CHAPTER 2

LITERATURE REVIEW

The literature review will consider RSI and its characteristics as well as the controversy around the causative diagnosis of RSI as well as the relationship between work and RSI. The reporting of RSI in South Africa (SA) and worldwide and various programmes for intervention and prevention of RSI will also be considered.

2.1 REPETITIVE STRAIN INJURY (RSI)

The resounding commonality is that RSI or Work Related Musculoskeletal Disorders (WRMSD) are slow to develop, involve the upper extremity and are related to repetitive tasks (Sanders, 2004, van Tulder *et al*., 2007, Nathan and Meadows, 2002). For the purposes of this report the term RSI will be used to indicate symptoms in the: neck, shoulder, arms, hands and wrists. Repetitive strain injury is one of the terms used to describe occupational related musculoskeletal disorders. To be compensated these must be caused by exposure to the workplace and can affect one of many of the following: muscles, tendons, bones, nerves, blood vessels, joints or bursa of the shoulder, arm, wrist or hand (Department of Labour, 2007).

The term RSI is used interchangeably with several other terms including Work Related Upper Limb Disorders (WRULD), Cumulative Trauma Disorders (CTD), Musculoskeletal Disorders (MSD), Upper Limb Disorders (ULD) and Upper Extremity Disorders (UED), Occupational Overuse Syndrome (OOS) and Occupational Cervicobrachial Disorders(OCD) (Bernaards *et al*., 2006, van Tulder *et al*., 2007, Palmer, 2003).

This group of conditions have a gradual onset of symptoms and are related to repetitive activities, involve any body part but occur with most frequency in the upper limb and are slow to recover (Sanders, 2004, van Tulder et al., 2007).

There is evidence to suggest that RSI develop, or are more prevalent in, certain occupations or industries like garment manufacturing. Typists, computer or visual display unit users, construction and factory workers have also been identified (Blatter and Bongers, 2002, Jepson and Thomsen, 2006).

2.1.1 Characteristics of Repetitive Strain Injury

Some medical evidence suggests that RSI are the result of repetitive movements with sub-maximal loading. Tissue exposed to this can recover, adapt and undergo additional loading if adequate rest periods are provided. Therefore RSI can affect one or many of the following: muscles, tendons, bones, nerves and blood vessels (Department of Labour, 2007).

This results in micro trauma. The body responds with an inflammatory response that releases vaso-active substances and enzymes. This can lead to tissue damage (Alexander and Currie, 2004). The condition is slow to develop, non specific, poorly localised, insidious in nature and recovers slowly and may involve an injury to a combination of the body structures mentioned above (Sanders, 2004, van Tulder *et al*., 2007).

Multi factorial causes that result from both occupational and non-occupational activities have been identified in relation to RSI making it difficult to diagnose even though the structures affected are easily recognised and defined. The mechanisms involved are both mechanical and physiological and in terms of occupation related RSI are related to the duration and work intensity of the job or activity (Ijmker *et al*., 2006 and van Tulder *et al*., 2007). The work cycle

(particularly short, repetitive cycles which involve highly repetitive movements where the same movement or movement pattern is performed every few seconds for more than two hours at a time) and static work which includes an uncomfortable non varying posture have been implicated (NIOSH 1995).

Other identified risk factors that are known to be causally related to RSI are movements at the end of reach, static muscle loading with fixed positions of the hands and limbs for two or more hours at a time and sustained awkward postures for two or more hours at a time. In the hand, repetition thresholds suggesting high risk activities or movements are 10 or more repetitions per minute for the forearm and wrist and 200 repetitions per minute or more for the fingers (Sanders, 2004, van Tulder, *et al*., 2007, Department of Labour, 2007). There is documented epidemiological evidence to prove the relationship between UL RSI and the duration of computer use. The research goes as far as to suggest that with every hour of

exposure per day a computer user's risk escalates accordingly in other words a dose response exists between computer use and the incidence of UL RSI. Several authors lend their support to the dose response theory (Ijmker *et al*., 2006, Galinsky *et al*., 2007, Tittiranonda *et al*., 1999, Jepson and Thomsen, 2006, Blatter and Bongers, 2002). This combined need for increased productivity and efficiency and increased computer use, has coincided with an increase in RSI or WRULDs. As such the prevalence of RSI, especially due to computer related risks is increasing (Blatter and Bongers, 2002).

There is no doubt that the ever advancing information and communication technology boom has afforded us many benefits. However alongside these benefits are several adverse effects. One such adverse effect is that with ever increasing technological knowledge, more people have computer related jobs which are further responsible for the increased incidence of RSI, linked to computer use. Over the past two decades, we have seen a marked improvement in our information and communication technology (Blatter and Bongers, 2002, Alexander and Currie, 2004). Ijmker, Blatter, van der Beek, van Mechelen and Bongers (2006) reported that there were over 77 million occupational computer users in the United States of America (USA) and over 88 million in the European Union (EU) in 2002. Over 50 million of the EU workers were reported to use the computer for at least 50% of their work. Jepson and Thomsen (2006) found that two thirds of employees in industrialised countries are involved with daily computer use, one fifth of whom use the computer for a minimum of three quarters of their working day.

Extrinsic factors which contribute to RSI and include the use of incorrect work technique, incorrect equipment, incorrect postures, inadequate rest periods as well as inadequate training and adaptation time (Alexander and Currie, 2004, van Tulder, *et al*., 2007). Intrinsic factors from previous injury, poor conditioning and anatomical variations as well as stress and the work environment have also been implicated in the condition. This is supported by van Tulder *et al*., (2007), who assert that two other risk factors namely psychosocial and individual risk factors result in RSI. However the effects of psychosocial or individual risk factors are not as easy to measure or document (Povlsen and Rose, 2008).

Research to date has focused on: prevalence, occupation types at risk, profession specific RSI development, effects of therapeutic intervention as well as the ergonomic causative and remediating factors. Signal risk factors that cause RSI have been identified by the NIOSH (1995) and Department of Labour (2007) and include

- rapid or repetitive motion
- forceful exertion
- excessive mechanical force concentration
- awkward or non-neutral postures
- vibration

A single response to any one of the above criteria is suggested as sufficient for assessment and intervention (Berg-Rice, 1998).

According to Cole, Ibrahim and Shannon (2005), there are several predictors of work-related RSI, namely:

- gender (female to male odds ratio of 1.98)
- tertiary education
- high physical exertion levels
- high psychological demands
- full time work (more than 30 hours per week) as opposed to part time work

2.1.1.1 Classification of Repetitive strain injuries according to Specific Body tissues

Tendons

The most common structures involved in RSI are tendons. Tendons are composed of 30% collagen and 70% elastin in an extracellular matrix that is 68% water. Tendon injuries result from disruptive forces such as shearing, tension and compression. This results in tendon injury that may be either macro or micro trauma. Macro trauma results in total tissue destruction whilst micro trauma results in chronic abuse and destruction. Thus micro trauma results in repeated relatively low level injuries to the tissue. Whilst tendons have restorative properties, they are by nature metabolically less active than other tissue types (Sanders, 2004).

Chronic abuse or repetition leads to fibre disorganisation with scattered vascular in-growth and local necrosis and calcification. An inflammatory response is triggered, resulting in pain and eventual decreased movement and function (Sanders, 2004, Palmer, 2003). Tenosynovitis or stenosing vaginitis and tendonitis are inflammation in the tendon/s, the tendon sheath/s or both. This hypertrophy causes a decreased vascular supply and thus decreased nutrition to the tendon/tendon sheath. The effects may be acute or chronic. The symptoms are insidious and variable in nature. They include: pain (localised and provoked by specific movements), swelling and erythema (Sanders, 2004, and Palmer, 2003).

Nerves

Neuropathy or the inflammation of a nerve due to a mechanical compression by the narrowing of the tunnel, in which the nerve travels, may also be acute or chronic in nature. Symptoms include altered sensation leading to decreased and absent sensation, pain and motor deficits. Carpal tunnel syndrome and Cubital tunnel syndrome are caused by nerve compression (Palmer, 2003).

Other

The effect of work on muscles and joints is problematic as static positions can cause muscle imbalances and trigger points. Proximal muscles may be more affected than distal tendons in this case causing tension in the neck, biceps strain as well as myalgia and myositis, (MacKinnon and Novak, 1997, Pheasant, 1991).

The slow insidious onset of and the multiple causes make RSI difficult to diagnose even though the structures affected are easily recognised and defined.

2.2 CAUSE AND DIAGNOSIS OF REPETITIVE STRAIN INJURIES

Upper limb pain with no consistent physical findings, in light repetitive work, has been reported since the advent of factories. There are proponents of the link between light repetitive work and RSI. As the condition is subjective, insidious and often without continuous physical findings however, the possibility for prospective, unbiased objective diagnosis is limited (Palmer, 2003). This then compounds the

difficulty faced by physicians when diagnosing and treating this already nebulous condition.

Thus the diagnosis of RSI is problematic due to a lack of objective evidence of a cause/effect relationship between work/noxious stimulus and the symptoms experienced (Sanders, 2004, Berg-Rice 1998, Ijmker *et al*., 2006). Consideration of the above in identifying risk factors has prompted WCA to remove RSI from the readily compensated diagnoses list. This is due to the inability to identify a work over a non-work activity as a factor in the cause of the condition. As it is also difficult to identify a single risk factor, so too is it difficult to apportion a relative contribution percentage to the said risk factor. RSI is usually related to multiple causative factors – each factor influencing the level of effect of the others (Sanders, 2004, Bernaards *et al*., 2006 Ijmker *et al*., 2006).

Socio economic differences occur in affected individuals, with a noted gender bias toward females (Barr, 2002*).* Variance in reporting systems between developed and developing countries and the lack of standardised inclusion criteria and assessment tools further add to the confusion around the management of this condition (Sanders, 2004). There are also a lack of standardised inclusion criteria and assessment tools to identify or evaluate it reliably. An added confounding factor is the disagreement in respect of classification codes used by insurance companies, medical aid companies and departments of labour as to what the cause and course of the condition is, or what aspects can be compensated (Berg-Rice, 1998).

This all makes diagnosis contentious and opinions on medical causation therefore remain polarised. Discrepancies abound between different countries in terms of definition, symptoms, causation, treatment, legislation and employer responsibility when dealing with RSI compound the problem even more (Bernaards *et al*., 2006 Ijmker *et al*., 2006 Blatter and Bongers, 2002, Jepson and Thomsen, 2006).

This highlights the need for appropriate individual assessment guidelines that are internationally standardised. If individuals and the causative factors could be assessed more adequately, we would be in a better position to apply appropriate intervention methods (Palmer, 2003). However this necessitates the acceptance of a work component to the disorder. Dissent abounds as to the involvement of work or

occupation as single causative factors (Sanders, 2004, Department of Labour 2007, Ijmker *et al*., 2006).

There are those that question the causal relationship and suggest causes such as secondary gain “compensitis” and psychological conversion disorders. The condition is subjective in nature and evidence suggests that cluster type occurrence may be linked to the fact that the populations affected are sensitised (by media linked ‘at risk occupations’) to the issue as opposed to being related to specific activities or tasks. This may lend credence to the “hysteria” causation. Cole *et al*. (2005) put forward that a risk predictor for RSI is tertiary education. He suggests that individuals with tertiary education are more likely to report having symptoms associated with RSI. Reasons attributed may be their increased insight into the relationship between work, work demands and RSI symptoms or onset (Winspur, 2001, Povlsen and Rose, 2008, Ijmker *et al*., 2006, Cole *et al*., 2005).

In terms of medical and legal requirements for the identification of a condition, definitions for “causation” are vastly different. The medical definition or criteria for scientific proof of causation include consistency, strength of association, specificity, temporality and biological gradient. This means that *all workers* (consistency) performing a *specific occupation* (specificity) (e.g. computer work in call centres) show the *same increased risk* (strength of association) or development of specific types of physical symptoms which can be *linked to and are preceded by* specific activities (temporality), of which *increased performance leads to increased symptoms*(biological gradient) (Winspur, 2001).

A legal definition of causation on the other hand only requires that there be proof of a causal relationship or link between the performance of an activity or lack of an intervention and the damage suffered. The damage needs to have been foreseeably avoidable. Thus this legal definition is based on probability (51%) and does not rely on medical fact (Winspur, 2001).

This discrepancy further fuels the differences and the debate in respect of handling RSI, leading to vastly differing decisions regarding causality, legislature and civil rights of employees and the burden on employers. In terms of the European Health

and Safety Regulations each claimant must demonstrate a breach of employer duty leading to employee damage. The definition of employer duty regarding repetitive manual work has been refined in the Manual Handling Operations Regulations 1992, Workplace and Welfare Regulations 1992 and Health and Safety (Display Screen Equipment) Regulations 1992) (Health and Safety Executive 2007a, Health and Safety Executive 2007b). In respect of the above safe working practice and work place ergonomic guidelines, the responsibility no longer lies with the employee to prove injury but with the employer to defend himself and prove best practice intervention (Winspur, 2001, Sanders, 2004).

There are proponents of the theory that RSI does not exist as separate entities (Ijmker *et al*., 2006). As pointed out by Alexander and Currie (2004) this evidence exists internationally and across studies in spite of differences in design, definitions and inclusion criteria and terminology used. The above would unfortunately, prevent obvious and direct comparisons between the studies. Despite this, the link exists and demands further investigation and this need for further investigation is supported by many authors. Despite the continued debate and nebulous nature of the disorder, should the cause of RSI be repetitive light work, poor ergonomics and work practices: the incidence of this diagnosis would decrease if the above legislation was enforced.

To know whether the legislation is effecting any change we first need to know the current figures. Again, due to the problems conducting unbiased, long term studies, these figures cannot be read in isolation (Williams, Westmorland, Schmuck and Macdermaid, 2004, Winspur, 2001).

2.2.1 Difficulty in reporting Repetitive Strain Injury

Due in part to the diffuse definition and varying inclusion criteria in diagnosing RSI, a disparity with the reported figures (incidence and prevalence) and the treatment thereof exists (Ijmker *et al*., 2006). There is controversy about the cause of RSI with critics of the RSI-occupation connection citing the following as possible explanations for these symptoms - poor psychosocial work context, lifestyle habits and psychological factors (Ijmker *et al*., 2006). Mention too is made of the increased knowledge of individuals about RSI, due to increased accessibility of information, resulting in increased reporting of RSI. The supposition is that an element of

suggestion may exist in this symptom reporting and may affect studies requiring questionnaire answering (Ijmker *et al*., 2006, Palmer, 2003).

Reasons abound for the poor reporting of RSI amongst which are poor consensus on diagnosis, diagnostic tools, risk factors and intervention types.

Studies show the one year prevalence of RSI to be 24%-44% in office workers and the one year incidence to be between 5% and 34%. Van Tulder *et al*., (2006) assert that the economic burden associated with RSI is especially high due to the costs of associated absenteeism. They further state that worker's compensation claims, in the USA, for RSI range from $5000 to $8000 per person and total $6,5 billion annually (Bernaards *et al*., 2006, van Tulder *et al*., 2006, Lacerda *et al*., 2005).

However when interpreting these figures one needs to consider several factors:

- the difficulties in researching RSI, thus the possible inaccuracies of the results reported (Bernaards *et al*., 2006, van Tulder *et al*., 2006, Lacerda *et al*., 2005)
- under reporting due to fear for job security (Palmer, 2003)
- conflicts in insurance claims and the definitions of RSI (Berg-Rice.V,1998)
- socioeconomic differences between developed and developing countries (Barr, 2002)
- gender bias in populations and jobs performed (Lacerda *et al*.,2005)
- variances in the reporting systems utilised in developed and developing countries (Sanders, 2006)
- private and government based agencies (Barr, 2002)
- the very important fact that the inclusion or diagnostic criteria are not standardised (Sanders, 2004, Berg-Rice 1998, Ijmker *et al*., 2006, Palmer,2003)

2.2.2 The reporting of Repetitive Strain Injury in South Africa

In South Africa, there is a very strict protocol to be followed when assessing an individual for work-related RSI with respect to WCA regulations. Among the requirements are: the completion of a different first medical assessment form to normal WCA claims, the need for information relating to the start and chronological progression of symptoms in relation to the specific offensive task at hand, supporting

evidence e.g. X Rays and nerve conduction studies among others. The above do not take into account the fact that RSI is an insidious condition with fluctuating symptoms that do not present initially with abnormal findings on assessment (except through thorough clinical assessment by an experienced clinician) (Department of Labour, 2007).

The consequences of an incorrectly completed form are devastating for the individual – the case will not be accepted as an injury on duty (IOD) and the individual will not be granted medical cover to seek therapeutic intervention. The individual is then responsible for the accounts accumulated and the subsequent time taken off work. Often employers will not recognise the individuals need for intervention (supported by the fact that WCA have rejected the claim) and do not allow or penalise the individual for seeking intervention. Thus the concept of job security is raised and this often leads to the individual not seeking intervention and returning to work at a suboptimal rate (Palmer, 2003, Berg-Rice, 1998).

This is further exacerbated by the poor consistency in treatment options, definitions of RSI and the link to the work environment. This further highlights the discrepancies that abound when one considers the term RSI (Department of Labour, 2007, Lacerda *et al*., 2005).

This provides a very real problem in that if the diagnostic criteria are not internationally standardised, neither can the assessment and treatment tools and protocols be. In a country such as South Africa, further discrepancies exist between the private and provincial; health care system (Department of Labour, 2007).

The links between occupational computer use and the development of RSI abound. The literature details evidence of: functional impairment, time off work, costs to industry, costs to health care services and the individual, reductions in the quality of life and psychosocial wellbeing of the affected individual, associated with computer use (Jepson, 2004, Blatter and Bongers, 2002, Ijmker *et al*., 2006).

2.2.3 Cost to individual and company

The financial burden of RSI is undeniable and is borne by the population at large. Significant socio-economic effects result. There are no figures available for South Africa (Department of Labour, 2007) but a third of all Workers Compensation Act (WCA) costs in the United States of America (USA) (private industry) are related to RSI. Similar statistics are reported for the Netherlands where 8% of the population is absent from work due to RSI, whilst 1% of all employees in Britain are affected by RSI (Lacerda, Nácul**,** Augusto, Olinto, Rocha and Wanderley, 2005).Thus one can understand that the high percentage of RSI reported world wide suggests the need for intensive research.

Little information is available regarding the interventions of RSI, especially with respect to work-related outcomes. As this is a disease associated with occupation, it can be extrapolated that to minimise the effect on the economy, knowledge regarding the above must be gained. Small sample sizes, methodological flaws and lack of focus on work-related outcomes of the trials can be listed among the research failures (van Tulder *et al*., 2007, Povlsen and Rose, 2008 Williams *et al*., 2004, Alexander and Currie, 2004 and Department of Labour, 2007). However despite the research flaws, industry is beginning to take note of the statistics reported, especially when it comes to their bottom line: profit (Attaran and Wargo, 1999).

With health care and labour costs constantly on the increase, some industry leaders are becoming concerned about the physical health of their workers. Such companies recognise the adverse effects of RSI on productivity and ultimately on their product margin. According to Attaran and Wargo (1999), RSI is the “fastest growing workplace illness” and is the cause of over 60% of workplace injuries in the USA. They too report a staggering increase in RSI of 26% over a 1 year period. Such high figures surely cry out for the need for intervention or change in the way businesses are conducted. Several businesses are heeding these figures and seeing an improvement in the quality of their workers’ health and productivity as well as in the profit margin. Among the interventions reported are ergonomic changes. Huge positive implications for companies are reported with between a 10% - 40% increase in productivity with the implementation of ergonomic programmes (Attaran and Wargo 1999).

Companies too realise the benefit of ergonomic changes when comparing increased productivity to the cost of relative ergonomic changes. An initial financial outlay by company may have benefit in the long term. A 15% increase in productivity of an employee (annual salary of R150 000), will pay for ergonomic changes of up to R15 340.00 in 11 weeks. In a similar vein, the benefit to cost ratio of ergonomic intervention and the increased productivity to intervention cost has been reported to be as high as 22:1 (Amick III, Robertson, DeRango, Bazzani, Moore, Rooney and Harrist, 2003). The increased productivity will continue or be maintained whilst the cost of the changes is negated or recouped in a relatively short time. Thus by recognising the presence of RSI and the poor ergonomic design of the workspace or routine, companies can prevent a loss of income due to employee absenteeism or decreased productivity, as well as preventing serious injuries. This simply requires an initial ergonomic assessment and the alteration of the work place and the equipment (Attaran and Wargo, 1999, Lacerda *et al*., 2005, Blatter and Bongers, 2002, Jepson, 2004).

Sanders (2004), succinctly concludes that the costs of an RSI are both direct and indirect. The direct costs would include the medical bills and the possible insurance payouts depending on the severity of the injury and the indirect costs (which probably make up the bulk of the costs) are largely discounted. An important point to note is that in 1991, the National Council on Compensation Insurance stated that the upper extremity WRMSD Claims amounted to 50% more than the average for other injury claims (Herbert, Dropkin, Warren, Sivin, Doucette, Kellogg, Bardin, Kass and Zoloth, 2001).

The indirect costs include human resources time spent on paperwork, the training of a replacement for the injured individual or the hiring of temporary staff. The decreased productivity of remaining staff members (due to increased conversation and speculation and decreased supervision), the decreased productivity of temporary staff in the early initiation phase and the possible increase in waste and scrap as the replacement is trained as well as the decreased productivity of the injured person once back on light duty and their loss of income (75% pay re-imbursement while on light duty) are often never considered. There are also many unrecognised or unreported RSI that may lead to early retirement or a great deal of

sick leave. These costs would be difficult to factor in, but are unfortunately a very real part of the costs involved in RSI (Sanders, 2004, Palmer, 2003, Ijmker *et al*., 2006, Bernaards *et al*., 2006, Lacerda *et al*., 2005, Department of Labour 2007).

Much is made of the effect of ergonomics on RSI in the literature and there has been international recognition that the work environment needs investigation. The importance of adequate ergonomic design of the workplace and the task at hand in initial planning has been highlighted in a number of studies (Attaran and Wargo, 1999, Fenety and Walker, 2002, Sanders, 2004). However this is obviously costly and in most cases the companies involved do not have in-house ergonomists on the staff resulting in further costs, as there is the necessity of using consultants. Ergonomically designed workplaces must be altered for the individual involved as well, which means that the workplace design may need to be altered as workers come and go. Corporations are not willing to authorise this type of expenditure without proof of a problem (Attaran and Wargo, 1999).

There is no way to assess the potential incidence of RSI in an office environment without specific assessments performed by a consultant and although prevalence statistics have been published because of the cost involved, most companies prefer to base any intervention on their own in-house statistics. Although online mechanisms and computer software can assess and interpret a user's potential risk for developing an RSI, this needs to be installed and used by the entire company's staff as well as being monitored. The financial implications for the company again cause reluctance to follow this route (Bertuca, 2001, Bernaards *et al*., 2006, Sanders, 2004).

The need for an institutional response to the presence of RSI, irrespective of initial cost, that is not incidence-based but broader and pro active cannot be denied. There is evidence to suggest that interventions aimed solely on an individual level are seldom effective over the long term and may exacerbate the psycho-social risk factors already present.

Thus intervention on an individual basis needs to be extended to incorporate prevention and promotion using ergonomics or the study of the interface between individuals, their work task/job, the work environment and the tools they utilise to

perform the task, for all workers within a given situation (Bernaards *et al*., 2006, Sanders, 2004, Kasch, 2002).

2.3 INTERVENTION FOR REPETITIVE STRAIN INJURY

Several authors indicate that certain types of professions and certain personalities are at potentially greater risk of developing RSI. This may however be related to the increased knowledge and access to the internet, which has influenced the increase in reporting and diagnosing of RSI (Alexander and Currie, 1999, van Tulder *et al*., 2007, Ijmker *et al*., 2006 and Bernaards *et al*., 2006).

The notion has also been reported that an intervention of any form may provide a change in the symptoms. It has been suggested this maybe because notice has been taken of the symptoms. These concerns indicate an intervention bias which cannot be excluded when assessing the effects of an intervention (Kasch, 2002 , Berg-Rice, 1998, Sanders, 2004, Palmer, 2003, Ijmker *et al*., 2006, Bernaards *et al*., 2006 and Lacerda *et al*., 2005). The contribution of the "Hawthorne effect" that is the individual's perception of the value attributed to an intervention, must be considered (Amick III *et al*., 2003).

Mention must be made that there exists very little unequivocal evidence in support of ergonomic intervention decreasing the incidence of RSI (Amick III *et al*., 2003). There is however evidence that ergonomic interventions decrease symptom severity, and in the long run it is hoped that understanding how ergonomics reduce symptomatology, may help in preventing injury resulting from RSI (Amick III *et al*.,2003). A number of different types of programmes need to be considered in the implementation of ergonomics (Williams *et al*., 2004).

2.3.1 Ergonomic programmes

There are proponents of the theory that RSI cannot solely be attributed to work related causes and that lifestyle, work psycho-social context and sociological factors (Alexander and Currie, 1999, van Tulder *et al*., 2007, Ijmker *et al*., 2006, Bernaards *et al*., 2006). As such ergonomics as used by occupational health practitioners must

include the social, economic, political and legislative environment. Work organisation which encompasses the psycho-social as well as physical workplace risk factors must be considered in relation to the individual. Any ergonomic intervention therefore must take all the above into consideration to be effective.

Interventions may be in the form of one or a combination of several styles. These styles may include: education on ergonomics (traditional passive or participatory education), education with the chance of affecting some of the ergonomic changes taught or simple provision of and education about ergonomic furniture.

The implementation of a holistic approach for intervention in RSI as described above does however fit well with the philosophy of occupational therapy. This is one profession where training in both medical conditions and the analysis of activity, allows the use of ergonomics in the work and personal situation to return those with RSI to pre-morbid functioning. When implementing or designing interventions, the recipient must also be considered with regard to education level, attitudes and beliefs regarding the intervention and motivation to effect the behavioural and ergonomic changes required (Weiss and Chan, 2008). Thus interventions used by occupational therapists for clients with RSI, include ergonomic modifications, task modifications, graded return to work as well as work place visits/evaluations and subsequent work trials (Williams *et al*., 2004).

Since RSI occurs as a result of repetitive movements, ergonomic intervention should consider a way in which to avoid the repetition. Occupational therapists use an adaptive approach by varying the task and/or the environment in which the task is done. The manner in which the task is performed can also be adapted. The application of this adaptive approach may be impossible and may be limited for a variety of reasons. These include limited space, restrictions on number and frequency of breaks that can be taken, as well as restrictions of the manner or sequence in which the task must be performed (Weiss and Chan, 2008).

Adaptations for office workers alone are considered in this literature review and the interventions used by occupational therapists for these clients with RSI, include modifications of:

- the environment -

  The environment includes the worker/person, the task, other individuals in the environment and any rules and regulations imposed on the worker.

  These aspects and others such as lighting, ventilation, breaks (length, frequency and timing) are not under the control of the worker. These limitations need to be taken into account by the occupational therapist when altering or designing a work space (Tittiranonda *et al*., 1999, Weiss and Chan, 2008, Williams *et al*., 2004).

- the work tools -

  Items in common use that may need ergonomic attention in a sedentary desk-bound worker's environment are the chair, the desk and the computer screen and keyboard. Ergonomic layouts of workspace are case sensitive. Each individual must design a work space to suit their job requirements, height and other personal characteristics (Tittiranonda *et al*., 1999, Weiss and Chan, 2008, Williams *et al*.,2004).

  Chairs that can be adjusted to suit the individual user are recommended. These chairs are adjustable in terms of height, arm rest length and back rest angle or rake. In order to place the upper limbs in the correct position to alleviate awkward postures, research emphasises the importance of correct seat height. Pheasant (1991) recommends that the seat height should be at popliteal height. Todd, Bennett and Christie (2007) suggested use of a footrest if the seat height is not adjustable.

  Correct seat depth encourages use of the backrest and must not be greater than the buttock-popliteal length (Pheasant, 1991).Although a backrest is considered to be important, many conflicting recommendations for tilt and height exist. The use of a lumber pad is advocated by a number of authors. (Todd et al., 2007) Tilting seat pans are also recommended as these allow for frequent posture changes which can be beneficial in sedentary jobs (Legg, Mackie and Milichich, 2002).

A leading cause of shoulder and arm and hand disorders may be due to working without armrests, which have been shown to reduce muscular exertion around the scapula (Todd et al., 2007). Therefore, armrests on the chair are recommended, but a gap between the armrest and the backrest is important in order to prevent ulnar nerve compression (Pheasant, 1991).

The importance of workstation layout in the reduction of RSI amongst seated workers includes the placement of the keyboard and computer screen as well as table space, forearm support and control of glare on the screen. Frequently used objects, should be placed within easy reach and screens placed to reduce glare (Pheasant, 1991). Research recommends placing the computer screen below eye level to reduce muscle activity in the neck and scapula area. There is no agreement on the exact height or distance from the worker for the computer screen placement, however. The approximate distance for the computer screen from the worker should be an arm's length.

Recommendations regarding seated posture should be provided such as: the position of the forearms should be parallel to the work surface and the wrists in neutral position. Keyboards should thus be at elbow height and near the edge of the desk to reduce wrist extension. Forearm and wrist supports have been found to be beneficial in some studies (Todd *et al*., 2007).

Some adjustable components (position of computer screen relative to telephone) may not be readily adjustable in all cases due to external factors such as space limitations, length of cords amongst others.
The desk is harder to adjust but corner/L shaped desks offer the most space and easiest layout. They can be adjusted by means of adding storage space and altering the equipment layout on the desk (Bertucca, 2001).

- task modifications -

  Task modifications are as important as correctly setting up the tools (with which the office worker is provided). With regard to computer use adaptation can be made by alternating between a mouse and another input device. This may limit the strain placed on specific muscles and thus limit the degree of

repetition inherent in that muscle (Bertucca, 2001). A major cause of the development of RSI in computer users is sustained awkward positions which are adversely affected when individuals do not take regular breaks (Visccher *et al*., 2004). Scheduled rest breaks in computer workers have been shown to reduce symptoms of discomfort but are not adequate in preventing or alleviating RSI. It is found that frequent, brief breaks distributed throughout the work shift are more effective (Galinsky *et al*., 2007). There is also evidence that in-chair stretches and exercises are beneficial to the symptom reduction of RSI (Bernaards *et al*., 2006, Fenety and Walker, 2002, Galinsky *et al*., 2007).

When the task is not adjustable - like call centre workers answering and logging calls using a computer - the task itself cannot be changed but the worker's perception of the task can be (Bohr *et al*., 2000). Such examples would include altered postures (avoiding non-neutral postures), altered key stroke force, performance of stretches and use of micro breaks (Galinsky *et al*, 2007, Bertucca, 2001, Tittiranonda *et al*., 1999, Visccher *et al*., 2004 and Williams *et al*., 2004).

- the person -

  Evidence supports the proposition that increased knowledge leads to decreased symptom growth, decreased use of awkward positions and a sense of empowerment (Robertson, Amick III, De Rango, Rooney, Bazzani, Harrist and Moore 2009, Amick III *et al*.,2003, Herbert *et al*.,2001). It does not appear to be sufficient to provide ergonomic furniture alone, but rather education as an adjunct to the environmental adaptations proves important (Robertson *et al*., 2009). This highlights the need for worker empowerment in long term management of the RSI. Knowledge better allows workers to incorporate and extrapolate the information received to other areas of their lives (Povlsen and Rose, 2008, Fenety and Walker, 2002).

  If patients/workers are empowered and understand the mechanics of ergonomics and the reasons behind the changes they are more likely to effect the changes over time. When work demands are high there is a tendency for

individuals to stop monitoring posture, to stop adjusting physical environments and not to take frequent breaks. It has been suggested that in a call centre it is more difficult to concentrate on posture when workers need to be cordial, responsible and efficient under significant time pressures (Todd *et al*., 2007).

Interventions that address work and lifestyle changes have the best carry-over in these times (Bernaards *et al*., 2006). Studies have shown that little control over work practices and procedures, distress, monotonous work and poor relationships at work are also associated with RSI (van Tulder *et al*., 2007). Sedentary work can result in a gradual deterioration in health if workers do not have a balanced and active lifestyle outside of the working environment (Todd *et al*., 2007). Being aware of the indicators of work stress and poor health practice are therefore also important.

Workplace studies that have evaluated the effects of ergonomic interventions on RSI symptoms among computer users have reported positive effects with increased frequency of work breaks, and ergonomics training (Brisson, Montreuil and Punnett, 1999). The components of ergonomic intervention considered in this study include adapting the task by taking breaks, (Galinsky *et al*., 2007) education on RSI and ergonomics but with the added aspects that includes the workers' lifestyle outside of the work environment (Weiss and Chan, 2008).

2.3.2 Education of Workers about ergonomics

There is evidence that specialized ergonomics training and education can prevent or reduce musculoskeletal symptoms. Office ergonomics training can help computer workers to understand proper workstation set-up and work postures (Brisson *et al*., 1999). Bohr (2000) found that those who received office ergonomics education reported less pain/discomfort and psychosocial work stress but results suggest that to achieve the benefits workers need to be able to easily implement the knowledge obtained (Amick III *et al*., 2003).

Workers in a later study by Robertson *et al*., (2009) reported that the office ergonomics education was beneficial and after programme implementation the participants' ergonomics knowledge and skills had noticeably improved. Amick III *et*

al., (2003) suggest that education about ergonomic change should also decrease musculoskeletal load thereby maximising productivity. They indicate that the goal of an ergonomic intervention should be to give the individual sufficient understanding of ergonomic principles so to be able to perform ergonomic self evaluations and subsequent changes to their environment and to their own posture. All interventions thus include an aspect of education but this education about ergonomics must be combined with a general education on RSI.

A holistic ergonomic intervention programme needs to include:

- information on RSI – definition, aetiology, symptoms, risk factors and intervention methods
- ergonomic information - the environment, the work tools, task modifications, the person/individual performing the task, work flow and planning of breaks

(Bohr, 2000, Robertson *et al*., 2009)

The manner in which the education is imparted to the workers is of importance in relation to the degree of change noted in their ergonomic set up. It is suggested that participatory education and the opportunity to practise what is being taught translates to greater behavioural change. Although traditional paper education booklets do not include the individual directly in the education sessions, they are the most cost effective method of providing education (Bohr, 2000).

2.3.3 Warning/Break software programmes

In order to add regular breaks into the work routine Viscchers *et al*., (2004) advocates the use of break warnings in the work place. This has become an accepted method of managing RSI. Obviously warnings can be achieved in the brochure format, but evidence supports the fact that passive programmes (information brochures or wall mounted warnings with no other intervention) are ineffective in the long term management of RSI (Ferreira,1997, Ijmker *et al*.,2006, Bernaards *et al.,*2006 and Viscchers *et al*.,2004).

Other forms of accepted intervention to manage RSI therefore include the use of computer software warning systems to facilitate breaks in a work routine, decreased or limited number of key strokes, decreased key stroke force as well as education of the worker and a combination of interventions.

Viscchers *et al*. (2004) state that to be effective the break warnings need to be offered repeatedly over a period of time, without directly interfering with the task at hand. The warnings must be concise, clear and engage the attention of the recipient. Thus we can see that it is not only the warning that must be considered but how it is presented as well as the recipient who needs to interpret it. In fact the recipient is central to the effectiveness of the warning. These warning systems have now been designed to be incorporated into computer break software and are most effective when presented as part of an intervention programme requiring active involvement of the worker, which may lead to longer term compliance (Ferreira, 1997, Ijmker *et al*., 2006, Bernaards *et al*., 2006, Viscchers *et al*., 2004).

Many employers fear that increasing the number of breaks will lead to decreased productivity. It has however been shown that increased breaks does not impair productivity and can increase work speed and accuracy. Many programmes also include stretches into the break sessions (Galinsky *et al*.,2007, Viscchers *et al*., 2004, Bernaards *et al*., 2006, Williams *et al*., 2004).

2.3.4 Workstyle/ Lifestyle programmes

Although lifestyle may play some part in the development of RSI most treatment has considered the existence of the condition related to the physical aspect of the work rather than the social and psychological context of the work environments. The basic work style premise suggests that RSI develops from an imbalance between work load and work capacity. As such, an intervention that addresses work style and the improvement of work capacity is thought to have an efficient effect on the reduction of RSI development and progression (Fenety and Walker, 2002).

This form of treatment for RSI is also supported by Williams *et al*. (2004). They suggest that hand therapists are treating more and more upper limb RSI, using treatment exercises and work place modification even though there is no reliable long term evidence as to the efficacy of this approach. One of the main reasons for this is the poor follow-up of these patients once they are discharged from the acute care environment.

A recent intervention study by Bernaards *et al*. (2006) called RSI@WORK utilised the theory that RSI are occupational disorders but that other aspects of lifestyle do impact on the development and progression of the disease. As such, aspects such as leisure and exercises were included in their intervention programme. RSI@work expands on the work style theory to three responses in terms of work demands:

- coping with high work demands
- optimal body posture and appropriate work place adjustments
- quality and number of breaks taken

Bernaards *et al*. (2006) intervention focused on education, work place adjustments, personal responsibility and exercises. Although previous evidence suggests that in-chair exercises improve symptoms associated with RSI, RSI@work addressed the question of long term compliance (Fenety and Walker, 2002, Bernaards *et al*., 2006, Galinsky *et al*., 2007).

2.3.5 Non compliance with the Intervention Programmes

Successful ergonomic programmes therefore seem to depend on several factors including the "buy-in" of the employer, the manager and the employee. It appears that this is attained most effectively through education, orientation and training of new and old staff, group/departmental training sessions and one-to-one sessions (Herbert *et al*., 2001).

Non compliance may be in part due to the difficulties experienced by the workers in co-ordinating breaks and required adaptations for correct positioning within their work routine. This is particularly evident in individuals whose work is monitored in terms of rate and volume like call centre workers. Evidence exists of the negative effect of external pacing conditions as a measure of proficiency (call centre workers being monitored with regards to call number and duration) and of compliance with work station ergonomic programmes (Ferreira, 1997). This poses a dilemma for the worker as to where to assign priority – work or ergonomic programme. This point is supported by Fenety and Walker (2002) who found that a constant struggle exists between internal constraints which include an individual's need for comfort at the

workstation, and external constraints like the work station fit/layout, the task at hand and the organisation's need or demand for efficiency.

Long term compliance with change required by any ergonomic programme is dependent on the individual's internal motivation and belief in the beneficial effects of the programme. In terms of RSI this motivation is dependent on three factors. These are symptom severity, perceived effectiveness of the intervention and the ability to incorporate the intervention into daily life (Bernaards *et al*., 2006, Fenety and Walker, 2002 and Campbell et al.,2001).

It is often easier for patients to be compliant when they are accountable to a therapist who plays a large part in defining their perception of efficacy and belief in the intervention. Once the supervised therapy is over and the home programme comes into play, it is only effective in the long term if it is incorporated into the workers activities of daily living with breaks and stretches fitting into toilet and coffee breaks (Fenety and Walker, 2002).

2.3.6 Evaluation and limitations of the Intervention Programmes

Results in a study by Amick III *et al*. (2003) assessing ergonomic intervention programmes indicate ergonomic knowledge was increased and postural risks were lower after intervention. Furthermore, the experimental group had lower average pain levels compared to the control group. Based on other studies, ergonomics education does appear to decrease the intensity of pain, but only Bohr (2000) has looked at the frequency and duration of the pain. There is however insufficient information available on the effects of simple cost-effective interventions on knowledge and reduction of RSI symptoms (Herbert *et al*., 2001).

Research has shown that interventions focussing only on warnings and educational material yielded worse results than those that included lifestyle adaptations. This re-enforces the point that for intervention programmes to be effective they need to be incorporated into the individual's activities of daily living both at work and at home (Bernaards *et al*., 2006, Fenety and Walker, 2002, Campbell *et al*., 2001). This also encourages long term compliance.

Taking all the above into account, when designing an intervention for RSI, the aim of the intervention must be borne in mind. Williams *et al*. (2004) suggest that the main

aim should be to return the worker to work in a safe and time efficient manner so that the worker stays at work.
A second question worth contemplating when designing an intervention is the benefit to the company versus the cost to the company. The costs of the intervention are obvious in that the staff need time to implement and monitor the intervention and possibly a few hours off work to attend education sessions. This is undoubtedly a loss of income; however the cost of having no intervention is increased number of injuries, increased restricted work days, increased absenteeism, decreased productivity, decreased worker morale and the obvious costs of compensation for RSI (Williams *et al*., 2004, Amick III *et al*., 2003).

The confounding factor when analysing any intervention or definition of RSI, is the lack of uniformity in assessment and evaluation and lack of standardised tests (Kasch, 2002, Berg-Rice, 1998, Sanders, 2004, Palmer, 2003, Ijmker *et al*., 2006, Bernaards *et al*., 2006, Lacerda *et al*., 2005).

2.4 SUMMARY

When considering RSI of the upper extremity - the following symptoms are uniformly present: pain, inflammation, decreased movement range and decreased strength. These symptoms are fluctuant, slow to develop and are insidious in nature. A work component is implicated and opinions as to the causation are polarised being either occupational or non specific involving life style factors.

No single internationally recognised standardised diagnostic criteria test or treatment guideline exists. The economy of every country is affected by this entity.
A resounding common thread is the need for developing a standardised set of guidelines or outcome measures for assessing RSI and the effect of the work place (Williams *et al*., 2004, Bernaards *et al*., 2006, Attaran and Wargo, 1999 and Sanders, 2004).

Consideration of the above in identifying risk factors has prompted WCA to remove RSI/WRMSD from the readily compensated diagnoses list in South Africa. This is due to the inability to identify a single causative factor i.e. work over non-work

activities. As difficult as it is to identify a single risk factor, so too is it difficult to apportion a relative contribution percentage to the said risk factor. RSI are usually related to multiple causative factors – each influencing the level of effect of the others.

Treatment of RSI include: rest, ergonomics in the form of workplace and task modification, ADL modification, possible splinting, graded strengthening and possibly invasive medical techniques (injections or surgery).

Ergonomics as used by occupational health practitioners, including occupational therapists, involves the study of the work and the individual's fit into the workplace. It must include the study of the social, leisure and personal management environment. Intervention using ergonomics can be therapeutic and these intervention programmes are best presented as an education programme with added computer-based break software and should include consideration of lifestyle and activities of daily living when planning long term implementation. Compliance is affected by motivation, education and belief in effectiveness.