing out work to give breaks from the computer as factors considered when organising their work, and, while most respondents knew it was important to take regular rest breaks when using a computer, approximately 10% did not know how often breaks should be taken. Most were aware of the need to leave the seat, move around, stretch the body and rest the eyes during rest breaks, but too many thought reading and writing tasks were suitable activities to be undertaken during rest breaks away from the computer. It is reasonable to infer a lack of awareness that these activities would not rest the eyes or muscles that had previously been used and, therefore, not fulfil the purpose of the breaks. While respondents generally gave ergonomic concerns such as adjustability, support and comfort as the factors they would take into consideration when selecting office furniture and equipment, they were unable to demonstrate that they were aware of the adjustments required to achieve the posture and layouts recommended. The low percentage of correct answers to the scenarios designed to test respondents' knowledge of the more specific ergonomic principles relating to posture and positioning of the body and layout of equipment also suggested that ergonomic principles were generally not known or understood.

These findings indicate that, while the respondents thought there was a need to have ergonomically designed chairs and furniture for computer use, to allow for adjustability and comfort at work, and knew it was important to take regular rest breaks when using a computer and to get out of the chair and walk to exercise the body in an endeavour to avoid aches and pains, their knowledge was limited to these general notions. Knowledge of more specific detail regarding how to adjust the furniture and equipment to allow the postures and positioning generally recommended, and additional techniques such as undertaking pause gymnastics and long-distance viewing when using the computer, was lacking.

The fact that most respondents did not carry out pause gymnastics when using the computer suggests either that they placed low priority on this aspect of ergonomics or that they lacked awareness of the possibility of undertaking such activity at the computer. In addition, while most respondents considered rest breaks were relevant to computer use, a quarter did not take them, putting themselves at risk of developing musculoskeletal disorders. When respondents who had attended training provided by their organisation in ergonomic computer use were asked how they had applied the ergonomic knowledge received to their work situation, most did not reply. This suggests that ergonomics was generally not applied – perhaps due to a lack of sufficient detail being given in the training so that the staff still did not know how to apply it to their own situation, or that they left the training, moved their attention onto other things and forgot to apply it, or considered the advice unimportant for themselves. Many respondents said work pressures did not allow them to organise their own work day, indicating that job demands may also have influenced the non-application of ergonomics.

The low priority given to ergonomic computer use was also similar within the Whyalla and Adelaide firms. Ergonomics was given low priority irrespective of the legal form of the organisation or its location. The respondents' perception that ergonomic computer use was given insufficient priority within their organisation was consistent with the evidence of a lack of training provided in ergonomics and a lack of awareness by respondents of the existence of policies and procedures regarding ergonomic computer use. While the majority of respondents replied that they were required to report computer-related injury to their organisation, some said they were not required to report and many were unsure. They may have had grounds for their uncertainty: less than half believed their organisation kept records of computer-related injuries and few respondents answered that their organisation had a written policy on procedures for the rehabilitation of employees affected by computer-related disorders. Generally the importance of keeping recommended ergonomic work practices in mind while using a computer was not emphasised and no-one had been delegated responsibility for ensuring ergonomic practices were followed, further indicating that ergonomic computer use was given low priority by organisations. The majority of respondents did not know how their organisation responded to breaches of recommended work practices and it was generally believed that the organisations ranked reduction of injury rate and legislative compliance lower than reducing operating costs and improving product quality, customer relations, and production rate. Occupational health, safety and welfare were considered to be low on the priority scale. This approach is consistent with previous examples of management strategies that allowed new techniques and technologies to proceed without due regard for the safety of the production workers (Bayer 1988; Dembe 1996).

The high percentage of respondents who did not know whether their organisation had written policies on ergonomic computer use or the rehabilitation of employees affected by computer-related disorders highlights that even if these documents existed they were not readily available and were rarely discussed. The high proportion of respondents who were unsure whether they were required to report incidents of computer-related disorders, and whether their organisation kept records of such disorders, also indicates that these matters were not often talked about. Similarly, the large number of non-responses to the question asking how the organisation responded to breaches of recommended work practices suggests little monitoring and reinforcement within the organisations of the importance of applying ergonomics to computer use.

However, the public service context appears to have made a difference. Respondents from public-sector organisations reported higher levels of awareness and were more likely to have attended training in ergonomic computer use provided by their organisation. Respondents from public-sector organisations also performed better on the scenario questions, indicating a better understanding of the recommended postures and layouts. Public-sector settings appeared to place more emphasis on the importance of applying ergonomics and were more likely to have a nominated person responsible for ensuring that ergonomic work practices were followed. In addition, government organisations were more likely to have a written rehabilitation policy and to keep records of computer-related disorders than were privately owned firms. It is noteworthy that during the period when the studies were conducted, both the State Government and the public-sector union were committing considerably more resources to occupational health, safety and welfare than private-sector organisations.

The highest proportion of respondents reporting that they were not aware of the ergonomic principles was in *Study III*. Academic staff and post-graduate students were the least likely to have received training from their organisation, were generally unaware of any written policies and procedures relating to ergonomic computer use, and reported the greatest proportion of physical health symptoms. Ergonomic computer use was perceived to be given low priority within the university. There appeared to be an urgent need for increased dissemination of ergonomic information within the university, particularly in computer pools, to better inform the general student population, but also for academic staff as their knowledge of ergonomic principles was inadequate in some important areas. Nearly all respondents had not received training in ergonomic computer use from the university. Often staff were not aware of what training, if any, was available and it appears that there was little information on ergonomics in circulation within the university. Almost three-quarters of staff and post-graduate students had not read material on ergonomic computer use in the preceding 12 months. Over half believed they needed to spend time in training/update session on ergonomic computer use.

Most university respondents replied that they did take rest breaks away from the computer and knew they should be taken approximately every one hour. They also knew that these breaks should be used to stretch and rest the eyes and to undertake tasks not involving the same muscles used in computer work. Most respondents also mentioned ergonomic factors such as adjustability and placement as their considerations when choosing office furniture and equipment but when knowledge of ergonomic principles related to posture and the layout of computer equipment were specifically tested by the questions containing the various scenarios, the overall average of correct responses was only 41%, which is similar to that found in Studies I and II and indicates these respondents were also generally not aware of the adjustments and placements required to keep their workplace safe. Few university respondents regularly carried out pause gymnastics or exercised when using a computer and over half never did. However, performance in this area was better than that for the Whyalla and Adelaide firms, where even fewer undertook pause gymnastics regularly and approximately three-quarters never did. Urgencies and deadlines clearly dominated the organisation of work for both staff and students, and when they planned their work day ‘job survival’, rather than ‘health survival’ was clearly the key concern. Very few mentioned ergonomic matters such as variation of tasks and avoiding extended periods of work at the computer as factors they took into consideration when planning their work day.

Few academic staff and post-graduate students believed the university had a written policy on ergonomics and computer use: over four-fifths were unsure. That so many people did not know whether such a policy existed suggests ergonomic computer use was rarely discussed within the university even though it could be anticipated that every academic staff member and post-graduate student would be using a computer regularly for prolonged periods. The proportions of respondents who were unsure whether their organisation had such a written policy were a lot lower in Studies I and II and, although still unacceptably high, indicated the situation was much worse within the university setting.

Less than 10% of staff and students believed ergonomic computer use was given sufficient priority within the university. The comments received suggested little knowledge of how the university managed ergonomic computer use: academic staff thought that the target may have been general office staff; post-graduate students indicated that they were not considered or informed; and, although appropriate chairs were provided, the computer pools were generally not set up to assist the application of ergonomics. Numerous academic staff and students supported the view given by one of their colleagues that “there’s not enough time to ensure work is carried out in an ergonomic manner”, suggesting the application of ergonomics was influenced by job demands and heavy workloads. Lack of money also appeared to inhibit the replacement of old, unsuitable furniture, suggesting that occupational health and safety were being compromised by increasingly tight university budgets. The budget priority seems to be particularly salient considering that 58% of staff and students reported experiencing a computer-related complaint of pain in some part of their body. The high percentage of reported complaints of pain requires commitment by the university to the provision of safe working conditions for computer users.

Study IV revisited the country firms four years on[54] to explore links between ergonomic awareness, psychosocial work environment, job satisfaction, and the mental and physical health of the computer users. Contrary to the findings in the previous studies, the majority of respondents in Study IV stated that they were aware of the ergonomic principles and did not believe they needed more time in training, a situation likely to be affected by the fact that these firms had previously participated in Study I and had been resurveyed. This study also recorded the highest proportion of employees who had attended training in ergonomic computer use provided by their employer. A greater proportion of people from these Whyalla firms had read material on ergonomic computer use in the preceding 12 months. However, the percentage of

[54] The question of adaptation and how the innovation process was bedded down has been significant in the development of technology (Rogers 1995).

correct answers to the scenarios designed to elicit understanding of the ergonomic principles was still low and indicated limited knowledge.

These firms also gave ergonomic computer use higher priority than those in the other studies, having the highest percentage of respondents reporting that their organisation had a written policy on ergonomic computer use and that ergonomic work practices were given sufficient priority. However, in both cases the proportions were less than 50%, indicating that considerable improvement was required.

Study IV showed that education and knowledge in ergonomics were more important in relation to health and job satisfaction levels than merely having organisational policies on ergonomic health and safety. Low levels of ergonomic knowledge were linked to lower job satisfaction and higher levels of psychological distress and hand and wrist problems; computer users with knowledge of ergonomics had more job satisfaction and fewer health-problem symptoms. On the other hand, organisational policies and ergonomic education were both positively linked to levels of knowledge, suggesting that they may provide a context and opportunity to enhance knowledge levels and in turn influence workers' positive health and work attitude formation (Sawyer, Dollard and Farrin 2002, p. 255).

Compared to other samples, job satisfaction within the Whyalla organisations was reasonably high. Type of organisation (public or private) and level of ergonomic knowledge were significantly associated with job satisfaction, with job satisfaction being higher in private-sector organisations and when workers had greater levels of ergonomic knowledge.

Ergonomic knowledge was similar within private and public-sector organisations and higher within medium–large-sized firms. There was an increase, compared to the previous studies, in the proportion who reported that they were aware of the relevant ergonomic principles, but still almost half believed they needed to spend more time in training/update sessions. In this study also, the majority of computer operators had learnt to use a computer on the job yet had never received training in ergonomic computer use provided by their organisation. Employees who had attended training in ergonomics performed better on the scenarios than those who had not, indicating they had better knowledge of the adjustments, positions and layouts that were generally recommended.

Overall, the employees were reasonably healthy. However, over half reported experiencing musculoskeletal aches and pain, particularly shoulder pain and neck tension, and eyestrain. Females and people working in a non-management position experienced more physical health symptoms than males and those who were managers, a situation not unexpected given that women are traditionally more likely to be the typists and not the managers. The importance of taking adequate rest breaks while doing computer work was also highlighted. Most people knew the importance of taking frequent rest breaks away from computer work and did take rest breaks. Employees who did not take regular rest breaks away from their computer were more likely to experience eye strain, elbow problems, wrist pain, arm problems, shoulder pain and neck tension than those who did. Hand problems were significantly associated with ergonomic knowledge, indicating that as ergonomic education and knowledge increased symptoms of pain in the fingers, thumbs and wrists decreased.

Ergonomic education was also significantly associated with the GHQ-12 results, indicating that the lower the ergonomic knowledge of employees, the higher their psychological distress. However, respondents were generally psychologically healthy. Male employees and those from medium–large and private-sector organisations tended to show lower levels of mental distress. There were no statistically significant differences in psychological health between managers and non-managers.

Study IV demonstrated that aspects of the work environment such as work pressure, peer cohesion, supervisor support and job security were linked to the job satisfaction and mental and physical health symptoms experienced by the respondents within the organisations surveyed. Work pressure and peer cohesion were significantly associated with the GHQ-12 results: when job demands increased so did psychological distress; when peer cohesion increased, psychological distress decreased. This relationship accords with the work of Theorell and Karasek (1990) and Johnson and Hall (1988), who proposed that social support could moderate the effect of high job demands on mental and physical health.

The psychosocial work environment within the organisations was generally supportive: supervisors usually supported their staff, although people often felt that too much was expected of them and that they were talked down to and criticised over minor things; peers went out of their way to help others, took a personal interest in each other, and often shared after-work activities; and individuals generally had autonomy over their work, were able to work independently of their supervisors, and make their own decisions. The workload was usually manageable and although there were always organisational deadlines to be met, “nobody worked too hard” and most people did not need to work overtime in order to complete their work.

However, when job demands increased physical health symptoms also increased. Upper body symptoms such as neck tension, upper back problems, shoulder pain and severe headaches were significantly associated with work pressure. Elbow and arm problems were also associated with job security: more symptoms were experienced when the workers perceived their job as being under threat. Respondents’ perceptions that their job was under threat were also significantly associated with lower levels of job satisfaction; as job security increased, job satisfaction increased.

Physical health symptoms of the upper body and arms were significantly associated only with aspects of the work environment, namely work pressure and job security. Psychological health and job satisfaction were associated with both work environment and ergonomic factors, namely work pressure, peer cohesion, job security and level of ergonomic education and knowledge. However, hand symptoms were linked only to lack of exposure to ergonomic education and low levels of ergonomic knowledge.

This study confirms the importance of ergonomic awareness to the health and satisfaction of computer users and highlights that exposure to education and organisational policies on ergonomic computer use may provide a context and opportunity to enhance knowledge levels and in turn influence workers’ positive health and work attitude formation.

Study V used the common data collected in Study IV in a quasi-longitudinal study that examined the change in knowledge of and priority given to ergonomic computer use within the organisations since Study I. Study V found that over the four-year period there was a considerable increase in reported awareness and a higher proportion of respondents had attended ergonomic training provided by their organisation, particularly within public-sector organisations. In addition, a greater proportion of respondents had read documents relating to ergonomic computer use, and more were taking rest breaks away from the computer. These improvements, together with the large increase since 1994 in the proportion reporting they had learnt to operate a computer in an educational institution, suggest that many computer users had been provided with outside training since the initial survey was conducted. There was also perceived to be an increase in the emphasis given to ergonomic work practices and the level of priority ergonomic computer use was given by the organisation. On the other hand, the percentage of people providing correct answers the various scenarios regarding sitting posture and the layout of computer equipment had not improved and the incidence of work-related complaints of pain had increased considerably.

By the time of the second round of surveying, in 1998, a smaller proportion of respondents believed they needed to spend time in training/update sessions related to ergonomic computer use, which aligns with the increase in reported awareness. Also, a smaller proportion of people had learnt to use a computer on the job; more had learnt in an educational institution and, therefore, were likely to have received training in ergonomics as part of their computing course. Regardless of these improvements**,** the answers to the various scenarios related to posture and the layout of computer equipment still suggested most respondents had limited knowledge of appropriate ergonomic practices. Over the period, correct answers received from managers and female respondents had decreased,[55] which is of concern because people in management positions require the expertise in order to provide a safe working environment, and generally it is the female employees who do the majority of the computer work and experience the most health problems. Also, the proportion of correct answers received from small-sized and private-sector firms had decreased, indicating that more emphasis was necessary within these types of organisation.

Respondents who replied that their organisation had a written policy on ergonomic computer use had also increased, but a high proportion continued to be unsure. On the other hand, a smaller proportion of people answered that their organisation had a written rehabilitation policy; that they were required to report incidents of computer-related injury; and that their organisations kept records of such injury. In each case the percentage of respondents who were unsure of the situation was similar in both periods and remained high, suggesting that this information was rarely discussed and not readily available within their organisations. The greatest improvement in relation to the existence of a written policy on ergonomic computer use and the rehabilitation of employees affected by computer-related disorders occurred within public-sector and medium–large-sized organisations. However, a smaller proportion of people from public-sector and medium–large-sized firms said they were required to report incidents of computer-related injury and that their organisation kept records of such injuries than had been the case four years earlier.

[55] It is acknowledged again that information on ergonomic positioning available at the time of the research does not always align with current thought and that the participants may have had an experiential understanding of the scenarios as being appropriate.

A greater proportion of respondents replied that their organisation stressed the importance of employees keeping ergonomic work practices in mind when using computers. Previously, almost two-thirds said their organisation did not emphasise ergonomic computer use, but this had dropped to approximately one-third. Over the period, public-sector organisations and medium-large-sized firms continued to be more likely to place emphasis on ergonomics and to have a person responsible for ensuring that ergonomic work practices were followed than private-sector and small ones. It is noteworthy that, while there had been an increase in the percentage of respondents who believed ergonomic principles were being given sufficient priority within their organisation, over half still believed more emphasis was required.

Study VI, conducted within a large private-sector organisation, extended the previous research by enquiring further into personality and attitude to compliance, the cultural work environment, and the computer users' health. While in Study VI, reported awareness of the ergonomic principles had further increased, to the point where almost two-thirds of the respondents said they were aware, this was again not supported by the answers provided to the various scenarios related to posture and the layout of computer equipment: correct answers were provided by only half the respondents. Very few respondents had read any documents relating to ergonomic computer use and most believed it was given insufficient priority within the organisation. They rarely received induction on ergonomic policy and were not encouraged to apply ergonomics to their work, yet a considerable proportion experienced eye problems and musculoskeletal disorders as a result of their work. These health problems can result from poor posture, poor workstation layout and poor work habits and are consistent with the low percentage of correct answers to the scenarios that suggested the recommended adjustments, positioning and postures were not well known. Respondents were generally aware of the importance of rest breaks away from computer work but, consistent with the findings of the previous studies, were not so well aware of the importance of taking micro-breaks or carrying out pause gymnastics and resting the eyes with long distance viewing while working at the computer, and generally failed to do so.

Responses to the personality scale indicated that the computer users were generally a methodical, well-organised and conscientious group of people who were not lazy, impatient, absent-minded or careless. These personality characteristics suggest they would be likely to apply ergonomic principles given appropriate training and encouragement. Their general compliance in other areas of health promotion such as sun-baking, cigarette smoking and alcohol consumption appears to confirm this suggestion. Respondents were generally aware of the health risks of each of these activities and most never or rarely participated in them. In addition, a clear majority frequently undertook preventative action to avoid the health problems linked to the particular activity.

The results of Study VI indicated that knowledge was the key factor in determining the application of ergonomics: over half of the computer users did not apply ergonomics to their computer work, with most citing lack of awareness as the reason. Only 5% said they did not apply ergonomics because they were too busy. 8% said they forgot and a further 3% thought ergonomics was not important. The personality inventory showed that the respondents possessed the personal qualities usually associated with compliance and were more conscientious and agreeable than other samples (Brebner 2001). Also, respondents were generally compliant in their behaviour related to other areas of health promotion and when aware of the health risks associated with a particular activity generally avoided the risky activity or followed the precautions recommended to prevent problems.

Statistical analysis of the responses to the compliance scale and the application of ergonomics showed no association between compliance in other areas and applying ergonomic principles to computer work. However, analysis conducted to determine the impact of personality on the application of ergonomic principles to computer work found that people who scored highly on the personality facet of agreeableness were more likely to apply ergonomics (refer Table 7.16).

Respondents generally worked on a variety of tasks that they found interesting. They were able to use their initiative, were given the responsibilities required, and had adequate control over their work and flexibility in planning their work day. They participated in decision-making related to their work and generally believed their input was valued. Supervision was usually supportive and there was a friendly spirit of cooperation between co-workers. Overall their job was quite demanding and urgencies and deadlines frequently dominated the organisation of their work. Occasionally they were given too much to do and the rate of work was too fast, and they needed to work overtime to get the work done. There were frequently problems catching up on work when returning from leave.

Ergonomically designed furniture and equipment were usually available but computer users were rarely encouraged to apply ergonomics to their work and new staff generally did not receive induction on organisational policy regarding ergonomic computer use. The application of ergonomics was not monitored and computer users were not encouraged to take rest breaks away from their work. Software that trains and reminds computer users about ergonomic computer use was not provided.

Statistical analysis used to ascertain the importance of these work environment factors on the application of ergonomic principles to computer use showed nothing statistically significant, indicating that there was no association between the cultural work environment and compliance with ergonomics. On the other hand, statistical analysis to determine the impact of ergonomic knowledge on the application of ergonomics found that respondents who said they were aware of the ergonomic principles were considerably more likely to apply ergonomics than those who said they were not aware (refer Table 7.10).

Overall**,** the respondents were not experiencing psychological distress, although over one-third were feeling more under strain than usual and many had lost sleep over worry and were less able to enjoy their daily activities. However, the job satisfaction measure indicated they were generally happy with their work. Respondents were also generally physically healthy, although one-third suffered lower back problems and many reported pain in the shoulders, neck tension, eye strain and headaches.

Analysis conducted to determine the impact of ergonomic knowledge on the physical health symptoms experienced by the computer users showed nothing statistically significant, suggesting that there was no association between ergonomic knowledge and the reported health problems in this study. Likewise, analysis used to determine the impact of personality and the impact of the cultural work environment on physical health symptoms found none of the personality facets or work environment factors was statistically significant, indicating that no relationship existed in this study.

These conclusions from the collected studies led to the following answers to the research questions raised in Chapter 1:

1. There was limited ergonomic understanding among managers and computer users within organisations in the late 1990s.

2. Insufficient priority was placed on the application of ergonomic principles to computer use within organisations in the late 1990s.

3. Ergonomic knowledge, more than personality and the work environment, was the key factor influencing the application of ergonomic principles to computer use.

Computer technology was introduced rapidly into many organisations with diverse activities and occupations. The speed of change meant that workers had to become computer operators ‘overnight’, learning their computing skills on the job**.** The knowledge important for the prevention of musculoskeletal and eye disorders simply does not exist in organisations beyond those people fortunate enough to have received training in ergonomic computer use, from whatever source.

Respondents reporting that they were aware generally received their information from in-service training, occupational health and safety personnel and union representatives, indicating the importance of these sources within organisations for the dissemination of ergonomic knowledge. However, nearly three-quarters of all respondents reported they had never attended an educational program/training session provided by their employer that included information on ergonomic computer use, or read material that contained information on ergonomic computer use in the preceding 12 months. This observation suggests a considerable gap in occupational health and safety provision within organisations. The majority of respondents believed they needed to spend more time in training/update sessions in relation to ergonomics and computer use.

Overall, the workers participating in the studies knew they should take rest breaks away from the computer and to exercise during these breaks. There was a large increase in the proportion of people who reported taking rest breaks over the period of the studies, indicating that this health message had been successful in getting through to computer users. However, they were not sufficiently aware of other ergonomic principles, including the usefulness of pause gymnastics and micro-breaks while using the computer.

The studies highlighted that during this period over one-third of computer users experienced work-related pain, particularly in the neck, lower back and shoulders. Interestingly, problems associated with the arms, hands and wrists were reported less often than other aches and pain. While this finding accords with those of Winkel and Oxenburgh (1990) and others, who found disorders linked to computer use tended to be centrally rather than peripherally located, it contrasts with the large proportion of carpal tunnel and other arm, elbow and hand-related problems reported in the mid-

1980s and which were generally associated with prolonged computer use. It could be that trained touch-typists who carried out the majority of computer work in the 1980s were more likely to experience arm and hand problems due to their continuous typing technique, whereas in the 1990s the large growth in computer use within organisations resulted in most people working at a computer regardless of whether they were typists. This meant that a large proportion of computer users had not received keyboard training and used a ‘hunt and peck’ approach and the mouse more frequently, a technique likely to lead to more neck tension and shoulder pain. It has also been demonstrated that head and neck posture has an impact upon the muscle activity of the forearm and that some forms of RSI such as carpal tunnel syndrome may be due to muscular dysfunction in the neck (Skubick et al. n.d. p. 2). However, these health symptoms did not appear to prevent most people from carrying out their normal work activities, although sometimes they did impact on after-work activities such as working around the house and playing sports.

Organisations generally provided ergonomically designed furniture and equipment and the tasks of computer users were usually varied and interesting. Computer users were able to participate in decision-making about their work, were given the responsibilities required to complete their tasks, and had supportive supervision. Occasionally the work demands were excessive and the rate of work too fast but these factors did not appear to affect the application of ergonomic principles. However, levels of psychological distress increased when job demands were high and peer cohesion low. Higher job demands were also positively associated with upper body symptoms such as neck tension, headaches, and upper back and shoulder pain. These symptoms increased as the hours spent daily on computer work increased, and were lowest among computer users who took regular rest breaks away from the computer. The respondents were generally careful, conscientious people who scored high on the scale of agreeableness, indicating they were more likely to apply ergonomic principles to their computer work and comply with health promotion recommendations.

Knowledge of ergonomics was associated with job satisfaction and physical health: employees with greater levels of ergonomic knowledge showed greater levels of job satisfaction and lower levels of physical health symptoms. In Study IV, low levels of ergonomic knowledge were linked with hand and wrist problems. In addition, aspects of the psychosocial work environment impacted on levels of job satisfaction, and mental and physical wellbeing, suggesting that changes to the work environment such as reduced job demands, increased job security and improved peer cohesiveness, together with providing employees with a better knowledge of ergonomic principles and practices, will contribute to improved physical and psychological health (Sawyer, Dollard and Farrin 2002, p. 256).

Overall, the findings suggest that lack of knowledge was the key factor influencing the non-application of ergonomic principles to computer use within organisations. The studies also indicated that training provided in ergonomic computer use and commitment to ergonomic computer use was generally lacking within organisations. This is consistent with data that show that occupational health and safety training ranked second lowest of training categories attended (NOHSC 1997). In 1997, the average annual wages and salaries spent on occupational health and safety training were $24 for each employee, with direct workers' compensation costs being 25 times higher than OHS training wages and salary costs.[56] The studies also highlighted the importance of educational institutions such as TAFE in providing ergonomic information to computer users as part of their training.

It appears that managers and computer users within organisations require more information to increase their awareness of the particular specific adjustments to furniture and equipment, the recommended sitting postures and positioning of the arms and wrists, and techniques available to rest the body and eyes and avoid the health risks associated with computer use. The findings also indicate that greater priority is required to be given to the management of ergonomic computer use if organisations are to control this area of risk and fulfil their obligations under occupational health and safety legislation. Strong leadership, at both the strategic and operational levels, is required to develop a culture of commitment to a system of managing workplace injury and illness. The appropriate organisational structures, policies and procedures must then be converted into action.

The finding that a low level of knowledge of ergonomic principles in relation to computer use was common in workforces in different settings (public and private sector organisations in a metropolitan and a regional setting, and a university) appears to confirm that this area of occupational health and safety was often ignored by organisations and was of little concern within society generally during the late 1990s. This may have been due, at least partly, to its having gone ‘underground’ following two Supreme Court decisions in the mid-1980s that found the employee had not

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[56] From analysis of ABS data by NOHSC staff published in *Worksafe news*, November 1997.

suffered an injury.[57] At the time a lot of discussion focused on the social and psychological factors influencing the diagnosis and reporting of RSI and challenged the reality of RSI as a legitimate medical condition. Subsequently, RSI became accepted to be socio-political rather than medical in nature, with the apparent lack of endorsement by the medical profession being interpreted as a lack of problem by many employers and employees (Ireland 1992; Dembe 1996).

The Context of the Findings of the Empirical Studies

The empirical studies forming this thesis confirmed that the knowledge of and priority given to ergonomic computer use was undesirably low and that neck, shoulder and back pain in particular were still common among computer users working within a variety of South Australian organisations in the 1990s. A modernist or rationalist view of health promotion in general, or ergonomics in particular, would observe the continuing existence of these potentially disabling problems and prescribe for computer operators enough additional education and training for them to understand the truths of ergonomics and to change their work habits accordingly.

The 'modern' view had been around for long enough. The first comprehensive, empirical study on the health effects of work was carried out in 1700 by Bernardino Ramazzini, an Italian physician who observed that health problems, especially in relation to the hand and upper extremity, gradually developed from unnatural

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[57] *Zabaneh v. Commonwealth of Australia,* 1985 and *Cooper v. Commonwealth of Australia* 1987, discussed by Ireland, D. 1992. 'The Australian Experience with Cumulative Trauma Disorders' in L. H. Millender, D. S. Louis and B. P. Simmons (eds) *Occupational Disorders of the Upper Extremity.* Churchill Livingston Inc., New York, p. 86.

positions of the body and repetitive actions in the workplace (Louis 1992, p. 15). Workplace injuries with ergonomic antecedents were not new and not a problem only in Australia (Kiesler and Finholt, 1988, p. 1004). However, there is little doubt that there was a dramatic increase in workstation injuries coincident with the introduction of computers to Australia in the mid-1980s and with increased use of electronic keyboards, which allowed much faster keystroke rates and reduced the natural breaks associated with typewriter use.

A desire to install and profit from the new technology as quickly as possible was accompanied by a lack of consideration of the ergonomic aspects of job design, and staff reductions that resulted in more work being concentrated onto fewer people. From July 1984 to June 1985, approximately 26% of Commonwealth Public Service employees in the Australian Capital Territory were affected by upper limb pain resulting from rapid, repetitious use of a keyboard, with the estimated cost of lost work in the Commonwealth Public Service alone being $24.13 million (Ireland 1992, p. 83). In South Australia, the number of RSI cases in the category that included keyboard operators rose from 12 cases in 1980–81 to 204 in 1984–85, and declined to 85 in 1986–87 (Gunn 1990, p. 379).

Some considered RSI to be an expression of a larger social/economic/political problem related to the introduction of new technology that changed work practices, resulting in a faster pace of work, increased workloads, fewer rest breaks, reduced staffing levels and increased overtime (Dainoff and Dainoff 1987, p. 21). Others argued that RSI could also occur with old equipment, so it was not uniquely related to new technology and its rising prevalence might, therefore, be more related to job satisfaction (Hocking 1987, p. 222; Ryan et al. 1985; Graham 1985). Intense debate ensued over the causes of RSI, with one strongly supported view being that it was a psychological problem where emotional stress and job dissatisfaction led to the development of physical symptoms. Whatever the workers might be experiencing could, then, be reduced to an expression of modern capitalism with its excessive productivity demands and dehumanisation of employees, particularly of women and ethnic workers in low-paid, low-prestige positions who were unable to change their working conditions (Lucire 1988; Kiesler and Finholt 1988). It was argued that the epidemic of RSI in Australia occurred at a time of technological change when computerisation threatened those people less adaptable to change, and that its prevention required “acceptance of RSI as a multifactorial, occupational and socioeconomic problem with a major psychological basis, rather than a physical condition resulting from injury” (Ireland 1992, p. 83). The assertion was that the pain had no “distinguishable clinical symptoms” or recognisable pathologic changes and, therefore, was not related to physical work but to “the psychological stress of the work task” and that this “non-physical” condition should receive non-physical treatment, in the form of instruction in coping mechanisms and relaxation therapies based on an “acceptance of its psychological origin” (Ireland 1992, p. 83).

Arguments about RSI were raised in “an intensely politicised context” marked by actions by workers’ health and women’s groups, excited coverage in the media, and legal actions for compensation (Bammer and Martin 1988, p. 348). The ‘standard view’[58] was that physical damage did exist: injuries in the neck, shoulders and/or

[58] The ‘standard view’ arose from the work of researchers such as Browne et al. (1984), Ferguson, (1984), McPhee (1982) and Stone (1983, 1984).

upper limbs were caused by rapid repetitive movements, forceful movements and static load that were work-related, although it was recognised they could also be caused or exacerbated by out-of-work activities. According to the ‘standard view’, the workers experiencing these problems were “highly motivated” people with “strong work ethics” who were “often their own worst enemy by denying the existence of symptoms and pressing on regardless”. Contrary views were that people with RSI were malingerers, that they suffered from compensation neurosis, that they had a conversion disorder, or that they had normal fatigue. In each case, RSI was regarded as either not real or not work-related, or both. Malingerers were considered to be faking their symptoms in order to receive workers’ compensation payments, time off work or lighter duties, encouraged by the political climate and attitudes prevalent in society at the time that were said to lack ‘work ethics’. Compensation neurosis was said to exist when people had disproportional disability and delayed recovery from a genuine injury, attributed to a desire for financial and other gains, such as invalid status, attention from others, and freedom from unwelcome work (Bammer and Martin 1988, p. 351). According to the conversion disorder view, there was considered to be no injury; rather, psychological conflict or emotional disturbance resulted in pain, which in turn allowed escape from the conflict. Proponents of this view argued that “the powerless and dependent who cannot otherwise express their righteous rage at their supervisors, employers and spouses, resort to the use of their exquisitely symbolic pain and incapacity as a mode of communication of their distress” (Lucire 1986). Lucire (cited in Bammer and Martin 1988, p. 352) commented that keyboards had become “symbols of physical danger or economic insecurity to which the vulnerable reacted neurotically". Sufferers were portrayed as compulsive, dependent people with "egg-shell personalities" who were reluctant to work. A fourth view was that, rather than there being an injury, people were reporting normal discomfort which might arise as a result of unaccustomed tasks, awkward postures and inability to regulate the pace or performance of work**.** This 'normal discomfort' would usually have been accepted in silence but, due to a climate of occupational medicine that warned that "no individual could or should attempt to ignore such discomfort", it resulted in an epidemic of RSI reporting (Hadler 1986; Spillane and Deves 1987). However, Bammer and Martin (1988, p. 354) noted that the critics of the standard view "failed to refute or even cite much of the evidence used to support the standard view", adding that "epidemics have also occurred outside Australia, that preventative strategies do work, that pathological changes and overuse may occur, and that work-related factors are often clearly associated with RSI".

It was suggested that the RSI epidemic was caused by heightened public awareness leading to more reporting and diagnosis; by increased production rates coupled with overtime and incentive payments; by reduction in task variety due to automation and inadequate job rotation; by less mobility as workers found it difficult to leave jobs that caused pain due to high unemployment and the economic recession; and by inadequate attention to ergonomic factors (Stone 1984, cited in Bammer and Martin 1988, p. 350). Others linked RSI to psychosocial factors such as low autonomy, low peer cohesion and a need to push oneself, suggesting that these factors increased muscle tension and therefore the propensity to injury (Blignault 1985; Ryan et al. 1987; Wall 1985).

The RSI epidemic in Australia peaked during 1983–85 but declined thereafter. Factors such as the liberalisation of criteria for compensation, a supportive Labor Government and trade union education campaigns were thought to have contributed to the increase in claims often believed to be a by-product of social issues related to the introduction of the new technology that led to changes in work practices and job losses (as Dembe had observed in other times and other settings) (Dembe 1996, pp. 91–92). The subsequent decrease in claims was attributed in part to clearing a back-log of previously unreported ailments, growing medical scepticism about the existence of RSI, and a social backlash that culminated in a finding against a worker in the case of *Cooper v. Commonwealth of Australia, 1987.* The decisions made in this case resulted in many pending suits being withdrawn on the advice of lawyers and trade union leaders (Ireland 1992, cited in Dembe 1996, p. 93). In response to the compensation claims, many employers made improvements in job design and work methods. Intervention programs in the area of keyboard work resulted in the provision of 'ergonomic furniture', job rotation, limits on keystroke rates, rest breaks and encouragement to report symptoms early. Other explanations for the decline included lack of reporting due to fear of discrimination, job loss and future unemployability due to being stigmatised as an RSI case; the Hawthorne effect, where "a non-specific behavioural or psychological effect is induced by the intervention irrespective of its content"; and a selection effect, where "those at risk had either developed the condition already or had transferred to occupations with less risk". However, while the epidemic waned, its underlying causes remained (Gun 1990, p. 379).

Social and political factors tend to become important where the link between work and a disorder is not easily determined. RSI might result from a multiplicity of factors including workplace and non-workplace activities, genetic makeup and individual susceptibility, and environmental and lifestyle attributes (Dembe 1996, p. 11). There has been continuing debate regarding whether repetitious work is the cause of carpal tunnel syndrome (CTS), the most frequently cited type of RSI. Dr Stuart Myers, an orthopaedic surgeon, argued it was not. He suggested that rather than spending money on ergonomic change to people's work, money might be better spent on people getting fit, losing weight and stopping smoking, as the risk factors for CTS were "obesity or lack of fitness, diabetes, reaching menopausal age, smoking and a lifetime alcohol intake" (Faulkner and Myers 2002).

Members of the Human Factors and Ergonomics Society of Australia strongly refuted Myers' claims. Darby[59] (2002)[60] questioned the source of Myers' finding and commented that it was "suspiciously neat" in blaming the worker: in Darby's opinion the relationship between repetitive work, forceful work, and repetitive plus forceful work and musculoskeletal disorders, as concluded by the NIOSH review in 1997, still stood. However, recent thought has focused on stretching and exercise as the "quickest solution" to reducing musculoskeletal injuries in the workplace (Eckenfelder 2004, p. 9). Eckenfelder[61] argued that, to deal effectively with

59 Mr Frank Darby, Senior Health Policy Advisor, Occupational Safety and Health Service, Wellington, NZ.

60 In the Australian Ergo List (Aus_ergo). This list is distributed by an HFESA member from the Department of Human Movement Studies at The University of Queensland. It is used widely by ergonomists from WorkCover, Centrelink and other government departments, academics from a variety of universities, ergonomic designers and consultants, physiotherapists and health consultants, and occupational health and safety employees within private organisations. It provides a forum for any person with an interest in occupational health to share ideas, ask for help and provide information. The range of topics covered is extensive and has included computer eye strain and spectacles for VDU work, screens and fonts, keyboards, seating, laptops and mouse use.

61 Mr Donald Eckenfelder, a leading OHS consultant and past president of the American Society of Safety, at SIA's Safety in Action Conference April 2004.

musculoskeletal injuries, employers must see their workers as athletes and implement a comprehensive exercise program “to warm up, relieve stress, and strengthen”.

Recent Developments in the Field of Ergonomics

A study examining seated working positions of computer users (Dowler et al. 2001, pp. 74, 76) supported the importance of workstation ergonomics. This study showed that placing the body in a posture that required less muscle activity to support its own weight reduced muscle activity during computer work, and that keyboard placement was the most important “positional factor”.[62] Dowler et al. (2001) recommended that the computer operator be positioned on a forward-tilting seat pan, which placed the head “in midline over the shoulders”, and relaxed the upper trapezius and wrist extensor muscles; that the desk height be determined by having the operator having the elbows at 90 degrees when sitting in a correctly adjusted chair; that the keyboard be at negative 15 degrees, sloping away, at an appropriate height to allow palms to rest on a palmrest; that monitors be set so that eyebrows aligned with the top of screen, and adjusted to accommodate bifocals or trifocals; and that the document holder be placed directly in front between the keyboard and monitor at a 45 degree slant, reducing the need for head flexion or rotation. Dowler et al. (2001) found the upper trapezius and wrist extensor muscles relaxed almost immediately when the hands were placed on a palm-supported, rear-sloping keyboard, placed just above the lap. In this position the palms were able to glide easily over the palmrest, wrists were in a neutral position and fingers arched, reducing extended reaching. Having elbows

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[62] These findings confirm those of Hedge et al. (1995), who found use of preset tilt-down (PT) keyboards resulted in improved wrist posture and seated posture and reduced upper body musculoskeletal discomfort.

in an open angle of approximately 115 degrees allowed the upper trapezius muscles to rest and opened the elbow angle, reducing stress on the upper and lower arms. Use of the rear-tilting keyboard also enabled the typist to take micro breaks automatically, increasing the rest cycles and reducing the load on the upper trapezius muscles, allowing them "to recuperate while maintaining the established working posture" (Dowler et al. 2001, p. 77). However, Cook and Burgess-Limerick (2003, pp. 27, 28) reported that a negative-slope keyboard might increase ulnar deviation and tendon travel of the long finger flexors, and reduce "postural variability due to the fixed position of the keyboard". Computer users need to be aware of a range of 'safe' postures and set-ups which can be adopted throughout the working day, including the option of workstations that can be used while standing and so provide further variability in position (Cook and Burgess-Limerick 2003, pp. 20, 21). This, also, is a 'modern, rational' debate but it is, at least, a debate about contested ergonomic reasons and does not slide off into arguments about occupational psychology or workers' dispositions. The same might be said about a more recent debate concerning the ergonomics of computer design.

An increasing demand for technology that is small and transportable has seen a large increase in the use of laptop computers which, while convenient, may become health hazards when used for prolonged periods in the workplace. Changes in computer design have reduced the size of the keyboard, the size and quality of the screen, and adjustability – and not all of the changes have been ergonomically rational. Having the screen hinged to the keyboard affects the placement of the screen and its angle to the keyboard, which may compromise comfortable working postures, and the use of a keyboard much narrower than the operator's shoulder width affects hand positioning, also increasing the likelihood of injury. Therefore, it is recommended that laptops be plugged into a standard desk monitor and used with a separate keyboard and mouse whenever possible to reduce neck and shoulder strain and visual fatigue, and that users be trained in the use of software, hardware and workstation furniture to enable them to use the portable computer equipment safely (WorkCover 2002). WorkCover emphasises that laptops are intended to be used for brief periods of work when away from the office, and not as a substitute for an adjustable desktop unit and workstation.

Mouse use became a more prominent part of computer operation with the introduction of Microsoft Windows software, resulting in increased disorders of the hand, wrist and upper arm. Pointing devices of different types and shapes, and which are cordless and digital, have been developed in an effort to overcome these injuries. One such device is the ‘whale mouse’, which cradles the whole hand and is designed to eliminate the repetitive click motion for the thumb and allow the whole hand to move to guide the mouse, eliminating the static force on the thumb. Recent publications indicate that mouse movements should be made using the elbow as a pivot point, keeping the wrist straight and neutral (Hedge 2004b) with the forearm supported (Cook and Burgess-Limerick 2003, p. 32). The recommended placement of the mouse is on a platform over the number keypad or on an angled pad to the side of the keyboard; placement on a flat surface, or on the desk, to the side of the keyboard is not recommended (Hedge 2004b). Non-hand input devices, such as the ‘no hands mouse’, which is foot operated, are available as alternatives. Desktop keyboards have become more stylishly contoured, with added scrolling rollers and wheels, application software starter buttons and controls for many of the most popular computing tasks that used to need mouse work. Models are available that are adjustable both horizontally and vertically, have detachable number pads and a touch sensitive mouse located in the centre of the keyboard, designed to overcome the musculoskeletal problems caused by reaching too far to the side. ‘Ergoports’ were also introduced with claims that the use of this device, which sits above the desk and provides support for the arms, reduced muscular stress in upper trunk muscles and promoted the upright posture and elbow positioning at the side of the body. However, because use of an Ergoport raises the user by approximately 50 mm, it may result in shoulder elevation and the need for a footrest; it may be restrictive, particularly to elbow movement; and it may encourage the operator to rest on their arms, causing higher loads at the shoulder (Walsh 2002).

Use of the generally recommended ‘floating’ method of typing, where the keyboard is positioned close to the edge of the desk, and the wrists are held level and the arms not supported, has also been questioned. Studies to determine the effects of arm supports on wrist angles and musculoskeletal strain in the neck and upper extremity found that forearm support decreased neck and shoulder activity and discomfort, and resulted in significantly less ulnar deviation during keyboard use (Cook and Burgess-Limerick 2001, p. 104). Cook and Burgess-Limerick (2001, p. 105) concluded, therefore, that forearm support during keyboard use, rather than a floating posture, should be the guideline, although they also (2003, p. 26) reaffirmed the importance of individual differences and acknowledged that, while forearm support may be beneficial for most people, it is not suitable for all. Their findings were supported by Lintula et al. (2001, pp. 103, 114), who found use of arm supports for both arms reduced muscle strain in the shoulders and decreased wrist extension.

More recent discussions on the positioning of VDUs favoured placing the monitor further than “an arms length” away (Burgess-Limerick et al. 2000). If it is possible to read the screen comfortably it is considered to be not too far away; if the characters cannot be read easily, then it is recommended that the image/font size be increased rather than moving the monitor closer.[63] Lowering monitor height was also recommended as looking downwards helped avoid dry eyes, as more of the eye surface was covered by the eyelid, causing the eyes to unconsciously blink more and produce more lubrication. Lower monitor locations allowed the preferred gaze angles of between 35 and 44 degrees below the ear–eye line, with no significant effect on the position of the neck relative to the trunk (Burgess-Limerick et al. 1999, p. 171). Flat panel, liquid crystal display (LCD) and plasma screens that take up less space, emit less heat and no radiation, and have better screen geometry[64] and image quality, are available as alternatives to cathode ray tube (CRT) monitors.

Developments in relation to seating for computer users saw the introduction of Swiss balls as an alternative to chairs, with the aim of creating a dynamic environment for sitting as opposed to static seating. Use of the balls in rehabilitation had been shown to improve balance, coordination, muscle balance, strength and endurance and it was argued that when used as chairs similar effects were achieved (Lee 2001). However, the use of Swiss balls at computer workstations was viewed with caution: use of the balls “would constitute a daily regime of constant exercising”, resulting in high concentration levels and fatigue; their use would not provide adequate support for the

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[63] Australian Standard AS3590.1 *Screen-based workstations, Part 1: Visual display units* (1990, p. 5) warns that the qualities of legibility and readability are not always complementary and that “increasing character size and intercharacter spacing may increase legibility while reducing readability”.

[64] Screen geometry refers to the fact that wherever an image on the screen lies it will look the same.

buttocks, thighs or back; and getting on and off or reaching from the ball could constitute a falling hazard. It is generally considered that Swiss balls are not appropriate for use as work chairs and should be used in the workplace only on the recommendation of a physiotherapist as part of an individualised physiotherapist-supervised rehabilitation program and after factors such as the nature of the tasks to be performed and the appropriate height/size of the ball have been taken into consideration (Worksafe Victoria 2003, pp. 1, 2).

Changes in the way computers were being used led to increased concern regarding eye and neck/shoulder problems. Over the past decade there has been greater use of the VDU to perform many tasks available in software systems, so that interfacing with pre-formatted screens is often more common than prolonged data entry. Problems can arise from holding the head still for a long time, focusing at the same distance for an extended period, and the length and intensity of the mental task. It has been suggested that the term 'visual and ocular fatigue' describes the fatigue that can occur better than use of 'eyestrain', which confines attention to the eyes, omitting emphasis on the rest of the body parts involved, and implies 'strain' "which has too many interpretations to be precise in the context" (Darby 2000). Darby considered the term 'Computer Vision Syndrome' (referred to in Chapter 1) to be unnecessary as it "simply complicated the matter when there were already sufficient descriptions available". He also placed emphasis on what he termed "application of the mind fatigue". Darby believed that, when Ramazzini (1713) wrote the words:

> …but what troubles these workers the most acutely is the intense and incessant application of the mind, for in work such as this the whole brain, its nerves and fibres, must be kept constantly on the stretch**,**

he was referring to what is now described as 'stress' and that viewing stress as 'attention fatigue' enables concentration on the notion that "stress may result when attention is held too strongly for too long without a break". Darby suggested that computer work could "draw people into it so strongly that the passage of time becomes shortened and high levels of attention are used for long periods without the person being aware". This approach focuses on the concept of altering the task to reduce the attention it requires, and awareness of how to allocate the resource 'attention' wisely, allowing for rest after effort and time for reflection after application (Darby 2000).

Theory versus Practice

My earlier empirical studies indicated that the complexities of the wide array of technical material available in the field of ergonomic computer use were not being conveyed adequately to the people on the 'shop floor' who were regularly using computers to complete their daily work. Ineffectual communication of the relevant available information resulted in its general non-application. The need to overcome this gap between the theory and its practice has been recognised recently by the ergonomics professional associations. Hedge (2004a),[65] speaking at an HFESA conference, emphasised that "human beings are not 'intuitive ergonomists'" and that organisations "cannot throw expensive products at employees" without appropriate training and see the desired results. Howard (2004, pp. 195, 196)[66] also stated that a

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[65] Professor Alan Hedge, Department of Design and Environmental Analysis, Cornell University, keynote speaker at *Ergonomics for a BIZ-e World*, Conference of the HFESA and PPCOE held in Cairns, Australia, August 2004.

[66] NIOSH Director Dr John Howard, commentary at Third National Occupational Injury Research Symposium (NOIRS) 2003.

“major challenge” facing the occupational injury prevention research community is “bridging the gap between research findings and the implementation of evidence based, culturally competent, prevention practices in workplaces” and that “NIOSH is most interested in ensuring that the roads from research to practice are well paved, clearly marked, and heavily trafficked”. He emphasised that “in the context of a public health approach to injury prevention research, more effort is needed to ‘close the loop’ and translate and implement the findings of injury prevention research”.[67]

“Training in how and when to adjust the workstation should be mandatory for computer users” (Cook and Burgess-Limerick 2003, p. 21). Physiotherapists are currently reporting a high proportion of neck and shoulder injuries among people working with computers, particularly middle-aged and older people who have used computers at work for many years (*Advertiser* 11 June 2004, p. 43). Holt (cited in Quinlivan 2004, p. 111), when surveying health problems that are preventable but still causing time off work, found two-thirds of the people recently surveyed had been off work due to back and neck pain. Often people suffering a complaint of pain do not relate it directly to their work, thereby ignoring the causes and possible solutions to problems which can be reversed and managed by proper ergonomic intervention (CUErgo 2004).

Providing appropriate furniture is beneficial, but ergonomic workstation modifications will not make a significant improvement if posture is not corrected (Bower 1994) and having ergonomic furniture available is no guarantee of it being used appropriately to

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[67] Modern rationalism has, perhaps, been displaced for the time being by humanism?

provide good posture.[68] Suitable furniture must be combined with the teaching of correct work habits that “form the basis of a lifelong association” with computer use (Shaw 1999). To avoid aches and pains, people need a suitable workstation, training in its use, and training in relaxed work (Brown 2002). With an emphasis on self-awareness, employees must be motivated to care for their bodies and use postures, movement patterns and preventive stretching to minimise fatigue (IMPACC USA 2001). Computer users must receive specific instruction on how to customise the adjustable features of their workstation to suit their individual requirements and also be made aware of other contributing factors of work organisation, workload and the psychosocial work environment, and understand the importance of breaks, variation in posture and activities, and regulating the pace of work.

“Knowledge alone doesn’t change behaviour … behavioural change requires an ongoing program of intervention, education and reinforcement” (Penny, cited in Quinlivan 2004, p. 111). Within organisations this can be achieved by making people responsible for the information flow (policy dissemination, reporting requirements, budget allocations and in-house promotion), by directing resources and putting them into action, by monitoring performance, and by providing appropriate follow-up.[69] It involves consultative processes between employees and management to understand work demands. Management should work proactively to avoid stressors such as harmful work styles and tight deadlines. In addition, within educational institutions

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[68] Oxenburgh (1991, p. 56) notes, however, that “there is an interrelationship between environmental and personal factors: good physical working conditions will encourage good (in the safety-related sense) behaviour; a good organizational and psychosocial environment will similarly encourage good behaviour”.

[69] Also discussed by Mr James Coe and Dr Ross Ulman in “The body or the machine: experts go into battle”, *Modern Office*, December/January 1984/85, pp. 8–9.

the dissemination of information can be assisted by ensuring that all courses taught in computer pools include appropriate instruction in ergonomics, that the application of ergonomics within class time is monitored, and that informative documents containing material related to ergonomic computer use are readily available. The computers themselves can be used as tools to encourage the application of ergonomics via the installation of software that instructs and reminds.

Employers have an obligation to provide a healthy workplace and to ensure that people working within their organisation are adequately informed and able to carry out their work in a safe way. The economic conditions of maximising profit and minimising costs, combined with global competition, have led to many employers under-investing in health and safety (Ochsner and Greenberg 1998, p. 354). Lower levels of union membership, corporate downsizing and outsourcing, and greater use of part-time and contract labour contribute to less employee participation in OHS. Unions often have a critical role in assisting workers to access and understand health and safety information and in providing OHS protection when employers have other priorities; research has shown that the most successful strategies for worker participation are linked with strong unions and vigorous government enforcement (Ochsner and Greenberg 1998, pp. 356, 362). In recognition of the higher incidence of computer-related health problems among female employees than among males, more emphasis must be placed on the training of women health and safety representatives and the strengthening of their powers, to improve the occupational health, safety and welfare of women in Australian workplaces (WorkCover 2003, p. 5).

Final Remarks

This thesis examines empirical material related to the introduction of new technology and its impact within different types of organisations in South Australia during the 1990s. The research on which the thesis is based sought to determine answers to the question “Why wasn’t ergonomics being applied to the use of computers?” and to investigate the reasons for such a gap between the large amount of material on ergonomic computer use that was available and its application in the workplace. A great deal of ergonomic thought and information was being published in the 1980s at the time of the RSI epidemic, much of which still reads as if it is valid for the purpose of health promotion. Over the past decade, the extensive development of sites on the world-wide-web and the use of subscription e-mail lists have provided even more information and enabled access to current debate. A large part of the problem appears to be that the complexity of the technical information is not being translated to the workplace. The empirical studies raise a moral question in relation to what can be done to deliver the information to those who would benefit from it. “Ergonomics is not being effective in society” (Oxenburgh 2004)[70]: in the United States of America, ergonomics is currently viewed by many people as “junk science”, with no real role (Hedge 2004)[71]; in Australia, it is argued, “few people are exposed to accurate information on ergonomics” (McFarlane 2004).[72]

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70 Dr Maurice Oxenburgh, in his presentation at *Ergonomics for a BIZ-e World*, the 40th Annual Conference of The Human Factors and Ergonomics Society of Australia and the 7th Annual Conference of Pan Pacific Council on Occupational Ergonomics, Cairns, Australia, 22–25 August 2004. Oxenburgh and Marlow (2004 p. 113) argued that “economics is an integral part of ergonomics” and that, in order to implement change in the workplace, ergonomists must use the language of finance to show management how the benefits of ergonomic interventions outweigh the cost.

71 Professor Alan Hedge, in his keynote address at the above HFESA Conference.

72 Mr David McFarlane, WorkCover New South Wales, expanding on the comments of Professor Hedge.

The quest for greater efficiency and more effective control over workers has governed the historical development of the capitalist labour process; greater worker participation and work enrichment is required to counteract the alienating direction in which work has been developing (Willis 1986, p. 214). Current management based on economic rationalisation aims to maximise productivity, quality and efficiency, while ergonomists emphasise safety, health and comfort “with a view to optimising the function of the human component” of the production system (Fraser 1983, p. 60). An ergonomics impact may be achieved through management approaches that focus on team building, flat organisations, and the multi-skilling of workers; “a ‘learning organisation’ and ‘team’ work may contribute to an improved psychosocial exposure”, which may, in turn, both increase productivity and reduce musculoskeletal complaints (Winkel and Westgaard 1996, pp. 71, 72, 75).

As the social environment “mediates the effects of the physiological and ergonomic factors” associated with computer-related disorders, the conclusions of this thesis must be considered within their broader social/economic/political context (Willis 1986, p. 211). It would be incomplete to view computer-related disorders as an individual and biological phenomenon for which ergonomic solutions alone are sufficient; it is also necessary to observe the social relations associated with the introduction of computer technology and “the development of the capitalist labour process for social and political causation”. The RSI epidemic of the 1980s emerged at a time of considerable change in the “social relations of production” and was “not related in any simple way to technological innovation”: in post-war Australian society, concern heightened regarding the provision of a safe, hazard-free working environment and occupational health, safety and welfare, and became "an industrial relations issue between capital and labour"; the new keyboard technology transformed the work of some traditionally male and strongly unionised occupations; and greater participation of Anglo-Saxon women in the paid workforce "diluted to a certain extent the sexual and ethnic stereotyping of jobs" and led to "greater opposition to obstacles to a continued career outside the domestic sphere". Also, while in times of high employment, the workers' response to aches and pains could be to change jobs, the economic period of high unemployment at the time restricted the movement of employees to alternative work (Willis 1986, pp. 211–217).

The thesis has revealed that the level of knowledge of and priority given to ergonomic computer use within organisations was low, and that greater knowledge was a key factor in increasing the application of ergonomics, improving job satisfaction and reducing health symptoms. The empirical studies were reviewed in the light of arguments at the time and since about the relative significance of ergonomic, social, psychological and even politico-economic perspectives on 'trouble at the works'. The review suggests that the initial debate was too rationalist, to the point of being anti-humanist. The combination of humanist and rationalist perspectives should have considerable consequence for computer operators by highlighting their informational and other needs in relation to the provision of a working environment appropriate to the prevention of computer-related disorders. It should also be useful in assisting organisations in planning their systems of hazard management and risk control and for the relevant professional, government and other bodies in their decision-making regarding strategies for improving this area of health promotion. New staff within organisations require induction in ergonomic work practices, followed by regular refresher courses, and a workplace culture developed that takes this area of work safety seriously and puts into action the proliferation of information available, closing the gap between theory and actual practice.

REFERENCES

Advertiser 3 November 1997, ‘PS stress compo passes $50m’, p. 5.

Advertiser 18 November 2000, ‘Thumbs up for new mouse’, p. 93.

Advertiser 11 June 2004, ‘Computer neck/shoulder injuries increase with time’, p. 43.

Armstrong, T. J. 1992. ‘Cumulative Trauma Disorders of the Upper Limb and Identification of work-Related Factors’, in L. Millender, D. Louis. and B. P. Simmons, (eds) 1992. *Occupational Disorders of the Upper Extremity*, Churchill Livingstone, New York, pp. 19-45.

Australian Industrial Safety, Health and Welfare, 1991. *Commercial Safety Regulations,* CCH Australia, North Ryde.

Australian Information Industry Association, 1988. *Computers in the Workplace, a Guide to Screens and Keyboards for Managers and Users,* Australian Information Industry Association, Canberra.

Bammer, G. and Martin, B. 1988. The Arguments about RSI: An Examination. *Community Health Studies*, XII (3), 348-358.

Banks, M. H. 1983. Validation of the General Health Questionnaire in a young community sample. *Psychological Medicine,* 13, 349-353.

Banks, M. H., Clegg, C. W., Jackson, P. R., Kemp, N. J., Stafford, E. M. and Wall, T. D. 1980. The Use of the General Health Questionnaire as an indicator of mental health in occupational studies. *Journal of Occupational Psychology,* 53, 187-194.

Bayer, R. 1988. *The Health and Safety of Workers: Case Studies in the Politics of Professional Responsibility,* Oxford University Press, New York.

Bendix, T. 1984. Seated trunk posture at various seat inclinations, seat heights and table heights. *Human Factors,* 26 (6), 695-703.

Bergqvist, U. 1984. Video display terminals and health. A technical and medical appraisal of the state of the art. *Scandinavian Journal of Work, Environment and Health,* 10, Suppl. 2, in S. Sauter, M. Dainoff and M. Smith (eds) 1990. *Promoting Health and Productivity in the Computerized Office,* Taylor and Francis, London.

Bernard, B., Sauter, S., Fine, L., Petersen, M. and Hales, T. 1994. Job task and psychosocial risk factors for work-related musculoskeletal disorders among newspaper employees. *Scandinavian Journal of Work, Environment and Health,* 20, 417-426.

Bigos, S. J., Battie, M. C., Spengler, D. M., Fisher, L. D., Fordyce, W. E., Hansson, T., Nachemson, A. L. and Wortley, M. D. 1991. A prospective study of work perception and psychosocial factors affecting the report of back injury. *Spine*, 16, 1-6.

Bigos, S. J., Battie, M. C., Spengler, D. M., Fisher, L. D., Fordyce, W. E., Hansson, T., Nachemson, A. L. and Zeh, J. 1992. A longitudinal, prospective study of industrial back injury reporting. *Clinical Orthopaedics and Related Research*, 279, 21-34.

Bird, F. E. and Loftus, R. G. 1976. *Loss Control Management,* The Institute Press, Georgia.

Blakistons, 1972. *Gould Medical Dictionary,* 3rd edn, McGraw Hill, New York.

Blignault, I. 1985. Psychosocial aspects of occupational overuse disorders. Master of Clinical Psychology thesis, Department of Psychology, Australian National University, Canberra, in G. Bammer and B. Martin, 1988. The Arguments about RSI: An Examination. *Community Health Studies*, XII (3), 348-358.

Bower, P. 1994. Twenty Clinical Truths About RSI. Accessed 10 December 2003, <http://www.tifaq.com/articles/20_rsi_truths.html>.

Braidwood, P. 1988. Fetal statistics that don't quite compute. *The Advertiser*, 29 November, p. 34.

Brebner, J. 1998. The Quick Scales. University of Adelaide, South Australia. Accessed 12 November 1999, <http://www.psychology.adelaide.edu.au/members/staff/johnbrebner/quickScales.htm>.

Brebner, J. <psyj-bre@complex.psych.adelaide.edu.au> 2001. The Quick Scales. Accessed 9 February 2001.

Brown, D. <davidbrown@bigpond.com> 2002. Backrest widths. Accessed 22 June 2002, <aus_ergo@lists.uq.edu.au>.

Browne, C. D., Nolan, B. M. and Faithfull, D. K. 1984. Occupational repetition strain injuries: guidelines for diagnosis and management. *Medical Journal of Australia*, 140, 329-332.

Bullock, M. 1999. Ergonomics in Australia. *Ergonomics Australia,* 13 (4), 24-37.

Burgess-Limerick, R., Mon-Williams, M. and Coppard, V. L. 2000. Visual display height. *Human Factors*, 42, 140-150

Burgess-Limerick, R., Plooy, A., Fraser, K. and Ankrum, D. R. 1999. The Influence of Computer Monitor Height on Head and Neck Posture. *International Journal of Industrial Ergonomics*, 23, 171-179.

Burns, R. B. 2000. *Introduction to Research Methods,* Pearson Education Australia, NSW.

Burt, S., Hornung, R. and Fine, l. 1990. Hazard evaluation and technical assistance report: Newsday, Inc., Melville, NY. Cincinnati, OH. NIOSH Report No. HHE 89-250-2046, in B. P. Bernard (ed.) National Institute for Occupational Safety and Health, 1997. *Musculoskeletal Disorders (MSDS) and Workplace Factors: A critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity and low back*, US Department of Health and Human Services, Cincinnati, OH.

Cakir A., Hart, D. and Stewart, T. 1980. *Visual Display Terminals,* John Wiley and Sons, Chichester, New York.

Cheek, F. and Miller, M. 1983. The experience of stress for correctional officers. *Journal of Criminal Justice,* 11, 105-120.

Christensen, J. M., Topmiller, D. A. and Gill, R. T. 1988. Human factors definitions revisited. *Human Factors Society Bulletin,* 31, 7-8, in J. R. Wilson and E. N. Corlett (eds) 1990. *Evaluation of Human Work,* Taylor and Francis, London, p. 3.

Coleman, N., Hull, B. P. and Ellitt, G. 1998. An empirical study of preferred settings for lumbar support on adjustable office chairs. *Ergonomics,* 41 (4), 401-419.

Cook, C. and Burgess-Limerick, R. 2003. Guidelines for Computer Workstations. *Ergonomics Australia,* 17 (1), 19-37.

Cook, C. and Burgess-Limerick, R. 2001. 'Forearm Support and Computer Keyboard Use', in M. Stevenson and J. Talbot (eds) *Proceedings of the 37th Annual Conference of The Ergonomics Society of Australia Inc.,* The Ergonomics Society of Australia Inc., Downer, ACT, pp.101-106.

Cook, C. J. and Kothiyal, K. 1998. Influence of the mouse position on muscular activity in the neck, shoulder and arm in computer use. *Applied Ergonomics,* 29 (6), 439-443.

Costa, P. T. and McCrae, R. R. 1992. *NEO Personality Inventory Revised Short Version.* Research Psychologists Press Inc., London.

CUErgo Cornell University Ergonomics Web, 2004. Carpal Tunnel Syndrome and Computer Use – is there a link? Accessed 20 July 2004, <http://ergo.human.cornell.edu/JMMayoCTS.html>.

Dainoff, M. 1994. ‘Three myths of ergonomic seating’, in R. Lueder and K. Noro (eds) *Hard facts about soft machines: the ergonomics of seating*, Taylor and Francis, London, pp. 37-46.

Dainoff, M. J. and Dainoff, M .H. 1987. *A Manager’s Guide to Ergonomics in the Electronic Office*, John Wiley, Chichester.

Daniels, K. 1999. Coping and the job demands-control-support model: An exploratory study. *International Journal of Stress Management*, 6 (2), 125-144.

Darby, F. 2000 Visual and Ocular Fatigue. Accessed 15 February 2000, <Ergonoz@lugb.latrobe.edu.au>.

Darby, F. 2002. Reply to the reported words of Stuart Myers. Accessed 2 April 2002, <aus_ergo@lists.uq.edu.au>.

Dembe, A. 1996. *Occupation and Disease. How Social Factors Affect the Conception of Work-Related Disorders,* Yale University Press, New Haven, London.

Doheny, M., Linden, P. and Sedlak, C. 1995. Reducing Orthopaedic Hazards of the Computer Work Environment. *Orthopaedic Nursing*, 14 (1), 7 -15.

Dollard, M. 1996. Work Stress: Conceptualisations and Implications for Research Methodology and Workplace Intervention (Doctor of Philosophy Thesis), The University of Adelaide, Adelaide.

Dollard, M. F., Winefield, A. H. and McGuirk, T. E. 1992. ‘Study into stress among correctional officers’, Techsearch, Adelaide.

Dollard, M. F., Winefield, H. R. and Winefield, A. H. 2000. *Occupational Strain and Efficacy in Human Service Workers*, Kluwer Academic Publishers, Dordrecht, The Netherlands.

Dowler, E., Kappes, B., Fenaughty, A. and Pemberton, G. 2001. Effects of Neutral Posture on Muscle Tension During Computer Use. *International Journal of Occupational Safety and Ergonomics,* 7 (1), 61-78.

Eckenfelder, D. 2004. Treat Workers like Athletes to reduce Musculoskeletal Claims, *Newslink,* 4, Workcover Corporation of South Australia, Adelaide, p. 9.

Elvey, R. L., Quintner, J. L. and Thomas, A. N. 1986. A clinical study of RSI. *Australian Family Physician*, 15, pp.1314-1319.

Emmett, T. 1995. Workplace health and safety record a national disgrace. *Worksafe News*, 10 (3), p. 8.

Ergonomics Society of Australia Inc., 2001. *ESA Directory.* Ergonomics Society of Australia Inc., Narrabundah, ACT.

Eversmann, W. W. 1992. ‘Employers’ Response to Occupational Disorders’, in L. H. Millender, D. S. Louis and B. P. Simmons (eds) 1992. *Occupational Disorders of the Upper Extremity*, Churchill Livingstone Inc., New York, pp. 69-77.

Faulkner, S. and Myers, S. 2002. When exactly can carpal tunnel syndrome be considered work-related? *Australian and New Zealand Journal of Surgery*, 72, 204-209, in ABC News Online, 28 March 2002, Study reveals repetitious work not the cause of nerve condition. Accessed 8 April 2002, <http://abc.net.au/news/newsitems/s515555.htm>.

Faucett, J. and Rempel, D. 1994. VDT-related musculoskeletal symptoms: interactions between work posture and psychosocial work factors. *American Journal of Industrial Medicine*, 26, 597-612.

Ferguson, D. 1984. The ‘new’ industrial epidemic. *Medical Journal of Australia*, 140, 318-319.

Fraser, T. M. 1983. *Human Stress, Work and Job Satisfaction, A cricital approach,* International Labour Organisation, Geneva, Switzerland.

Gold, J. E., Cherniack, M. and Buchholz, B. 2004. Infrared thermography for examination of skin temperature in the dorsal hand of office workers. *European Journal of Applied Physiology*, 93, 245-251.

Goldberg, D. P. 1978. *Manual of the General Health Questionnaire*, Nfer-Nelson, Windsor.

Graham, G. 1985. Job satisfaction and repetition strain injury (Dissertation). Elton-Mayo School of Management, SA Institute of Technology, Adelaide.

Grandjean, E. 1987. *Ergonomics in Computerized Offices*, Taylor and Francis, New York.

Grandjean, E., Hunting, W. and Piderman, M. 1983. VDT workstation design: preferred settings and their effects. *Human Factors*, 25, 161-175, in S. Sauter, M. Dainoff and M. Smith (eds) 1990. *Promoting Health and Productivity in the Computerized Office.* Taylor and Francis, London.

Graps, A. 1998. Ergonomic computing – don’t let your computer cripple you. Accessed 2 February 1998, <http/www.amara.com/aboutme/rsi.html>.

Gun, R. T. 1990. The incidence and distribution of RSI in South Australia 1980-81 to 1986-87. *Medical Journal of Australia*, 153, 376-380.

Hadler, N. M. 1986. Industrial rheumatology. The Australian and New Zealand experiences with arm pain and backache in the workplace. *Medical Journal of Australia*, 144, 191-195, in G. Bammer and B. Martin, 1988. The Arguments about RSI: An Examination. *Community Health Studies*, XII (3) 348-358.

Hailstone, B. 1990. RSI's toll waning in the workplace. *The Advertiser*, 1 October, p. 10.

Hair, J. F., Anderson, R. E., Tatham R. L. and Black W. C. 1995. *Multivariate Data Analysis*, 4 edn, Prentice-Hall Inc., New Jersey.

Hales,T. R., Sauter, S. L., Peterson, M. R., Fine, L. J., Putz-Anderson, V., Schleifer, L. R., Ochs, T. T. and Bernard, B. P. 1994. Musculoskeletal disorders among visual display terminal users in a telecommunications company. *Ergonomics*, 37 (10), 1603-1621.

Hancock, P. A. and Rosenberg, S. M. A Model for Evaluating Stress Effects of Work with Display Units, in B. Knave, P.-G. Wideback (eds) 1987. *Work with Display Units 86*, Elsevier Science Publishers, Amsterdam, The Netherlands.

Harper, D. 1991. Are people the forgotten factor in computing? *Industrial Distribution*, 80 (3), 39.

Harvard RSI Action, 2004. Preventing RSI. Accessed 12 August 2004, <http://www.rsi.deas.harvard.edu/preventing.html>.

Hedge, A., McCrobie, D. and Morimoto, S. 1995. Healthy keyboarding: effects of wrist rests, keyboard trays and a preset tilt down keyboard on wrist posture, seated posture and musculoskeletal discomfort. *Proceedings of HFES 39th Annual Meeting*, Vol. 1, pp. 630-634.

Hedge, A. 1995 Intervention for Prevention/Treatment of Carpal Tunnel Syndrome. Department of Design and Environmental Analysis, Cornell University. Accessed 6 April 1998, <http://www.tc.cornell.edu/Researc...Articles/CIE/IRI/Hedge/hedge/html>.

Hedge, A. 2004a. 'Ergonomics Benefits Everyone', presentation at *Ergonomics for a BIZ-e World, Proceedings of the 40th Annual Conference of The Human Factors and Ergonomics Society of Australia and the 7th Annual Conference of Pan Pacific Council on Occupational Ergonomics*, The Human Factors and Ergonomics Society of Australia Inc., Narrabundah, ACT.

Hedge, A. 2004b. 10 Tips for Using a Computer Mouse. Accessed 20 July 2004, <http://ergo.human.cornell.edu/cumousetips.html>.

Higgs, P. E., and MacKinnon, S. E. 1995. Repetitive Motion Injuries. Accessed 6 March 1998, <http:www.annurev.org/series/medicine/vol46/higgme46.htm>.

Hocking, B. 1987. Epidemiological aspects of "repetition strain injury" in Telecom Australia. *Medical Journal of Australia*, 147, 218-222.

Holmes, S., Hodgson, A. and Nevell, P. 1991. *Accounting Students Handbook,* Harcourt Brace, Sydney.

Horrigan, K. <K.Horrigan@mailbox.gu.edu.au> 2001. Mouse design/use. Accessed 12 July 2001, <aus_ergo@lists.uq.edu.au>.

Howard, J. 2004. Occupational injury research at NOIRS 2003. *Injury Prevention*, August, 10, 195-196.

IBM. 1999. Healthy Computing. Accessed 21 December 1999, <http://www/pc.ibm.com/healthycomputing/we-key.html>.

IMPACC USA. 1995. Repetitive Strain Disorders, RSI FAQ. Accessed 9 March 1998, <http://www.impaccusa.com/impacc9b.html>.

IMPACC USA. 2001. IMPACC Ergonomic Work Injury Prevention. Accessed 25 May 2004, <http://impaccusa.com/impacc1.html>.

Ireland, D. C. R. 1992. 'The Australian Experience with Cumulative Trauma Disorders', in L. Millender, D. Louis, and B. P. Simmons (eds) 1992. *Occupational Disorders of the Upper Extremity*, Churchill Livingstone, New York, pp. 79-88.

Johansson, G. 1987. Growth and Challenge Vs Wear and Tear of Humans in Computer Mediated Work, in B. Knave, P.-G. Wideback (eds) 1987. *Work with Display Units 86*, Elsevier Science Publishers, Amsterdam, The Netherlands.

Johansson, J. A. 1994. Psychosocial factors at work and their relation to musculoskeletal symptoms. Dissertation Thesis, Department of Psychology, Goteburg University, Sweden.

Johnson, J. V. and Hall, E. M. 1988. Job strain, work place social support, and cardiovascular disease: a cross-sectional study of a random sample of the Swedish working population. *American Journal of Public Health*, 78, 1336-1342.

Jones, G. n.d. in newspaper article 'RSI – it's really a pain in the neck', p. 6.

Jones, J. W. and Dubois, D. 1989. 'Stress management in work settings', in L. R. Murphy and T. F. Schoenborn (eds.) *Stress management in work settings,* Praegar, New York, pp. 43-59.

Jonge, J de., and Kompier, M. A. J. 1997. A critical examination of the demand-control-support model from a work psychological perspective. *International Journal of Stress Management*, 4 (4), 235-258.

Karasek, R. A. and Theorell, T. 1990. *Healthy Work: Stress, Productivity and the Reconstruction of Working Life*, Basic Books, New York.

Kiesler, S. and Finholt, T. 1988. The Mystery of RSI. *American Psychologist,* 43 (12), 1004-1015.

Knave, B. G., Wibom, R. I., Voss, M., Hedstrom, L. D. and Bergqvist, U. O. 1985. Work with video display terminals among office employees. I. Subjective symptoms and discomfort. *Scandinavian Journal of Work Environment and Health,* 11, 457-466, in B. P. Bernard (ed.) National Institute for Occupational Safety and Health, 1997. *Musculoskeletal Disorders (MSDS) and Workplace Factors: A critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity and low back,* US Department of Health and Human Services, Cincinnati, OH.

Kuorinka, I., Jonsson, B., Kilbom, A., Vinterberg, H., Biering-Sorensen, F., Andersson, G. and Jorgensen, K. 1987. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Applied Ergonomics,* 18, 233-237.

'Latest from the experts on tenosynovitis'. 1985. *Modern Office.* 24 (1), 41.

Lee, A. <annalee@workready.com.au> 2001. Balls. Accessed 24 October, <aus_ergo@lists.uq.edu.au>.

Lindstrom, K. 1991. Well-being and computer-mediated work of various occupational groups in banking and insurance. *International Journal of Human Computer Interaction,* 3, 339-361.

Lintula, M., Nevala-Puranen, N. and Louhevaara, V. 2001. Effects of Ergorest Arm Supports on Muscle Strain and Wrist Positions During the Use of the Mouse and Keyboard in Work with Visual Display Units: A Work Site Intervention. *International Journal of Occupational Safety and Ergonomics,* 7 (1), 103-116.

Louis, D. S. 1992. 'A Historical Perspective of Workers and the Work Place', in L. Millender, D. Louis and B. P. Simmons (eds) 1992. *Occupational Disorders of the Upper Extremity*, Churchill Livingstone, New York, pp.15-18.

Lucire, Y. 1986. Neurosis in the workplace. *Medical Journal of Australia*, 145, 323-327, in G. Bammer and B. Martin, 1988. The Arguments about RSI: An Examination. *Community Health Studies*, XII (3), 348-358.

Lucire, Y. 1988. Social iatrogenesis of the Australian disease RSI. *Community Health Studies*, 12 (2), 140-150.

McFarlane, D. <David.McFarlane @WORKCOVER.NSW.GOV.AU> 2004. Publish or be damned? Accessed 30 September 2004, <aus_ergo@lists.uq.edu.au>.

McPhee, B. 1982. Deficiencies in the ergonomic design of keyboard work and upper limb and neck disorders in operators. *Journal of Human Ergology,* 11, 31-36.

Macklin, D. S. and Dollard, M. F. (under review). Public and Private Sector Work Stress: Workers compensation, levels of distress and the demand-control-support model. *Australian Journal of Psychology.*

Mandal, A. C. 1981. The seated man (Homo sedans), the seated work position. Theory and practice. *Applied Ergonomics,* 2 (1), 19-26, in S. Sauter, M. Dainoff and M. Smith (eds) 1990. *Promoting Health and Productivity in the Computerized Office,* Taylor and Francis, London.

Marriott, I. A. and Stuchly, M. A. 1986. Health aspects of work with visual display terminals. *Journal of Occupational Medicine,* 28 (9), 833-848.

Martin, D. K. and Dain, S. J. 1988. Postural Modifications of VDU operators wearing bifocal spectacles. *Applied Ergonomics,* 19 (4), 293-300, in B. P. Bernard (ed.) National Institute for Occupational Safety and Health, 1997. *Musculoskeletal Disorders (MSDS) and Workplace Factors: A critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity and low back*, US Department of Health and Human Services, Cincinnati, OH.

Meilach, D. Z. 1983. Ergonomics ... The Science of Safe Computer Use. *Interface Age,* 8 (7), 49-53.

Millender, L. H., Louis, D. S. and Simmons, B. P. (eds) 1992. *Occupational Disorders of the Upper Extremity*, Churchill Livingstone Inc., New York.

Miller, J., Straker, L. and Pollock, C. 1992. 'A field study investigating the effects on performance of sifting postures of VDU operators', in E. Hoffmann and E. Owen (eds), *Unlocking Potential for the Future Productivity and Quality of Life. Proceedings of the 28th Annual Conference of the Ergonomics Society of Australia*, Ergonomics Society of Australia Inc., Downer, ACT, pp. 175-181.

Minitab Inc. 1995. *Minitab user's guide: Release 10 Xtra for Windows and Macintosh.* Minitab Inc., State College, Pennsylvania.

Moore, M. 1990. Locating the seat of the problem. *The Advertiser*, 26 April, p. 45.

Moos, R. H. 1986. *Psychology and Work: Productivity, Change and Employment,* American Psychological Association, Washington, DC, USA.

Morison, N. 1994. Get a Straight Back to Work. *Australian PC World,* August, IDG Communications Pty Ltd., pp. 131-136.

Morrison, D. L., Dunne, M. P., Fitzgerald, R. and Cloghan, D. 1992. Job design and levels of physical and mental strain among Australian prison officers. *Work and Stress,* 6, 13-31.

Murrell, K. F. H. 1975. *Ergonomics,* Chapman and Hall, London.

Nadelson, T. 'Psychological Factors in Upper Extremity Disorders: Pain as a Paradigm' in L. Millender, D. Louis and B. P. Simmons (eds) 1992. *Occupational Disorders of the Upper Extremity*, Churchill Livingstone, New York, pp. 221-226.

Nakazawa, T., Okubo, Y., Suwazono, Y., Kobayashi, E., Komine, S., Kato, N. and Nogawa, K. 2002. Association Between Duration of Daily VDT Use and Subjective Symptoms. *American Journal of Industrial Medicine,* 42, 421-426.

National Occupational Health and Safety Commission, 1997a. *Worksafe News,* 12 (3), p. 12.

National Occupational Health and Safety Commission, 1997b. *Worksafe News*, 12 (4), pp.18-19.

National Institute for Occupational Safety and Health, 1984. *Health Issues - Video Display Terminals,* US Department of Health and Human Services, Cincinnati, Ohio.

National Institute for Occupational Safety and Health, 1997. *Musculoskeletal Disorders (MSDS) and Workplace Factors: A Critical Review of Epidemiologic Evidence for Work-Related Musculoskeletal Disorders of the Neck, Upper Extremity, and Low Back,* B. P. Bernard (ed.), U.S. Department of Health and Human Services, Cincinnati, OH. Accessed 3 December 2001, <http://www.cdc.gov/niosh/ergoscil.html>.

Norusis, M. J. 1990. *Base system users guide,* SPSS Inc., Chicago.

Occupational Health, Safety and Welfare Act, 1986. South Australian Government Printer, Adelaide.

Ochsner, M. and Greenberg, M. 1998. Factors Which Support Effective Worker Participation in Health and Safety: A Survey of New Jersey Industrial Hygienists and Safety Engineers. *Journal of Public Health Policy,* 19 (3), pp. 350-366.

O'Grady, W., Porter, B. and Chua, F. 1993. Knowledge of the Code of Ethics. Paper presented at the Accounting Association of Australia and New Zealand Conference, Darwin, 11-14 July.

O'Mara, N. 1993. *Office Ergonomics The Ergonomics Systems Approach to Optimise the Design of Office Work and Environments.* Department for Industrial Affairs, Adelaide.

O'Mara, N. 1992. 'The Ergonomics Systems Approach: Panacea for preventing workplace accidents and injuries', presentation at The Changing Face of Workplace Injury Prevention and Rehabilitation Seminar, University of South Australia, Whyalla, 2 July.

Oxenburgh, M. 1991. *Increasing Productivity and Profit through Health and Safety*, CCH Australia Limited, Sydney.

Oxenburgh, M. and Marlow, P. 2004 'Implementing Ergonomics through Financial Arguments', in *Ergonomics for a BIZ-e World, Proceedings of the 40th Annual Conference of The Human Factors and Ergonomics Society of Australia and the 7th Annual Conference of Pan Pacific Council on Occupational Ergonomics*. The Human Factors and Ergonomics Society of Australia Inc., Narrabundah, ACT, pp. 113-118.

Parker, C. S. 1990. *Understanding Computers and Information Processing: Today and Tomorrow with Basic*, The Dryden Press, New Mexico.

Pater, R. and Button, R. 1992. Organizing for Strategic Ergonomics. *Occupational Hazards*, 54 (11), 55-58.

Patkin, M. 1987. Ergonomics: A perspective for engineers and managers. Paper presented to the South Australian Chamber of Commerce and Industry, 17 June.

Peper, E. and Shumay, D. 1996. *Healthy Computing: Tips*. Institute for Holistic Healing Studies/Health Education, San Francisco State University, San Francisco, <healthco@sfsu.edu>.

Peper, E., Wilson, V. S., Taylor, W., Pierce, A., Bender, K. and Tibbetts, V. 1994. Repetitive Strain Injury. *Electromyography Applications in Physical Therapy*, Amed Supplies, West Gosford.

Petkov, J. 1999. *Measurement of Body Posture Using Multivariate Statistical Techniques*, University of South Australia, Whyalla.

Pinksy, M. A. 1993. *The Carpal Tunnel Syndrome Book*, in A. Grapps 1998. Ergonomic Computing. Accessed 2 February 1998, <http://www.amara.com/aboutme/rsi.html>.

Polanyi, M. F., Cole, D. C., Beaton, De, Chung, J., Wells, R., Abdolell, M., Beech-Hawley, L., Ferrier, S. E., Mondloch, M. V., Shields, S. A., Smith, J. M. and Shannon, H. S. 1997. Upper limb work-related musculoskeletal disorders among newspaper employees: cross-sectional survey results. *American Journal of Industrial Medicine* 32, 620-628.

Pritchard, M. H., Pugh, N., Wright, I. and Brownlee, M. 1999. A vascular basis for repetitive strain injury. *Rheumatology*, 38, 636-639.

Public Service Association of South Australia, 1990. *PSA Occupational Health and Safety Representative Office Design and Equipment Handbook*, Public Service Association of South Australia, Adelaide.

Quibble, Z. 1996. *Administrative Office Management,* New Jersey, Prentice Hall, pp. 77-101.

Quilter, D. 1998. Warning signs of repetitive strain injury (RSI). Accessed 5 February 1998, < http://www.resihelp.com/warning.html>.

Quinlivan, B. 2004. Screen Test. *Business Review Weekly,* July 15-21, pp. 110-111.

Ramazzini, B. De Morbis artificum diatribe, 1713. Diseases of Workers. Translated by Wilmer Cave Wright, 1940. University of Chicago Press, Chicago, in D. S. Louis, 'A Historical Perspective of Workers and the Work Place', in L. Millender, D. Louis and B. P. Simmons (eds) 1992. *Occupational Disorders of the Upper Extremity*, Churchill Livingstone, New York, pp. 15 -18.

'Repetitious injuries can be prevented'. 1984. *Modern Office,* 23 (7), 20-21.

Rogers, E. 1995. *Diffusion of Innovation,* The Free Press, New York.

Rossignol, A. M., Morse E. P., Summers, V. M. and Pagnotto, L. D. 1987. Video display terminal use and reported health symptoms among Massachusetts clerical workers. *Journal of Occupational Medicine,* 29, 112-118, in B. P. Bernard (ed) National Institute for Occupational Safety and Health, 1997. *Musculoskeletal Disorders (MSDS) and Workplace Factors: A critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity and low back,* US Department of Health and Human Services, Cincinnati, OH.

Ryan, A., Pimble, J., et al. 1985. 'Repetition strain injury and the influence of the work environment', presentation at the ANZAAS 55th Congress, Melbourne August 26-30, in B. Hocking 1987. Epidemiological aspects of "repetition strain injury" in Telecom Australia. *Medical Journal of Australia,* 147, 218-222.

Ryan, G. A., Hage, B. and Bamptom, M. 1987. 'Postural factors, work organisation and musculoskeletal symptoms', in P. Buckle (ed.), Musculoskeletal disorders at work. Taylor & Francis, London, pp. 251-253, in G. Bammer and B. Martin 1988. The Arguments about RSI: An Examination. *Community Health Studies,* XII (3), 348-358.

Sanders, M. S. and McCormick, E. J. 1987. *Human Factors in Engineering and Design,* 6th edn,. McGraw Hill Book Company, New York.

SAS Institute, 2001. SAS Version 8.2. Cary, NC, USA.

Sawyer, J., Dollard, M. and Farrin, J. 2002. Ergonomic awareness, work environment, health and job satisfaction in computer users. *Journal of Occupational Health and Safety,* 18 (3), 247-257.

Shaw, C. 1999. *Ergonomic Issues,* System Shawtec Ergonomics. Accessed 25 September 2003, <http://members.iinet.net.au/~shawtec/schools/scergo.html>.

Sheedy, J. E. 1991. Vision Problems at Video Display Terminals: A Survey of Optometrists. *Journal of the American Optometric Association*, 63, 687-692.

Shelley, S. 1984. *Research Methods in Nursing and Health,* Little, Brown and Company, Boston/Toronto.

Skubick, D. L., Clasby, R., Donaldon, S and Marshall, W. n.d. Carpal Tunnel Syndrome as an Expression of Muscular Dysfunction in the Neck. Amed Supplies, West Gosford, New South Wales.

Smith, M. J., Carayon, P. and Miezio, K. 1987. VDT Technology: Psychosocial and Stress Concerns, in B. Knave, P.-G. Wideback (eds) 1987. *Work with Display Units 86,* Elsevier Science Publishers, Amsterdam, The Netherlands.

Smith, M. J. 1997. Psychosocial aspects of working with video display terminals (VDTs) and employee physical and mental health. *Ergonomics*, 40 (10), 1002-1015.

South Australian Health Commission, 1988. Notes for Supervisors of Keyboard operators Ergonomic Practice, South Australian Health Commission, Adelaide.

Spillane, R. and Deves, L. 1987. RSI: pain, pretence or patienthood? *Journal of Industrial Relations*, 29, 41-48, in G. Bammer and B. Martin 1988. The Arguments about RSI: An Examination. *Community Health Studies*, XII (3), 348-358.

Stammerjohn, L. W., Smith, M. J. and Cohen, G. F. 1981. 'Evaluation of Work Station Design Factors in VDT Operations', in National Institute for Occupational Safety and Health, *Select Research Reports on Health Issues in Video Display Terminal Operations.* US Department of Health and Human Services, Cincinnati, Ohio.

Standards Association of Australia, 1976. *Ergonomics in Factory and Office Work, AS 1837,* Standards Australia, North Sydney.

Standards Association of Australia, 1987. *Acoustics - Recommended design sound levels and reverberation times for building interiors, AS 2107,* Standards Australia, North Sydney.

Standards Association of Australia, 1990a. *Screen-based workstations, Part 1: Visual display units, AS 3590.1,* Standards Australia, North Sydney.

Standards Association of Australia, 1990b. *Screen-based workstations, Part 2: Workstation furniture, AS 3590.2,* Standards Australia, North Sydney.

Standards Association of Australia, 1990c. *Screen-based workstations, Part 3: Input devices, AS 3590.3,* Standards Australia, North Sydney.

Standards Association of Australia, 1997. *AS/NZS 4438 Office Panel Systems,* Standards Australia, North Sydney.

StatSoft Inc., 2001. STATISTICA version 6. <www.statsoft.com>.

Stevenson, M. G. 1991. Ergonomics in the Modern Office Environment. *Proceedings of the 27th Annual Conference of the Ergonomics Society of Australia,* Ergonomics Society of Australia, Downer, ACT, pp. 47-54.

Stone, W. E. 1984. Occupational repetitive strain injuries. *Australian Family Physician,* 13, 681-684, in G. Bammer and B. Martin, 1988. The Arguments about RSI: An examination. *Community Health Studies*, XII (3), 348-358.

Stone, W. E. 1983. Repetitive strain injuries. *Medical Journal of Australia,* 2, 616-618.

The body or the machine experts go into battle. 1984. *Modern Office,* 23 (11), 8-9.

Theorell, T., Harms-Ringdahl, K., Ahlberg-Hulten, G. and Westin, B. 1991. Psychosocial job factors and symptoms from the locomotor system – a multicausal analysis. *Scandinavian Journal of Rehabilitation Medicine,* 23, 165-173.

The Human Factors and Ergonomics Society of Australia Inc. 2004. *HFESA Directory Promoting systems, spaces and designs for people.* The Human Factors & Ergonomics Society of Australia Inc., Narrabundah, ACT.

Vallfors, B. 1985. Acute, subacute and chronic low back pain. Clinical symptoms, absenteeism and working environment. *Scandinavian Journal of Rehabilitation Medicine,* suppl. 11.

Wall, J. S. 1985. Investigation of attribution of cause, exposure factors and psychosocial stress parameters as they relate to musculoskeletal complaints in keyboard operators, Grad Dip Science thesis, Department of Psychology, Australian National University, Canberra, in G. Bammer and B. Martin, 1988. The Arguments about RSI: An Examination. *Community Health Studies*, XII (3), 348-358.

Walls, S. 1993. Work a pain in the neck. *Worksafe Australia Newsletter,* 8 (2), 16-17.

Wanous, J. P., Reichers, A. E. and Hundy, M. J. 1997. Overall job satisfaction: How good are single-item measures? *Journal of Applied Psychology,* 82 (2), 247-252.

Walsh, K. 2002. Ergoports. Accessed 18 June 2002, <aug_ergo@lists.uq.edu.au>.

Warr, P. B., Cook, J. D. and Wall, T. D. 1979. Scales for the measurement of some work attitudes and aspects of psychological well-being. *Journal of Occupational Psychology*, 52, 129-148.

Weber, A. 1983. With ergonomics, the user comes first. *Data Management*, 21 (8), 8-10.

Willis, E. 1986. Commentary: RSI as a Social Process. *Community Health Studies*, X (2), 210-219.

Wilson, J. R. 1990. 'A framework and a context for ergonomics methodology', in J. R. Wilson and E. N. Corlett (eds), *Evaluation of Human Work*, Taylor and Francis, London.

Winkel, J. and Oxenburgh, M. 1990. 'Towards Optimizing Physical Activity in VDT/Office Work', in S. Sauter, M. Dainoff and M. Smith (eds), *Promoting Health and Productivity in the Computerized Office*, Taylor and Francis, London.

Winkel, J. and Westgaard, R. H. 1996. A model for solving work related musculoskeletal problems in a profitable way. *Applied Ergonomics*, 27 (2), 71-77.

WorkCover Corporation, 2003. Every working woman's risk. *Bulletin*, 21, 4-5.

WorkCover Corporation, 2002. Hazard Alert 5: Using laptop and notebook computers in the workplace. Accessed 13 July 2004, <www.workcover.com>.

Worksafe Australia, 1989a. *Guidance Note for the Prevention of Occupational Overuse Syndrome in Keyboard Employment,*Australian Government Publishing Service, Canberra.

Worksafe Australia, 1989b. *Technical Report of the Study Group on Radiation and Visual Display Units*, Australian Government Publishing Service, Canberra.

Worksafe Australia, 1996. *Description of Occupational Overuse Syndrome*. Accessed 6 February 1998, <http://www.worksafe.gov.au/worksafe/FULLTEXT/docs/h5/00997-01,html>.

Worksafe Australia, 1997. Compendium of Workers' Compensation Statistics, Australia, 1994-95, April. Accessed 10 March 1998, <http://www.worksafe.gov.au/worksafe/04/stats/97001.htm>.

Worksafe Victoria. Guidance Note. Use of the fitness ball as a chair. Accessed 4 February 2003. <http://www.workcover.vic.gov.au/dir090/vwa/alerts.nsf/PrintVersion/6CBCFAEB3FE2.

Wright, J. 1992. Marina's Flair. *The Advertiser*, 16 February, p. 112.

Wright, K. S. and Andre, A. D. 1998. *Alternative Keyboards: A User Survey.* Accessed 6 March 1998, < http://www.tifaq.com/articles/alt...rd_survey-feb98-scott_wright.html>.

Wright, K. S. and Wallach, D. S. 1997. Mice Pointing Devices. Accessed 10 March 1998, <http://www.tifaq.com/mice/mice.html>.

Zaviska, P. 1985. Confusion over RSI treatment. *Melbourne Viewpoint*, 4 (6), p. 1.

APPENDICES

Appendix 1

ERGONOMICS

AND

COMPUTER TECHNOLOGY

Please work independently when completing this questionnaire.

Most of the items in the questionnaire simply require a tick or circling of the most appropriate response, but additional information and comments are welcome.

All responses will be strictly confidential and no individual respondent will be identified in the results of the study.

I would greatly appreciate your cooperation in completing this questionnaire and returning it to me in the reply-paid envelope provided by Friday

Your contribution will be vital to my research.

Conducted by Ms. Janet K. Sawyer
University of South Australia, Whyalla Campus

Please tick the appropriate box:

1. Please indicate your age

- 18 - 27yrs ☐
- 28 - 37yrs ☐
- 38 - 47 yrs ☐
- 48 - 57 yrs ☐
- over 57 yrs ☐

2. Please indicate your gender

- Male ☐
- Female ☐

3. What is your position/job title within the organisation? eg Typist, Secretary, Manager, Supervisor, ASO

....

4. Is your organisation

- Government-owned ☐
- Privately-owned business ☐
- Other ☐

Please specify ....

5. Where did you learn to operate a computer?

- In an educational institution ☐
- On the job ☐
- Other ☐

Please specify ....

6. What is your estimated average daily use of computer technology?

..................Hours/Day

Ergonomics is defined in AS 1837 (1976:6) as "the design of work so that the best use is made of human capabilities without exceeding human limitations", and can be applied to the following aspects of work:

* the work environment eg. temperature, lighting, noise factors, etc.
* the seating
* the workstation e.g. desks, keyboards, VDU, Document holders, footrests
* job design e.g. job rotation, workload, rest periods, etc.

7. Are you aware of the ergonomic principles that relate to the use of computer technology. eg: do you know the recommended adjustments, and layouts?

Yes ☐
No ☐

If yes, how did you receive this information.

....

....

....

8. Have you attended an educational program/training session provided by your organisation that included information on ergonomics in relation to the use of computer technology?

In the last 12 months ☐
In the last two years ☐
Over 2 years ago ☐
Never ☐

If yes, how have you applied the knowledge acquired about ergonomics to your own work situation?

....

....

....

9. Does your organisation have a written policy on procedures related to ergonomics and the use of computer technology?

Yes ☐
No ☐
Unsure ☐

If not, is your organisation in the process of formulating a written policy on procedures related to ergonomics and the use of computer technology?

Yes ☐
No ☐
Unsure ☐

10. Is there a person in your organisation who has been delegated the responsibility for ensuring that employees do follow recommended ergonomic practices?

Yes ☐
No ☐

11. Does your organisation stress the importance of keeping recommended ergonomic work practices in mind while operating computer equipment?

Yes ☐

No ☐

12. How does your organisation respond to breaches of work practices recommended in relation to computer usage?

....

....

....

13. On what scale of priority do you think your organisation places the importance of ergonomics in relation to computer usage?

High ☐

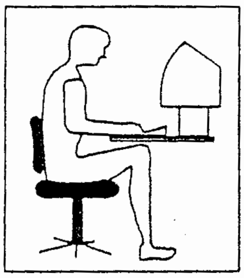
Medium ☐

Low ☐

14. Rate each item below by circling the number you believe reflects the importance that your organisation places on it. (One indicates it is extremely important, five indicates it has no importance.)

		Extremely Important				Not Important at all
(a)	provide personal satisfaction	1	2	3	4	5
(b)	improve labour relations	1	2	3	4	5
(c)	enhance public relations	1	2	3	4	5
(d)	increase production rate	1	2	3	4	5
(e)	give legislative compliance	1	2	3	4	5
(f)	improve product quality	1	2	3	4	5
(g)	reduce injury rate	1	2	3	4	5
(h)	improve operating costs	1	2	3	4	5
(i)	increase job pride	1	2	3	4	5
(j)	reduce liability potential	1	2	3	4	5
(k)	improve customer relations	1	2	3	4	5

15. Study the diagrams carefully to determine whether accepted ergonomic principles are being applied in relation to sitting posture, and positioning of the arms and wrists. Circle the appropriate response and indicate the reason for your response.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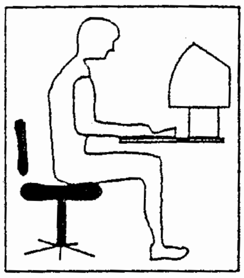
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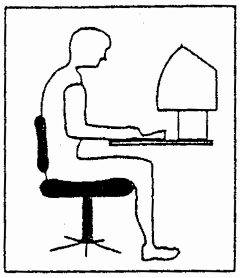
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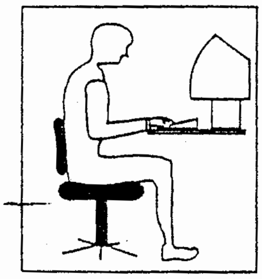
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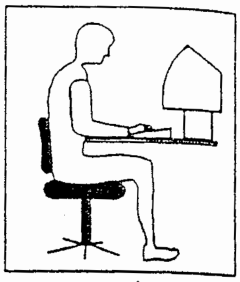
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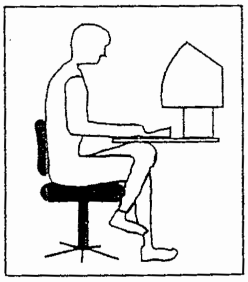
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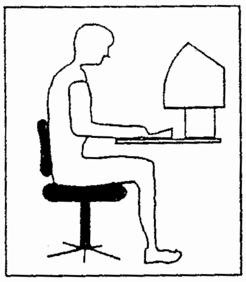
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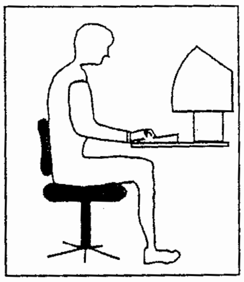
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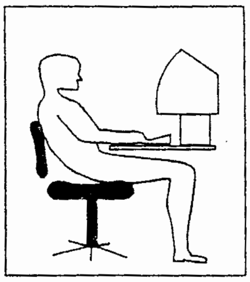

(i)

(a) Yes No Unsure Reason ....
....

(b) Yes No Unsure Reason: ....
....

(c) Yes No Unsure Reason: ....
....

(d) Yes No Unsure Reason: ....
....

(e) Yes No Unsure Reason: ....
....

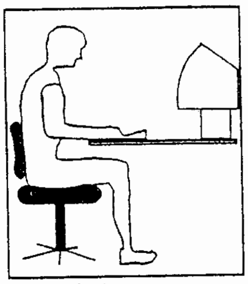
(f) Yes No Unsure Reason: ....
....

(g) Yes No Unsure Reason: ....
....

(h) Yes No Unsure Reason: ....
....

(i) Yes No Unsure Reason: ....
....

16. Study the diagrams carefully to determine whether accepted ergonomic principles are being applied <u>in relation to posture and the layout of equipment</u>, circle the appropriate response below and indicate the reason for your response.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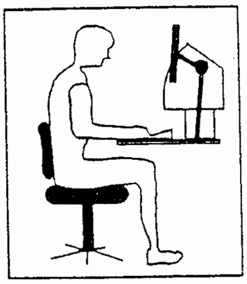
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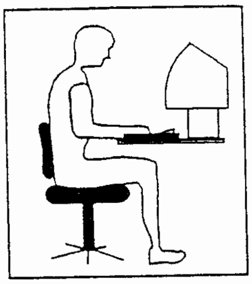
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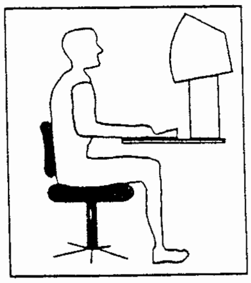
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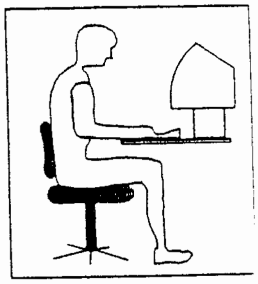
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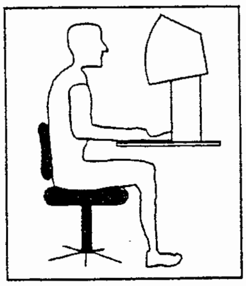
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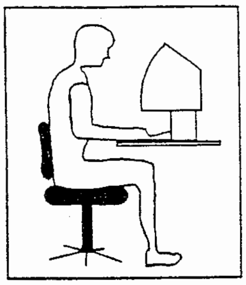
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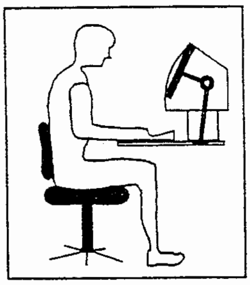
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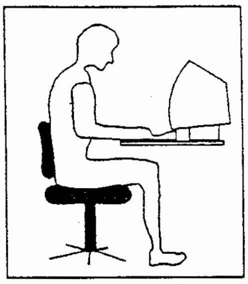
(i)

(a) Yes No Unsure Reason: ....

....

(b) Yes No Unsure Reason: ....

....

(c) Yes No Unsure Reason: ....

....

(d) Yes No Unsure Reason: ....

....

(e) Yes No Unsure Reason: ....

....

(f) Yes No Unsure Reason: ....

....

(g) Yes No Unsure Reason: ....

....

(h) Yes No Unsure Reason: ....

....

(i) Yes No Unsure Reason: ....

....

17(a) Do you believe that rest breaks are relevant to the use of computer technology?

Yes ☐
No ☐

If yes, how often should they be taken ....

What tasks could be undertaken in these breaks? ....

....

....

(b) Do you take rest breaks

Yes ☐
No ☐

18. Are computer users required to report incidences of computer related injury?

Yes ☐
No ☐
Unsure ☐

19. Does your organisation keep records relating to incidences of computer related injury?

Yes ☐
No ☐
Unsure ☐

20. Does your organisation have a written policy on procedures related to rehabilitation of employees affected by computer related injury?

Yes ☐
No ☐
Unsure ☐

If not, is your organisation in the process of formulating a written policy on procedures related to rehabilitation of employees affected by computer related injury?

Yes ☐
No ☐
Unsure ☐

21. What factors would you take into consideration when choosing office furniture and equipment?

....

....

....

22. Does your job involve tasks other than those requiring the use of a computer?

Yes ☐

No ☐

If yes, what factors do you take into consideration in organising your work day?

....

....

....

23. Do you carry out "pause gymnastics" or exercise when using computer technology?

Yes ☐

No ☐

If yes, how often?

Regularly ☐

Occasionally ☐

Rarely ☐

24. Approximately how much time have you spent in training/update sessions, in relation to ergonomics and the use of computer technology, that have been provided by your organisation in the last 12 months?

.... hours

Do you believe you need more time?

Yes ☐

No ☐

25. Have you read any documents that include information on ergonomics in relation to the use of computer technology in the last 12 months?

Yes ☐

No ☐

26. Do you believe ergonomic principles in relation to the use of computer technology are being given sufficient priority in your organisation?

Yes ☐

No ☐

27. Have you ever had a work-related complaint of pain in the arm or neck or some other part of the body?

Yes ☐

No ☐

If yes, please specify

....

....

....

28. Any other comments:

....

....

....

....

THANK YOU

PLEASE RETURN THE SURVEY NOW

to

Ms J Sawyer
Faculty of Business and Management
University of South Australia
Nicolson Avenue
WHYALLA NORRIE SA 5608

Appendix 2

AN ANALYSIS OF

ERGONOMIC PRINCIPLES

AND WORK

Please work independently when completing this questionnaire.

Most of the items in the questionnaire simply require a tick or circling of the most appropriate response, but additional information and comments are welcome.

All responses will be strictly confidential and no individual respondent will be identified in the results of the study. You are, of course, free to discontinue your participation or to decline to answer particular questions.

I would greatly appreciate your cooperation in completing this questionnaire and returning it to me in the reply-paid envelope provided by Friday .

Your contribution will be vital to this research.

Conducted by Ms. Janet K. Sawyer
University of South Australia, Whyalla Campus
Telephone 8647 6018
Fax 8647 6082
E Mail Janet.Sawyer@Unisa.edu.au

PLEASE CIRCLE THE APPROPRIATE NUMBER FOR EACH QUESTION.

PART A

1.	Please indicate your age	16-25 years	1
		26-35 years	2
		36-45 years	3
		46-55 years	4
		over 55 years	5
2.	Please indicate your gender	Male	1
		Female	2
3.	What is your position/job title within your organisation?	Manager	1
		Non-Manager	2
4.	How many years and months have you been working in your current position?	...... years ...... months	
5.	On average, how many hours a week do you work?	...... hours	
6.	Please indicate the highest level of your educational qualifications.	Secondary Education	1
		Traineeship	2
		TAFE Certificate	3
		TAFE Diploma	4
		University level Diploma	5
		Bachelor's Degree	6
		Post-Graduate Course	7
7.	Is your organisation	Government-owned	1
		Privately-owned	2
8.	What is your estimated average daily use of a desktop computer? - at work	...... hours	
	- at home	...... hours	
9.	Where did you learn to use a computer	In an educational institution?	1
		On the job?	2
		At home?	3
10.	Do you wear glasses when using the computer?	Yes	1
		No	2
11.	If yes, are the glasses that you wear bifocals?	Yes	1
		No	2
12.	How do you rate your physical fitness level?	Low	1
		Medium	2
		High	3
		Very High	4

13.	How often do you exercise for 30 minutes or more?	Every Day	1
		5-6 Days Per Week	2
		3-4 Days Per Week	3
		1-2 Days Per Week	4
		Once a Fortnight	5
		Less Than Once a Month	6
		Less Than Once a Year	7
14.	Do you consider that your present position is	Insecure	1
		Secure	2
		Very Secure	3
15	Do you consider that your present position is	Low paid	1
		Adequately paid	2
		Highly paid	3
16.	Do you consider your present position to have	Low prestige	1
		Medium prestige	2
		High prestige	3

PART B

Ergonomics is defined in AS 1837 (1976:6) as "the design of work so that the best use is made of human capabilities without exceeding human limitations", and can be applied to the following aspects of work:

* the work environment e.g. temperature, lighting, noise factors
* the seating
* the workstation e.g. desks, keyboards, VDU, Document holders, footrests
* job design e.g. job rotation, workload, rest periods

1.	Are you aware of the ergonomic principles that relate to the use of computer technology? Eg. do you know the recommended adjustments and layouts?	Yes	1
		No	2
2.	(a) Do you apply ergonomic principles relevant to the use of computers to your work situation?	Yes	1
		No	2
	(b) If yes, do you apply them because	You know you should	1
		It is expected by the organisation	2
		You have experienced health symptoms	3
	(c) If no, please indicate the reason/s why you do not apply them.	Not aware of the ergonomic principles	1
		Forget to do it	2
		Too busy	3
		No health symptoms so why bother	4
		Don't think it is important	5
3.	(a) Have you attended an educational program/training session provided by your organisation that included information on ergonomics in relation to the use of computers?	In the last 12 months	1
		In the last 2 years	2
		Over 2 years ago	3
		Never	4

(b) If yes, how have you applied the knowledge acquired about ergonomics to your own work situation?

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4. Approximately how much time have you spent in training/update sessions in relation to ergonomics and the use of computers, provided by your organisation, in the last 12 months? ...... hours

5. Do you believe you need to spend more time in training/update sessions in relation to ergonomics and the use of computers?

Yes	1
No	2

6. (a) Do you take rest breaks away from the computer?

Yes	1
No	2

(b) If yes, how often do you take a rest break?

Approx every 30 minutes	1
1 hour	2
1-1/2 hours	3
2 hours	4
2-1/2 hours	5
3 hours	6

Other, please specify

....

(c) What activities do you usually undertake during these breaks?

....
....
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....

7. Do you take regular micro-breaks or rest pauses when using a computer?

Yes	1
No	2

8. How often do you carry out pause gymnastics or exercise when using a computer?

Never	1
Regularly	2
Occasionally	3
Rarely	4

9. How often do you stop and rest your eyes with long distance viewing when doing computer work?

Never	1
Regularly	2
Occasionally	3
Rarely	4

10. Have you read any articles or documents that include information on ergonomics and the use of computers in the last 12 months?

Yes	1
No	2

11. Do you believe ergonomic principles in relation to the use of computers are being given sufficient priority in your organisation?

Yes	1
No	2

Please elaborate.

....
....
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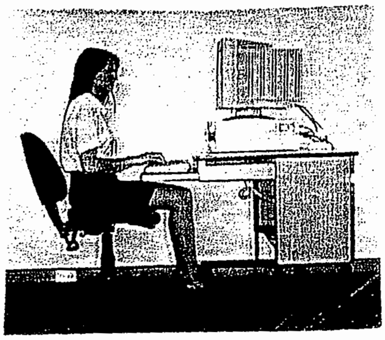
....

12. Study the diagrams carefully to determine whether accepted ergonomic principles are being applied in relation to sitting posture, and positioning of the arms and wrists. For each diagram, circle the appropriate response and indicate the reason for your response.

(a) Yes No Unsure

Reason...

....



(b) Yes No Unsure

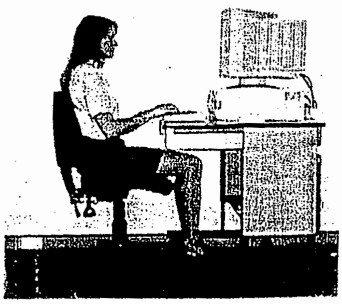
Reason...

....

(c) Yes No Unsure

Reason...

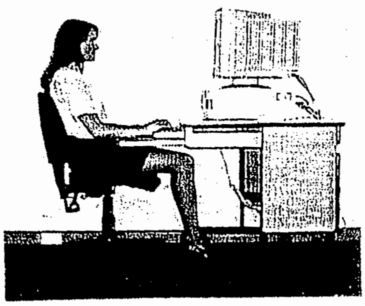
....



(d) Yes No Unsure

Reason...

....



(e) Yes No Unsure

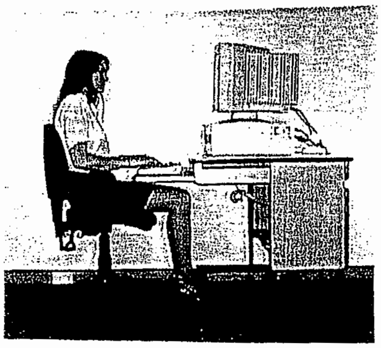
Reason...

....

(f) Yes No Unsure

Reason..

....



(g) Yes No Unsure

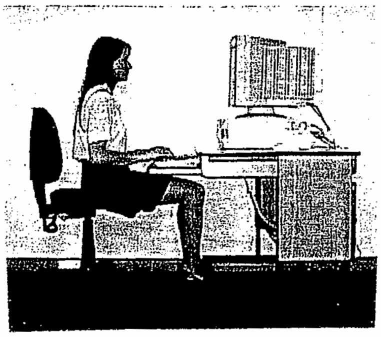
Reason..

....

(h) Yes No Unsure

Reason..

....



(i) Yes No Unsure

Reason..

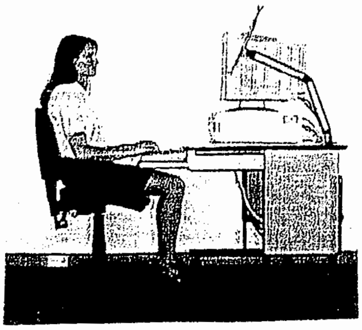
....

13. Study the diagrams carefully to determine whether accepted ergonomic principles are being applied **in relation to posture and the layout of equipment**. For each diagram circle the appropriate response below and indicate the reason for your response. Please note that "blanks" are treated as being incorrect responses.

(a) Yes No Unsure

Reason..

....



(b) Yes No Unsure

Reason...

....

(c) Yes No Unsure

Reason...

....

(d) Yes No Unsure

Reason...

....

(e) Yes No Unsure

Reason...

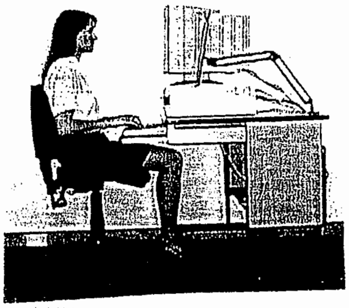
....

(f) Yes No Unsure

Reason...

....

13. Contd. Study the diagrams carefully to determine whether accepted ergonomic principles are being applied in relation to posture and the layout of equipment. For each diagram circle the appropriate response below and indicate the reason for your response. Please note that "blanks" are treated as being incorrect responses.



(g) Yes No Unsure

Reason...

....

(h) Yes No Unsure

Reason...

....

(i) Yes No Unsure

Reason...

....

(j) Yes No Unsure

Reason...

....

PART C

In this section we are interested in how you have felt over the past two weeks. (Please circle a number for each question. It is important that you try to answer ALL questions).

1.	Have you recently been able to concentrate on whatever you're doing?	better than usual	1
		same as usual	2
		less than usual	3
		much less than usual	4
2.	Have you recently lost much sleep over worry?	not at all	1
		no more than usual	2
		rather more than usual	3
		much more than usual	4
3.	Have you recently felt that you are playing a useful part in things?	more than usual	1
		same as usual	2
		less so than usual	3
		much less than usual	4
4.	Have you recently felt capable of making decisions about things?	ore than usual	1
		same as usual	2
		less so than usual	3
		much less capable	4
5.	Have you recently felt constantly under strain?	not at all	1
		no more than usual	2
		rather more than usual	3
		much more than usual	4
6.	Have you recently felt that you couldn't overcome your difficulties?	not at all	1
		no more than usual	2
		rather more than usual	3
		much more than usual	4
7.	Have you recently been able to enjoy your normal day-to-day activities?	more so than usual	1
		same as usual	2
		less so than usual	3
		much less than usual	4
8.	Have you recently been able to face up to your problems?	more so than usual	1
		same as usual	2
		less so than usual	3
		much less than usual	4
9.	Have you recently been feeling unhappy and depressed?	not at all	1
		no more than usual	2
		rather more than usual	3
		much more than usual	4
10.	Have you recently been losing confidence in yourself?	not at all	1
		no more than usual	2
		rather more than usual	3
		much more than usual	4
11.	Have you recently been thinking of yourself as a worthless person?	not at all	1
		no more than usual	2
		rather more than usual	3
		much more than usual	4

12. Have you recently been feeling reasonably happy, all things considered?

more so than usual	1
about the same as usual	2
less so than usual	3
much less than usual	4

13. Taking everything into consideration, please indicate how satisfied or dissatisfied you feel with your present job by circling the appropriate number.

Extremely dissatisfied	1
Very dissatisfied	2
Moderately dissatisfied	3
Not sure	4
Moderately satisfied	5
Very satisfied	6
Extremely satisfied	7

PART D

The following questions are about how you apply knowledge in other areas.

1. Were you aware that exposure to the sun can cause health problems such as skin cancer?	Yes	1
	No	2

	Never	Rarely	Occasionally	Frequently	Very Frequently
1a. How often do you sunbake?	1	2	3	4	5
1b. How often do you wear a hat when you go out into the sun?	1	2	3	4	5
1c. How often do you use a sunscreen regularly when outdoors?	1	2	3	4	5
1d. How often do you cover up with appropriate clothing when you go into the sun?	1	2	3	4	5

2. Were you aware that smoking cigarettes can cause health problems such as lung cancer and heart disease?	Yes	1
	No	2

	Never	Rarely	Occasionally	Frequently	Very Frequently
2a. How often do you smoke cigarettes?	1	2	3	4	5
2b. How often do you smoke cigarettes indoors at home?	1	2	3	4	5
2c. How often have you tried to give up smoking cigarettes?	1	2	3	4	5

2d. How many cigarettes would you smoke a day? .... cigarettes

3. Were you aware that excessive drinking of alcohol can cause health problems?

Yes	1
No	2

	Never	Rarely	Occasionally	Frequently	Very Frequently
3a. How often do you drink more than the recommended standard alcoholic drinks per day - 4 per day for men 2 per day for women	1	2	3	4	5
3b. How often do you have at least 2 alcohol free days each week?	1	2	3	4	5
3c. How often would you drive a motor vehicle after having had more than the recommended number of standard drinks?	1	2	3	4	5
3d. How often would you operate machinery or undertake activities in potentially hazardous situations after having had more than the recommended number of standard drinks?	1	2	3	4	5
3e. How often have you tried to significantly reduce drinking alcohol?	1	2	3	4	5

PART E

1. The following questions are about your general physical health symptoms <u>in the last month</u>. Please indicate how often you have suffered from the following problems by circling the number in the appropriate column. Circle 'never' if not applicable.

		Never	Rarely	Occasionally	Frequently	Very Frequently
1.	Headaches	1	2	3	4	5
2.	Eye strain	1	2	3	4	5
3.	Blurred vision	1	2	3	4	5
4.	Dry, irritated eyes					
5.	Difficulty in turning the pages of a book	1	2	3	4	5
6.	Difficulty in turning door knobs or taps	1	2	3	4	5
7.	Cold hands while entering data	1	2	3	4	5
8.	Waking during the night with pain or numbness in hands	1	2	3	4	5
9.	Increased sensitivity of eyes to light	1	2	3	4	5
10.	Elbow problems	1	2	3	4	5
11.	Upper back problems	1	2	3	4	5
12.	Lower back problems	1	2	3	4	5
13.	Wrist pain	1	2	3	4	5
14.	Arm problems	1	2	3	4	5
15.	Pain in the hands	1	2	3	4	5
16.	Pain in fingers or thumbs	1	2	3	4	5
17.	Swollen ankles	1	2	3	4	5
18.	Pain in the foot or toes	1	2	3	4	5
19.	Pain down the legs	1	2	3	4	5
20.	Aches or pain in shoulders	1	2	3	4	
21.	Eye Tics	1	2	3	4	5
22.	Grinding teeth	1	2	3	4	5
23.	Shooting pains in jaws and into ears	1	2	3	4	5
24.	Neck tension	1	2	3	4	5
25.	Other - Please specify					

....

....

2. To what extent do you believe the symptoms you have suffered in relation to the parts of the the body indicated are
   solely related to your present work,
   partly related and partly not related to your present work, or
   are solely related to other factors than your present work.
   Please indicate by circling the appropriate point along the five-point scale.

		Soley related to present work				Solely related to non work activities
1.	Head					
2.	Eyes					
3.	Neck					
4.	Shoulders					
5.	Arms					
6.	Wrists					
7.	Hands					
8.	Legs					
9.	Elbows					
10.	Ankles/feet					
11.	Lower Back					
12.	Upper Back					

3. If the symptoms were work-related, did you report the problem to your organisation?

Yes	1
No	2

4. Please indicate how much of your out of work time you spend in activities that use the same muscles that you use while at work.

1.	Knit or crochet	...... hours
2.	Write for extended periods	...... hours
3.	Read for extended periods	...... hours
4.	Draw or paint	...... hours
5.	Embroider, quilt or sew	...... hours
6.	Watch television	...... hours
7.	Play computer games	...... hours
8.	Play a sport such as tennis, squash, badmington, TenPin Bowls or similar	...... hours

Please give details of any other activity(ies) that you believe may be relevant.

....

....

5. Please indicate, by circling the appropriate response, whether you have <u>ever</u> hurt any of the following parts of the body in an <u>accident</u> that is unrelated to your work.

1.	Head	Yes/No
2.	Eyes	Yes/No
3.	Neck	Yes/No
4.	Shoulders	Yes/No
5.	Arms	Yes/No
6.	Wrists	Yes/No
7.	Hands	Yes/No
8.	Legs	Yes/No
9.	Elbows	Yes/No
10.	Ankles/feet	Yes/No
11.	Lower Back	Yes/No
12.	Upper Back	Yes/No

6. Please indicate whether pain or discomfort in the following parts of the body have prevented you from doing your normal activities <u>in the last 12 months</u>, and the total length of time that you were prevented from doing your normal activities, <u>in the last 12 months</u>, if applicable.

		At Work	Out-of-Work	Total No. of Days
1.	Head	Yes/No	Yes/No	.... Days
2.	Eyes/Vision disorders	Yes/No	Yes/No	.... Days
3.	Neck	Yes/No	Yes/No	.... Days
4.	Shoulders	Yes/No	Yes/No	.... Days
5.	Arms	Yes/No	Yes/No	.... Days
6.	Wrists	Yes/No	Yes/No	.... Days
7.	Hands	Yes/No	Yes/No	.... Days
8.	Legs	Yes/No	Yes/No	.... Days
9.	Ankles/feet	Yes/No	Yes/No	.... Days
10.	Elbows	Yes/No	Yes/No	.... Days
11.	Lower Back	Yes/No	Yes/No	.... Days
12.	Upper Back	Yes/No	Yes/No	.... Days

Please elaborate.

....

....

7. Please indicate, by circling the appropriate response, whether you consulted a professional such as a doctor, optometrist, physiotherapist, chiropractor or similar person due to pain or discomfort in the following parts of the body <u>in the last 12 months</u>.

		Consultation	No. of Visits
1.	Head	Yes/No	.... visits
2.	Eyes/Vision disorders	Yes/No	.... visits
3.	Neck	Yes/No	.... visits
4.	Shoulders	Yes/No	.... visits
5.	Arms	Yes/No	.... visits
6.	Elbows	Yes/No	.... visits
7.	Wrists	Yes/No	.... visits
8.	Hands	Yes/No	.... visits
9.	Legs	Yes/No	.... visits
10.	Ankles/feet	Yes/No	.... visits
11.	Lower Back	Yes/No	.... visits
12.	Upper Back	Yes/No	.... visits

8. Please indicate whether you had to change jobs or duties because of the problem and whether you needed time off work because of the problem in the last 12 months.

		Changed Jobs/Duties	No. of Days Lost
1.	Head	Yes/No	.... days
2.	Eyes/Vision disorders	Yes/No	.... days
3.	Neck	Yes/No	.... days
4.	Shoulders	Yes/No	.... days
5.	Arms	Yes/No	.... days
6.	Elbows	Yes/No	.... days
7.	Wrists	Yes/No	.... days
8.	Hands	Yes/No	.... days
9.	Legs	Yes/No	.... days
10.	Ankles/feet	Yes/No	.... days
11.	Lower Back	Yes/No	.... days
12.	Upper Back	Yes/No	.... days

9. Did you return to your original job/duties? Yes/No

PART F

Please rate the following statements about the place in which you work. Please answer every statement.

		Never	Rarely	Occasionally	Frequently	Very Frequently
1.	Staff are encouraged to apply ergonomics to their work	1	2	3	4	5
2.	Staff are able to use their initiative in organising their work.	1	2	3	4	5
3.	Staff skills are under utilised.	1	2	3	4	5
4.	There is scope to be flexible when organising your work day.	1	2	3	4	5
5.	There are problems catching up on work when returning from leave.	1	2	3	4	5
6.	The work is interesting.	1	2	3	4	5
7.	There is a variation of tasks.	1	2	3	4	5
8.	The application of ergonomics to computer use is monitored by a person within the organisation.	1	2	3	4	5
9.	Work demands are excessive.	1	2	3	4	5
10.	Staff input into decisionmaking is valued.	1	2	3	4	5
11.	New staff receive appropriate induction on the organisation's policy on ergonomics and computer use.	1	2	3	4	5
12.	Staff are consulted when decisions are to be made about their work.	1	2	3	4	5
13.	Urgencies and deadlines dominate the organisation of work.	1	2	3	4	5

		Never	Rarely	Occasionally	Frequently	Very Frequently
14.	Staff are encouraged to take rest breaks away from the computer.	1	2	3	4	5
15.	Staff are given too much to do.	1	2	3	4	5
16.	The workload does not allow rest breaks away from the computer.	1	2	3	4	5
17.	Staff are given the responsibilities required to complete their tasks.	1	2	3	4	5
18.	Staff have adequate control over the order in which tasks are completed.	1	2	3	4	5
19.	The rate of work is too fast.	1	2	3	4	5
20.	The work is narrow and monotonous.	1	2	3	4	5
21.	Staff find supervision supportive.	1	2	3	4	5
22.	There is a friendly spirit of cooperation between co-workers.	1	2	3	4	5
23.	Ergonomic furniture and equipment are available for use.	1	2	3	4	5
24.	Staff are provided with software that reminds/ trains in the application of ergonomic principles	1	2	3	4	5
25.	People often have to work overtime to get their work done.	1	2	3	4	5

Any Other Information:

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THANK YOU
PLEASE RETURN THE SURVEY NOW
IN THE REPLY-PAID ENVELOPE PROVIDED

to

Ms Janet Sawyer
Division of Business and Enterprise
University of South Australia
Nicolson Avenue
WHYALLA NORRIE SA 5608

Appendix 3

THESIS PUBLICATIONS

Book Chapters

Sawyer, J. (1999), The Application of Ergonomics to the Use of Computers: Universities Have a Part to Play, in *New Learning Technologies A Challenge for Educators*, (Lorraine Ling, Peter Ling, Bernie Neville Ed.), Graduate School of Education, La Trobe University, Victoria, 36-41.

Refereed Journal Articles

Sawyer, J. (2004), Knowledge of ergonomics and computer use of post-graduate students and academic staff. *The Journal of Occupational Health and Safety*, Vol 20 (2), 139-153.

Sawyer, J., Dollard, M. and Farrin, J. (2002), Ergonomic awareness, work environment, health and job satisfaction in computer users. *The Journal of Occupational Health and Safety*, Vol 18 (3), 247-257.

Sawyer, J. K. (1998), 'Ergonomics: A Forgotten Factor?'. *Journal of Occupational Health and Safety*, Vol 14 (1), 85-89.

Refereed Conference Proceedings

Sawyer, J. (2004), Compliance with Ergonomic Computer Use. In *Ergonomics for a BIZ-e World!* Proceedings of the 40th Conference of the HFESA & the 7th Conference of the PPCOE, HFE 2004, Cairns, Queensland. 22-25 August, pp. 36-45.

Sawyer, J. (2003), Ergonomics and computer use: Do not underestimate its importance, in *RED Snapshots*, Issue 2: *PHCRED-SA Conference 2003 Proceedings,* 16-17 October 2003, Flinders University, Adelaide, S. A., 97-106.

Conference Publications - Extracts

Sawyer, J. (2004), Ergonomic Computer Use: it still needs to be taken seriously, *Our Region, Our Future Forum*, Spencer Gulf Rural Health School, 30 September - 1 October 2004, Whyalla, S.A.

Sawyer, J. (2002), A Study of Ergonomics and Computer Use of Post-Graduate students and Academic staff, in *Rural Research in Action Seminar*, Spencer Gulf Rural Health School, 17-18 October 2002, Whyalla, S.A.

Sawyer, J. and Dollard, M. (2000), The Predictive Health Effects of Ergonomic Knowledge, *Ergonomics for Life: At work, home and leisure, Proceedings of the 36th Annual Conference of the Ergonomics Society of Australia Inc*, Adelaide, SA, 8 October 2000, in *Ergonomics Australia*, Vol 14 (6), 28.

Newsletter Articles

Sawyer, J. (1998), Application of ergonomic principles within SA Organisations. *Grapevine,* Ergonomics Society of Aust (SA), July, 2.