

1. Orientation to the study

1.1 Introduction

“People work better on their feet than on their seat”. A change in work posture from seated to stand-up, can improve employee health (Vercruyssen, Simonton 1994: 119). High volumes of sedentary activity – regardless the amount of physical activity - is not only related to the development of common chronic diseases (Owen, Bauman *et al.* 2009 81-83), but prolonged sitting is also a risk factor for all-cause mortality (Van der Ploeg, Chey *et al.* 2012 494).

“Work-related illness and injury constitutes a costly problem for workers, employers and society” (Baldwin 2004: 34). If companies are to increase profitability, managers need to maximise productivity and minimise medical costs (Pheasant 1991: 17). Likewise, if workers are to maintain the quality of their work and home life, they need to take responsibility for protecting their health. Furthermore, if healthcare is to alleviate disability, health professions must step beyond the clinics onto the ‘real world’ of industry and business. Cooperatively, productivity must be balanced with health, considering long-term gains versus short-term profit, and re-examining the value of work for the modern-day worker (Sanders 1997: 4).

As “employers play an important role in employee health” (Punnett, Wegman 2004: 22), evidence-based healthcare (regarding the impact of work posture on employee health), is indispensable (Bury, Mead 1998: vii). Although sitting time is detrimentally associated with several health outcomes (Alkhajah 2012: 298), including musculoskeletal pain (Schierhout, Meyers *et al.* 1995: 49), standing for prolonged periods, can cause both discomfort and pain in the lower legs (Lin, Chen *et al.* 2012: 965-970). Furthermore, prolonged sitting is also associated with obesity and diabetes, both known risk factors for work-related upper extremity disorders, i.e. carpal tunnel syndrome (Stallings, Kasdan *et al.* 1997: 211; Becker, Nora *et al.* 2002: 1429; Lam, Thurston 2008: 190; Roquelaure, Ha *et al.* 2009: 342). Therefore, when health intervention programmes focus on reducing sitting time (Roquelaure, Ha *et al.* 2009: 342; Van der Ploeg, Chey *et al.* 2012: 494), it is important for all the role players to

understand the association between personal, ergonomic and psychosocial risk factors and work-related musculoskeletal disorders (WRMSDs), amidst continued pressure in businesses to increase productivity in a safer and healthier work environment (Richardson, Eastlake 1994: 38-52; Wilson 2002: 12-20; Parks, Steelman 2008: 58-68)

Physiotherapists are trained to take a holistic approach to managing their patients with musculoskeletal disorders. This approach includes a natural progression from treatment to education, aimed at the prevention of recurrence of musculoskeletal disorders (MSDs) (Richardson, Eastlake 1994: 28-29). According to the declaration of principle of the World Confederation for Physical Therapy (WCPT) in 2009, the physiotherapy curriculum should equip physiotherapists to practise in a variety of healthcare settings, including, but not limited to, institutional, *industrial, occupational*, and primary health care environments in urban as well as rural communities. Therefore, prevention is an important part of the scope of practice of the occupational-health physiotherapist in a multidisciplinary team (Richardson, Eastlake 1994: 28-29).

According to Enderby, Iliot and Newham (1989) the occupational-health physiotherapist needs considerable clinical experience, to have confidence in herself, to be able to communicate with managers and be persuasive in justifying proposed recommendations for changes in working practices while understanding the cost implications of these changes. Therefore, her contribution in a multi-disciplinary team would inevitably involve more than just clinical treatment of a patient. A major part of her role is to educate and to prevent health problems. In order to deliver this responsible educative service in a multidisciplinary team, evidence-based healthcare is indispensable, as physiotherapists gain the additional confidence that accompanies an increased knowledge of the evidence base in their field when they use evidence to deliver an optimal service. Evidence is a tool with which to enter into partnerships with managers and other professionals to make shared decisions about appropriate interventions, i.e. the change in work posture (Bury, Mead 1998: vii).

The model for this study is therefore based on a clinical approach to prevention, treatment and rehabilitation, as described by Wilson (2002). Two models for treatment and management of the injured patient are described:

The first, the manual model: is a series of manual techniques based on the identification and removal of musculoskeletal dysfunction and the provision of manual techniques for the relief of pain. The second: the clinical-ergonomics model is based on looking at the cause of dysfunction and removing the inputs responsible for the injury process. (Wilson 2002: 71-72)

Clinical ergonomics is predominantly focussed on the individual, trying to optimize the synchronisation between people, their environment and the myriad of influences to which they are subjected: work-related and domestic, biomechanical, physiological and psychosocial. (Wilson 2002: xi)

For the purpose of the current study, manual therapy and clinical ergonomics are conceptualised as the combination of physiotherapy and ergonomics.

Part of the implementation of a work-based physiotherapy and ergonomics programme (hereafter referred to as “the programme”) is the managing of risk factors. According to (Wilson 2002: 39-71), the risk factors of WRMSDs are threefold. They include personal, ergonomic and psychosocial risk factors. For the purpose of the current study, the following risk factors were included: firstly, the personal factors, including: age, gender, medical history, musculoskeletal history, and body mass index (BMI), and secondly, the ergonomic factors, including: posture, force, and duration of exposure to work. (See Figure 1.1.) The postural ergonomic risk factor included the change in work posture from sitting to standing (hereafter described to as “the intervention”). The psychosocial factors can include: monotonous work, lack of variety, machine-paced work, fear of job loss, high work load, time pressure, insufficient work breaks, low social support, and environment stress (lighting, noise, temperature and electromagnetic radiation) (Wilson 2002: 51-62) and are excluded from the current study. The associations between risk factors, change in work posture and WRMSDs – managed within the programme in a working setting are shown in Figure 1.1.

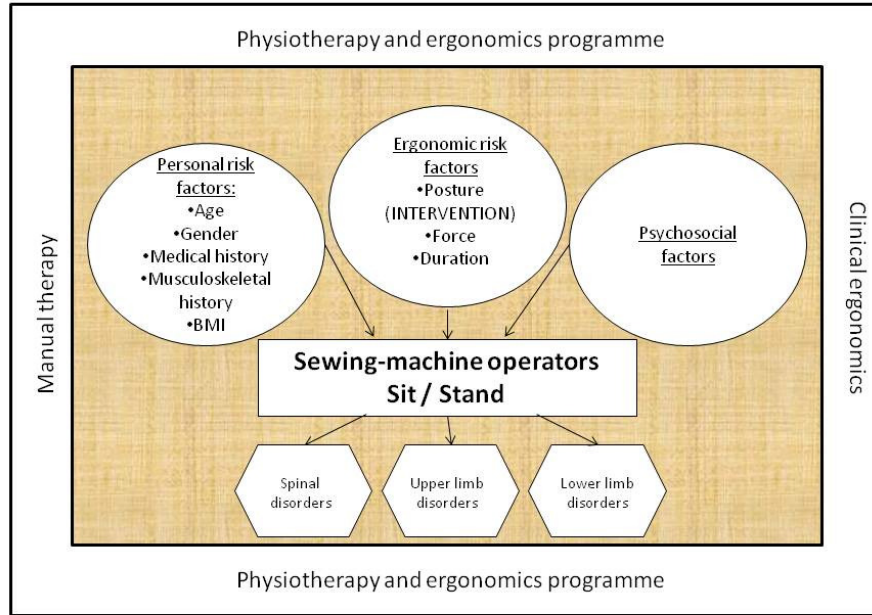


Figure 1.1 Conceptual framework based on (Wilson 2002). (Source: designed by the researcher)

In conclusion: clinical effectiveness is defined by the National Health Service as:

The extent to which clinical interventions, when deployed in the field for a particular patient or population, do what they are intended to do – i.e. maintain and improve health and secure the greatest possible health gain from the available resources (Bury, Mead 1998: 26-27).

Poor ergonomic design leads to poor work posture and is one of the factors that lead to WRMSDs. Poor ergonomics negatively influences company profit and employee health. Physiotherapists working in a multidisciplinary team can make a positive contribution towards the implementation of ergonomic principles. The impact of a change in work posture on WRMSDs can be determined by: 1) investigating the incidence of multiple WRMSDs, as well as in different anatomical areas of the body, e.g. the spinal area, the upper limbs and lower limbs; and 2) investigating the association between work posture, and personal- and ergonomic risk factors and WRMSDs. The incidence can be determined by documenting the number of newly diagnosed WRMSD's during the period of the study. The incidence is distinct from the prevalence, which refers to the number of cases alive on a certain date or over a period (Aldous, Rheeder et al. 2011: 25).

1.2 Background

The company, Johnson Controls, was established 126 years ago (1885), with their main focus on devices that control and regulate room temperature. In 2012, they served the building and automotive industries from three business units: building efficiency, automotive experience and power solutions, in more than 150 countries. They only started manufacturing automotive products more than 80 years ago, and are a supplier of automotive seat foam, metal structures and mechanisms, trim, fabric and complete seat systems.

Globally Johnson Controls has 12 research-and-development centres and 30 manufacturing plants, producing 15 million seat sets for more than 200 million vehicles per year. The registered company name in South Africa is Johnson Controls Automotive S.A. (Pty) Ltd, and their four manufacturing plants operate in East London, Pretoria and two plants in Uitenhage. The current study was conducted in its car-seat manufacturing plant at 79 Waltloo road, Samcor Park, Silverton, Pretoria, 0127 (hereafter referred to as “the company”). The company commenced production in Pretoria during 1998, and employed administrative personnel and operators, including sewing-machine operators (hereafter referred to as “sewing-machine operators”).

Health-promoting workplace programmes, including a work-based physiotherapy and ergonomics programme, were implemented in all the manufacturing plants globally and aimed at prevention and managing of WRMSDs. These programmes aimed to reduce the negative impact of risk factors on the incidence of WRMSDs, but also to improve health by rehabilitating injured employees.

As part of the programme, the health effects of standing and seated sewing work postures were investigated beforehand in Germany and thereafter, the stand-up work posture was implemented in all their manufacturing plants globally (See an English summary of the German investigation report, in Appendix 1.). This intervention and programme were implemented between June 2004 and January 2009 (hereafter referred to as “the period”) among sewing-machine operators in the company, without an impact study to guide the company and the physiotherapist through the process of adaptation (towards the programme and the stand-up work posture).

1.3 The state of the existing research

International studies have been published on the change in work posture of sewing-machine operators, the implementation of similar programmes (models and outcomes), the incidence and prevalence of WRMSDs among sewing-machine operators, as well as suggestions for prevention and management of WRMSDs in the general working population. Unfortunately, most of them were done on sewing-machine operators with demo- and bio graphics that differ from the South African-sewing-machine-operator population – and most of the studies were conducted on sewing-machine operators working in the seated work posture. This gap in the literature is covered in Chapter Two and is discussed on the basis of the results of the current study in Chapter Five.

1.4 Statement of the problem

Many questions were asked by the company, sewing-machine operators (represented by the union) and the physiotherapist when the programme was implemented in June 2004 in the company's plant in Pretoria.

- Do the personal and ergonomic risk factors of this South African sewing-machine operator population correspond to the populations in the mentioned studies?
- How could the incidence of WRMSDs be described during the period of the study?
- What was the association between individual risk factors (personal and ergonomic) and WRMSDs?
- What was the association between work posture and WRMSDs adjusted for influential risk factors?

The answers to these questions would allow the implementation of evidence-based interventions, applicable to a South-African setting. The aim of the newly established programme should be to enhance health, prevent injuries, and increase the profitability of the company – however most of the questions were unanswered by the implementation team, whom faced some practical challenges.

As part of the implementation of the programme, the change of work posture caused opposition from the sewing-machine operators (who were represented by the union) towards management – who had no research-based answers from a South African setting. This created conflict between employee wellness (sewing-machine operators who experienced difficulty adjusting to a different work posture) and management’s concern of ensuring profit to the company.

In spite of all these challenges, the change in work posture was implemented, and managed within the programme for the period of 4.5 years, and thereafter the sewing department was re-located to East-London (January 2009). At the time when the retrospective study was done (2011 to 2012), the unions (representing the sewing-machine operators in East London) required research-based answers again from the company’s management in East-London, as to why the sewing-machine operators have to work in a stand-up work-posture. From this request it was observed that there was a need for reducing the “research-to-practice”-gap with regards to a better understanding of the postural demands among sewing-machine operators in a South-African setting. It was very important to document the whole implementation process, in order to advise all the role players in this particular environment later on the outcomes.

South Africa has its own unique background of high unemployment and uses a model of financing medical services amidst labour and security legislation. According to legislation, South African employers must accommodate workers in a safe work environment. Changing the work posture might impact WRMSDs, and implementing a programme could assist companies to optimise a safe work environment.

Evidence-based health care is all about decision-making. (Bury, Mead 1998: 11)

The current study aimed to answer some questions on managing the impact of a change in work posture on WRMSDs among sewing-machine operators within a programme, in order to make recommendations for the future. The choice of a retrospective study design is therefore justified as the best method to gain insight into the answers to some of the questions posed at the beginning of this section. Therefore,

describing the impact of the change in work posture on the incidence of WRMSDs, as well as determining the association between risk factors and work posture, and WRMSDs among sewing-machine operators should lead to discussions and recommendations in order to advise other industries asking the same questions. This is the first study known to the researcher that describes and investigates an intervention of this nature among sewing-machine operators in South Africa.

1.7 Significance of the study

The findings from the study should contribute to a few sectors:

- To the company: This is the only sewing company in South Africa known to the researcher where the sewing-machine operators worked in the stand-up work posture. The outcome of the current study could primarily provide answers about on musculoskeletal wellness in a South African setting, i.e. the impact of the change in work posture on WRMSDs to the company's management.
- To the sewing industry: The implementation of the stand-up work posture is new to South African sewing-machine operators (who were represented by the union). Up to 2012, most research was done on sewing-machine operators in the seated work posture. From a health perspective, the whole industry may benefit if it can be shown that the stand-up work posture had a positive influence on the incidence of WRMSDs.
- To other industries: If the change in work posture, managed within a programme, lead to a decrease in the incidence WRMSDs in sewing-machine operators in this car-seat manufacturing plant, other industries could also benefit when a similar change in work posture is managed in a programme.
- Physiotherapists: The clinical environment in which the physiotherapist operates is fundamentally different from that in which the patients earn a living. The ideal is that the positive effect of rehabilitation will reach as far as the work station of the patient. The current study ought to create awareness within the physiotherapy profession of the need for clinical ergonomics in the

workplace. Lessons learnt in this setting could be applied to similar working environments.

The current study documents the benefits of an integral approach for injury prevention in a health-promoting work place.

1.8 The purpose of the study

The purpose of the study was to develop evidence for the company (management and the union representing the sewing-machine operators) and the physiotherapist by determining the impact of the change in work posture on the incidence of WRMSDs among sewing-machine operators, managed within a physiotherapy and ergonomics programme.

1.9 The aim of the study

The aim of the study was to determine the impact of the change in work posture on the incidence of WRMSDs (spinal, upper- and lower limb) among sewing-machine operators.

1.10 Objectives of the study

The objectives of the study were:

1. To describe the population in terms of personal and ergonomic risk factors.
2. To describe the incidence of WRMSDs for the period of the study.
3. To determine the association between individual risk factors (personal and ergonomic) and WRMSDs longitudinal.
4. To determine the association between work posture and WRMSDs adjusted for influential risk factors.

1.11 Outcome measures

Outcome measures of sewing-machine-operator health in the current study were:

- o Incidence of WRMSDs
- o Association of risk factors (personal and ergonomic) and WRMSDs
- o Association of work posture and WRMSDs

1.12 Exposure of interest

The primary exposure variable is work posture

1.13 Clarification of key terms

Change in work posture

The work posture of the sewing-machine operators changed from seated to stand-up.

Company

Johnson Controls Automotive S.A. (Pty) Ltd is a car-seat manufacturing plant in Pretoria, where the retrospective study was conducted.

Ergonomics

Ergonomics is the scientific study of human work; therefore, the application of scientific information concerning human beings to the design of objects, systems and environments for human use (Pheasant 1991: 4). Ergonomics is also referred to as the science of matching the job to the worker and the product to the user. An effective match is one that optimises:

- o Working efficiency (such as performance, productivity)
- o Health and safety
- o Comfort and ease of use (Pheasant 1991: 4).

Incidence

Incidence is the frequency with which something, such as a disease, appears in a particular population or area at a specified time. It is the rate of occurrence per population group. In disease epidemiology, the incidence is the number of newly diagnosed cases during a specific time period. The incidence is distinct from the prevalence, which refers to the number of cases alive on a certain date or over a period (Aldous, Rheeder *et al.* 2011: 24).

Period of the study

The period of the study refers to the period between June 2004 and January 2009, as this was the period when the impact of the change in work posture on WRMSDs was managed within the physiotherapy and ergonomics programme.

However, the retrospective study itself was conducted between 2011 and 2012, and these two years are not included in the period of the study (hereafter referred to as the data collection period).

Furthermore the 'full period' refers to the scenario where data on all 56 months were included. The 'reduced period' refers to the scenario where two groups of data were omitted. The first group was data on the first three months of the study (programme adaptation period), and the second group included data on the month that each sewing-machine operator changed his/her work posture and the consecutive month (postural adaptation period). These data were omitted to determine the effect of the change in work posture, and the implementation of the programme on the incidence of WRMSDs.

Work-based physiotherapy and ergonomics programme

The term programme will refer to the work-based physiotherapy and ergonomics programme, described in the current study. Physiotherapy (manual therapy) aims to minimise the effects of injuries and to reduce musculoskeletal dysfunction that may be exacerbating the symptoms or contributing to the injury. The clinical ergonomist aims to identify barriers to recovery (personal, ergonomic and psychosocial). The programme

assessed people's ability to function in their environment, and meet the demands of their environment and to minimise the risk of developing symptoms (Wilson 2002: xi).

Work-related musculoskeletal disorders

Work-related musculoskeletal disorders are disorders of the muscles, skeleton and related tissues which have been empirically shown or are suspected to have been caused by a workplace activity, particularly a repetitive activity that causes overuse of the tissues or lead to muscle atrophy (Pheasant 1991: 49). These disorders are therefore a heterogeneous group which includes numerous specific clinical entities, including disorders of the muscles and tendon sheaths, nerve entrapment syndromes, joint disorders and neurovascular disorders (Pilgian, Herbert *et al.* 2000: 75). The diagnosis of musculoskeletal disorders is based on a physical examination, and work-relatedness is ascertained by relying on general principles of occupational medicine. These principles are: relation of symptoms to work, history of workplace exposures to ergonomic factors likely to contribute to the condition, presence of similar conditions among co-workers, presence of prior trauma to the affected body parts, and vocational activities that may cause or contribute to injury (Pilgian, Herbert *et al.* 2000: 76).

Self-reported symptoms are frequently used in studies to determine musculoskeletal health status. As examination techniques that can serve as the 'golden standard' for many of the symptoms that are frequently reported in workplace studies still do not exist, symptom reports are highly correlated with physical findings of musculoskeletal disorders. "Cases defined by symptoms and by physical findings show very similar associations with ergonomics characteristics with the subjects' jobs." (Punnett, Wegman 2004: 15). Collins, Van Rensburg *et al.* confirms this by stating that "ninety per cent of all people purporting to suffer from low back pain have non-specific back pain." (2011: 241). These symptoms can include: pain, swelling, local tenderness, restricted range of movement due to pain, stiffness and/or weakness (Pilgian, Herbert *et al.* 2000: 77-79). The symptoms of musculoskeletal disorders are often intermittent and episodic, especially in the early stages (Punnett, Wegman 2004: 15).

For the purpose of the current study, self-reported symptoms of work-related musculoskeletal disorders were divided into individual groups for spinal, upper limb and lower limb disorders, and combined in a multiple group of disorders where a sewing-machine operator had one or more than one disorder in a specific month.

1.14 Scope of the study

The scope of the study covered the personal and ergonomic risk factors, as well as work-related spinal, upper limb and lower limb disorders of the sewing-machine operators (Figure 1.1).

Furthermore, the scope of the study described the content of the programme in terms of the roles of the company, the physiotherapist and the sewing-machine operator as background to the intervention. No analysis of these data was done.

The scope did not cover psychosocial risk factors. All sewing-machine operators were subjected to personal - and work-related psychosocial factors and because of the retrospective design of the study and the fact that the programme was not designed to address these factors, no data were available on any psychosocial factors. All psychosocial risk factors were therefore excluded from the study,

As far as ergonomic risk factors are concerned, the design of the sewing machine, pedals, and chairs influencing posture or force was predetermined and none of these could be adjusted.

2. Literature review

2.1 Introduction

This literature review will report on the prevalence of WRMSDs among sewing-machine operators, applicable risk factors in this population, and the content of similar programmes (to the one that was implemented in the current study). Associations between risk factors and work posture, and WRMSDs will also be investigated.

Epidemiology of WRMSDs

Question 1: Are sewing-machine operators internationally and locally more at risk of developing WRMSDs than the rest of the working population?

Question 2: If sewing-machine operators are more at risk of developing WRMSDs than the rest of the working population, which disorders are more prevalent among sewing-machine operators?

Question 3: Which risk factors are causative to these WRMSDs among sewing-machine operators, and what are the associations between them?

Workplace programmes

Question 4: What are the components of the programmes developed to prevent and manage WRMSDs in the working-population?

Question 5: What are the outcomes of such programmes?

Question 6: What are the key determinants of such a programme?

Question 7: Has a programme been implemented in a sewing plant before?

Research methodology

Question 8: From a conceptual point of view: How should the current study be conducted?

As this is a retrospective study, the scope of the literature review was guided by the objectives of the study.

2.2 Literature search strategy for the dissertation

A comprehensive literature review – guided by the eight questions and the conceptual framework - was carried out using the search strategy described below.

Electronic and manual literature searches were conducted in order to identify available literature to select relevant resources for the review. The search was performed using EBSCOHost, which included the CINAHL database, as well as Business Source Premier, and Family and Society Studies Worldwide, Medline (Ovid) and Science Direct as databases. The keywords are listed in Table 2.1. From the articles obtained, the researcher searched the reference lists for relevant articles as well

Table 2.1 Keywords for the literature search strategy

Concepts	Keywords
Employer/Company	Automotive industry, garment industry
Work-based physiotherapy-and-ergonomics programme	Occupational health programmes, prevention programmes, ergonomics programmes, education, prevention and control, rehabilitation, participatory ergonomics, ergonomics, health-care delivery.
Risk factors (personal, ergonomic and psychosocial)	Work posture, sedentary work posture, job rotation, work force, overtime, production volume, risk factors, and trends.
Employee	Sewing machinists, sewing-machine operators, industrial operators, garment workers, sedentary workers, sewing.
Disorders	WRMSDs, musculoskeletal disorders, cumulative trauma disorders, work-related upper-extremity/limb musculoskeletal disorders, repetitive strain disorders, diagnosis, neck pain, back pain, upper limb pain, lower limb pain.
Outcomes	Epidemiology

2.3 Discussion of the literature

The articles summarised in Appendix 2 are discussed below according to the eight questions asked at the beginning of this chapter and are answered in relation to the conceptual framework shown in Figure 1.1.

2.3.1 Epidemiology of WRMSDs

Question 1: Are sewing-machine operators internationally and locally more at risk of developing WRMSDs than the rest of the working population?

The international working population

Musculoskeletal disorders are a common complaint among the general working population (McDonald, DiBonaventura *et al.* 2011: 767; Kaergaard, Andersen 2000: 533). These disorders are often associated with significantly lower levels of health-related quality of life. Roquelaure, Ha *et al.* (2006: 765) agrees by stating: “Nonspecific upper-limb symptoms and specific upper-limb musculoskeletal disorders are common in the working population.” This was the conclusion of a surveillance done on upper extremity musculoskeletal disorders in France among 2,685 men and woman representing almost all economic sectors and occupations in the salaried workforce. More than 50% of the population experienced nonspecific musculoskeletal symptoms during the preceding 12 months of the study. The most affected industries were manufacturing (including garment, shoe and leather industries) and public administration. Occupations with the highest prevalence rates were those employing unskilled industrial workers and agriculture workers of both genders, as well as material handlers, drivers, and employees of public services for men, and personal care employees for women. The study demonstrated wide variations in the prevalence rate of musculoskeletal disorders across economic sectors.

The local working population

In a cross-sectional analytical study conducted in 11 factories from seven sectors of manufacturing industries (mining excluded) in South Africa (n=401), exposure to workplace ergonomic stressors (repetition, force, static posture, dynamic posture and other job exposures) was assessed (Schierhout, Meyers *et al.* 1995: 46-50). Exposure was measured with an observational model developed for this purpose. The highest prevalence for neck and shoulder pain were found in the motor assembly, fruit packaging and clothing industries. Furthermore, the chicken processing and clothing factories had the highest prevalence of low back pain. Ergonomic exposures in the work place were significantly associated with musculoskeletal pain of the neck and shoulders for repetition, and for seated compared with standing work (Schierhout, Meyers *et al.* 1995: 48). Unfortunately, no mentioning was made of the specific work posture of the employees in the clothing industry.

The sewing population

Four studies compared the prevalence of musculoskeletal disorders among sewing-machine operators to another sector of the workforce (Brisson, Vinet *et al.* 1989: 323-328; Sokas, Spiegelman *et al.* 1989: 197-206; Tartaglia, Cinti *et al.* 1990: 39-44; Andersen, Gaardboe 1993: 677-687). In the first study (Brisson, Vinet *et al.* 1989: 326), an increased prevalence of disability (due to musculoskeletal and vascular diseases) among sewing-machine operators currently employed in Quebec (Canada) was documented. Furthermore, an increased prevalence of disability was also documented among sewing-machine operators that left the industry, compared to woman employed in clerical work, services and manufacturing industries. A limitation of the study was that the prevalence of severe disability might have been influenced by the availability of pension and other supports for illness.

The outcome of the second study (Sokas, Spiegelman *et al.* 1989: 197-206) was that sewing-machine operators (members of the ILBWU in the USA) had more back pain lasting six weeks or longer compared to the control group (general population). The sewing-machine operators also complained of ache and swelling of the upper and lower limbs. The shortcoming of this study is that the sewing-machine operators in this study were not representative of the industry as a whole, in that they were all literate in English, and that they were invited to participate at a weekend seminar on health promotion on the basis of union activism and may be more aware of the possible work relatedness of disease because of this activism.

In the third study, carried out in Italy (Tartaglia, Cinti *et al.* 1990: 39-44), the results indicated that sewing-machine operators had a greater risk of contracting spinal disorders than the control population matched for gender and age, and the fourth study also showed that production workers – mainly sewing-machine operators – had significant higher scores with respect to musculoskeletal disorders (95%) compared to the group with more varied tasks (71%) in Norway (Andersen, Gaardboe 1993: 677-687).

The conclusion is that musculoskeletal disorders are common among the general working population, but the prevalence rates of these disorders might be higher among sewing-machine operators, internationally and local.

Question 2: If sewing-machine operators are more at risk of developing WRMSDs than the rest of the working population, which disorders are more prevalent among sewing-machine operators?

It was difficult to make comparisons between musculoskeletal studies, because the measures used in the different studies were not always consistent. Some studies used self-reported medical symptoms, while others studies used a clinical/medical diagnosis. Both measures were taken into account for the purpose of this literature review.

No explanation was found in literature on the specific anatomy regarding joints or muscle groups included/excluded from the four groups listed in Table 2.2. Table 2.2 summarises the categories of musculoskeletal disorders found in the literature, compared to the categories in the conceptual framework (Figure 1.1). For the purpose of the literature review in this chapter, the articles will be discussed according to these four groups of disorders found in the literature (Table 2.2).

Table 2.2 Groups of musculoskeletal disorders as found in literature, compared to the conceptual framework (figure 1.1)

Groups of musculoskeletal disorders	Groups of disorders in conceptual framework (figure 1):
found in literature:	
1. Neck-and-shoulder area	1. Spinal
2. Upper limb	2. Upper limb
3. Lower back pain or back pain	3. Lower limb
4. Lower limb	

The biomechanics of the seated work posture vary substantially to those of the stand-up work posture, and should be noted when the articles below are discussed, as these biomechanics might have had an influence on the prevalence of injuries (Halpern, Dawson 1997: 429-440).

Neck-and-shoulder area

Seven studies reported on the prevalence of musculoskeletal disorders of the neck-and-shoulder areas of sewing-machine operators. It was interesting to note that three of the studies summarised below were conducted among sewing-machine operators working in a seated posture. Unfortunately the other four did not mention work posture.

The first 'seated' study was a randomised controlled trial conducted by Westgaard and Jansen (1992: 156). The sewing-machine operators had 71% more complaints of the head, neck, shoulders and arms than the secretaries. The other two 'seated' studies that published the prevalence of disorders in a group of sewing-machine operators were cross-sectional surveys. In the second 'seated'-study, Blåder, Barck-Holst *et al.* (1991: 251-257) investigated the frequency of neck-shoulder disorders in a population of sewing-machine operators in Sweden, and clinically examined those who screened positively in order to describe the picture behind the complaints. The prevalence rate of neck-shoulder complaints during the previous 12 months was 75%, the previous seven days 51% and daily problems were experienced by 26% of the sewing-machine operators (1991: 252). Gender of the sewing-machine operators was not mentioned in the article. In the third 'seated' study, Wang, Rempel *et al.* (2007: 806-813) determined that the prevalence among the Los Angeles sewing-machine operators for moderate/severe musculoskeletal pain in the neck/shoulder region was 24.0%.

The following three international studies did not mention work posture. Firstly, only the abstract of the study of Serratos-Perez, Mendiola-Anda (1993: 793-800) was available in the university library. The prevalence rate of musculoskeletal disorders among male Mexican sewing-machine operators in eight shoe factories was investigated. The rate of musculoskeletal disorders was 47.5%. Of sewing-machine operators working on the column-type machines, 14% had shoulder pain (three times more frequent among column-machine operators), and 4.9% of sewing-machine operators working on flat machines had neck pain. In the second study, Kaergaard and Andersen (2000: 528-534) reported on a comparative study carried out on female sewing-machine operators and woman in a control group with varied non-repetitive work in Denmark. At baseline, the overall prevalence of two neck-shoulder disorders, myofascial pain syndrome and

rotator cuff tendinitis, was 15.2% and 5.8% among sewing-machine operators compared with 9.0% and 2.2% respectively, among controls. Lastly, Andersen and Gaardboe (1993: 689-700) conducted a clinical epidemiological study among sewing-machine operators in Denmark. The results indicated a highly significant trend for chronic neck, shoulder and neck/or shoulder pain, while only a tendency was shown for elbow, forearm/wrist and hands.

The seventh study was conducted in South Africa, and confirmed the results of the previous studies, by reporting that the highest prevalences of pain in the neck and shoulders were found among employees in the motor industry, fruit packaging and clothing industries (Schierhout, Meyers *et al.* 1995: 48).

With these high prevalence rates (some more than 70%), one must bear in mind that sewing-machine operators who have experienced persistent pain in the neck and/or shoulders might be expected to be more willing to answer questionnaires than those who have not suffered from pain (Andersen, Gaardboe 1993: 683).

Upper limb

In an epidemiological surveillance of upper extremity musculoskeletal disorders in the working population in France (Roquelaure, Ha *et al.* 2006: 765-778) the most common upper extremity musculoskeletal disorder among this working population, was rotator cuff syndrome (6.8% in men and 9.0% in women), followed by carpal tunnel syndrome (2.3% in men and 4.0% in women) and lateral epicondylitis (2.2% in men and 2.7% in women).

Four studies were found on the prevalence of upper limb disorders specifically among sewing-machine operators. Three studies were conducted on sewing-machine operators working in seated work stations, and in one study (Mostert-Wentzel, Grobler *et al.* 2010: 6-18) the sewing-machine operators gradually changed their work posture during the study period.

In the first study, Sokas, Spiegelman *et al.* (1989: 187-206) conducted a comparative study of sewing-machine operators (active or retired members of the ILGWU) compared

to a matched segment of the general population. These sewing-machine operators complained significantly more of ache and swelling of the fingers, wrists, shoulders elbows and feet than the controls. The sewing-machine operators also complained of: elbow ache, foot swelling and knee pain and – swelling.

In the second study, Vézina, Tierney *et al.* (1992: 268-276) conducted interviews with ten sewing-machine operators in a trouser manufacturing plant in Quebec, Canada, after ergonomic analysis of their work stations. During these interviews, 90% of the sewing-machine operators reported suffering from shoulder pain at the end of the day.

Thirdly, in a more recent study, Wang, Rempel *et al.* (2007: 806-813) reported the results of a cross sectional study of self-reported musculoskeletal symptoms among sewing-machine operators. Face-to-face interviews to assess the association between work organisational factors and the prevalence of musculoskeletal pain among 520 sewing-machine operators from 13 garment shops in Los Angeles were conducted, and the prevalence of moderate/severe musculoskeletal pain for the distal extremity was 15.8%.

Fourthly, the results of the study of Mostert-Wentzel, Grobler *et al.* (2010: 6-18) answered the question on specific injuries to the upper limb in more detail. The study was conducted on the same population of sewing-machine operators as in the current study, and mentioned specific WRUEMSDs; i.e. carpal tunnel syndrome, muscle spasm (thumb, triceps muscle), medial epicondylitis, lateral epicondylitis, finger injuries (tendonitis of the indicis muscle), tendonitis of the biceps muscle, de Quervian tendonitis, tenosynovitis (shoulder) and tendonitis of the forearm muscles.

The conclusion of these studies was that upper limb disorders are highly prevalent among the working population, but even more so among sewing-machine operators.

Lower-back or back pain

Five articles were found on the prevalence of lower-back pain, or back pain among sewing-machine operators. Four of the five studies mentioned the seated work posture, and for the fifth study of Serratos-Perez, Mendiola-Anda (1993: 793-800), work posture was not mentioned. The prevalence of LBP in the latter study was 18.2%, and 14% for

pain in the back-as-a-whole (for the 143 Mexican male sewing-machine operators in the shoe manufacturing industry).

Of the four 'seated' studies found, findings from three researchers agreed on the outcome of a high prevalence of back disorders among sewing-machine operators. The first 'seated' study was done as a cross-sectional study. A group of 144 sewing-machine operators (active or retired members of the ILGWU) was compared with 62 controls in the general population, and the sewing-machine operators had significantly more back pain lasting six weeks or longer than the controls (Sokas, Spiegelman *et al.* 1989: 197-206). The second 'seated' study was published by Tartaglia, Cinti *et al.* (1990: 39-44) in the Italian language, and the abstract was available in English. A sample of female sewing-machine operators was compared to a control group (occupation unknown) matched for gender and age, and a greater risk for contracting spinal disorders was found among the sewing-machine operators, compared to the controls. The third 'seated' study of Westgaard and Jansen (1992: 154-162) was mentioned under the *Neck-and-shoulder area* paragraph. Although the Norwegian sewing-machine operators had significant higher scores than the controls with respect to self-reported musculoskeletal complaints of the head, neck, shoulders and arms, it was not the case for the lower back, hips and lower extremities. Lastly, Sealetsa and Thatcher conducted a 'seated' study in Botswana to identify possible ergonomics deficiencies of sewing-machine operators (2011: 279-289). The baseline data reflected that there were more complaints in the lower back, upper back and mid-back followed by complaints in the shoulders, neck and legs. Therefore, back, neck and shoulder discomfort was highly prevalent among these sewing-machine operators.

Furthermore, in the cross sectional study conducted in South Africa (the study was mentioned under the *local working population* paragraph of question 1), low back pain was mentioned as being more prevalent among the chicken processing and clothing factories, compared to seven other sectors of manufacturing industry (Schierhout, Meyers *et al.* 1995: 48).

Therefore, most of the authors agree on the conclusion that spinal disorders are highly prevalent among certain groups of sewing-machine operators.

Lower limb

Due to the nature of sewing, manually feeding the sewing machine with material, and controlling pedals with feet, Vézina, Tierney *et al.* (1992: 268-276) did a study to describe the components of physical load in sewing. After an ergonomic analysis and interviews were done on ten seated sewing-machine operators in a trouser manufacturing plant, they found that the lower limbs exerted an average of 24 267.9 kg per day with their legs. A literature review was therefore done to determine the impact of sewing as an occupation on the prevalence of lower limb disorders in sewing-machine operators. Two articles were found as part of the review on the prevalence of lower limb disorders among sewing-machine operators, and both mentioned the seated work posture. The first study was cross-sectional. Sokas, Spiegelman *et al.* (1989: 197-206) concluded that seated sewing-machine operators complained more often of knee pain (left and right) than a control group in the general population. Knee swelling was noted more often among sewing-machine operators, although they were not more likely to have undergone knee surgery than were controls. The second study of Westgaard and Jansen (1992: 154-162) has already been mentioned under the *Neck-and-shoulder area*, and *lower-back or back pain* paragraphs. Although the Norwegian sewing-machine operators had significant higher scores than the controls with respect to self-reported musculoskeletal complaints of the head, neck, shoulders and arms, it was not the case for the lower back, hips and lower extremities.

It seems that there are more published studies on spinal- and upper limb disorders than on lower limb disorders. One might derive that the prevalence of upper limb and spinal disorders is higher than for lower limbs, but it does not necessary mean that there is no prevalence of lower limb disorders.

Question 3: Which risk factors are causative to these WRMSDs among sewing-machine operators, and what are the associations between them?

According to Wilson (2002: 39-63), the risk factors of WRMSDs are threefold. (See Figure 1.1.) Firstly, the personal factors in Wilson's (2002) study included: age, gender, medical history, musculoskeletal history, fitness level, physical characteristics,

anatomical variations, smoking and personality. Secondly, the ergonomic factors, included: posture, force, and duration of exposure to work. In the third place, the psychosocial factors, included: monotonous work, lack of variety, machine-paced work, fear of job loss, high work load, time pressure, insufficient work breaks and low social support, and environment stress (lighting, noise, temperature and electromagnetic radiation). Studies found on these factors are summarised below.

As all three categories of risk factors influence the prevalence of musculoskeletal disorders individually and jointly, a literature search was conducted to cover all.

Personal risk factors

Age

The correlation between age as a risk factor and musculoskeletal disorders is not the same on all parts of the body. In a randomised controlled study done in Norway on production workers (mainly seated sewing-machine operators) it was found that the upper three body regions had the same symptom level at all ages, the lower back had a negative correlation, and the lower limb had a positive correlation with age (Westgaard, Jansen 1992: 154-162).

Age (more than 40 years) was found to be a contributory risk factor for neck pain as well as shoulder pain (even though not significant at the chosen level for shoulder pain) among garment workers in Denmark (Andersen, Gaardboe 1993: 677-687) but, among other factors, the elevated prevalence of upper body pain was also associated with age of less than 30 years among sewing-machine operators in Los Angeles (Wang, Rempel *et al.* 2007: 806-813).

Not all researchers agreed that age is a contributory risk factor to musculoskeletal disorders among the general population. One example was a case controlled study conducted in Sweden by Ekberg, Bjorkqvist *et al.* (1994: 262-266). It was concluded that among other factors, age was not associated with neck disease for these musculoskeletal patients. Although the current study was not done on sewing-machine operators, it was still worth mentioning as this study was conducted in a working population.

It was therefore not a foregone conclusion that age is a risk factor for musculoskeletal disorders. Length of employment as a sewing-machine operator should also be considered when age as a risk factor is investigated.

Gender

In a South African study on the general working population, Schierhout, Meyers *et al.* (1995: 48) concluded that gender (being a man) was a significant contributor to pain in the wrists and hands. Men working in the seated posture had a higher prevalence of pain in the wrists and hands than woman. Furthermore, woman had a higher prevalence of regional pain (pain in the neck and shoulders, and back pain) in seated, mixed and standing work than men (Schierhout, Meyers *et al.* 1995: 48). One has to bear in mind that woman tend to report pain more than men, and that the healthy worker effect might have influenced the results (in the healthy worker effect is when workers with problems in the hands and wrists were disabled for their work) (Schierhout, Meyers *et al.* 1995: 49). In contrast with Schierhout, Meyers *et al.* (1995: 48), Ekberg, Bjorkqvist *et al.* (1994: 264) reported that among other factors, female gender is associated with a higher prevalence of neck and shoulder disorders among the general population in Sweden.

With the results of the previously mentioned studies in mind, the outcome of the study of Serratos-Perez, Mendiola-Anda (1993: 793-800) on the prevalence of musculoskeletal disorders among sewing-machine operators in shoemaking in Mexico is interesting. In this group of male sewing-machine operators, the prevalence of spinal and upper limb disorders was lower than those reported by other authors who previously studied (mostly female) sewing-machine operators.

Lastly, in an epidemiologic surveillance of upper-extremity musculoskeletal disorders in the working population in France, Roquelaure, Ha *et al.* (2006: 765-778) found the prevalence rate for upper-extremity musculoskeletal disorders in the working population was high for both genders.

In conclusion, it was not generally accepted that female gender is a risk factor for musculoskeletal disorders, as other factors (such as parenting) should also be considered when gender as a risk factor is investigated.

Medical history

A few risk factors for musculoskeletal disorders were mentioned in literature. In the first place, Brisson, Vinet *et al.* (1989: 323-328) found an increased prevalence of disability among sewing-machine operators who had left employment due to musculoskeletal-, cardiovascular- and other diseases combined, compared to women employed in other industries. This finding leads to the question of causative risk factors (regarding medical history) for musculoskeletal pain.

Adverse psychosocial work- environment was associated with increased catabolic metabolism (Hansen, Kaergaard *et al.* 2003: 264-276). This finding could contribute to other findings: Firstly, Wang, Rempel *et al.* (2007: 806-813) found that among other factors, systemic illness (no mention was made of specific illnesses) was associated with the elevated prevalence of upper body pain and no association was found between a high BMI and upper body musculoskeletal disorders among sewing-machine operators. Secondly, arthritis was also found to be associated with significantly lower levels of health-related quality of life among patients with back and fibromyalgia pain (McDonald, DiBonaventura *et al.* 2011: 765-769). In the third place, smoking was significantly associated with disease of the neck and shoulders (Ekberg, Bjorkqvist *et al.* 1994: 262-266) and, lastly, Wilson (2002: 39-63) included medical history as a personal risk factor for musculoskeletal disorders.

In conclusion, certain systemic illnesses (including obesity) might contribute to the prevalence of musculoskeletal disorders among sewing-machine operators.

Musculoskeletal history

Wilson (2002: 39-63), mentioned “previous injury to the musculoskeletal system” as a personal risk factor to WRMSDs. This correlation between musculoskeletal history and WRMSDs correlated with Westgaard and Jansen's (1992: 158) opinion ten years earlier

that: “Workers who have suffered symptoms before employment may have established a health condition at the time of employment that makes them particularly susceptible to similar injuries at the workplace.” Two more studies were in unison with this finding. Firstly, Kaergaard and Andersen (2000: 529-534) found that besides other factors, the risk of having a neck-shoulder disorder at baseline was significantly associated with high stress among sewing-machine operators. Secondly, Wang, Rempel *et al.* (2007: 806-813) concluded that among other factors, the elevated prevalence of upper body pain was associated with having a diagnosis of musculoskeletal disorders before.

In conclusion, musculoskeletal history is a risk factor for musculoskeletal disorders.

Fitness level

Fitness level can be protective to musculoskeletal disorders, but the level should be specified. Ekberg, Bjorkqvist *et al.* (1994: 262-266) concluded that among other factors, exercise of less than five hours per week seemed preventive, whereas exercise of more than five hours per week was significantly associated with disease in the neck and shoulders for musculoskeletal patients in the general population in Sweden.

On the other hand, in a historical follow-up investigation on a dynamic cohort of garment-industry workers in Denmark, the hypothesis of exercise as a protecting factor was not confirmed (Andersen, Gaardboe 1993: 677-687).

In conclusion, when fitness level is investigated as a possible risk factor for musculoskeletal disorders, the level of fitness should be specified.

Length of employment

Four studies were found on employed sewing-machine operators. In the first place, Andersen and Gaardboe (1993: 689-700) found a positive exposure-response relationship between years of employment as a sewing-machine operator and the prevalence of persistent neck and upper limb pain. Work for more than eight years as a sewing-machine operator probably had a cumulative deleterious effect on the neck and shoulders, for currently employed sewing-machine operators as well as for formerly employed sewing-machine operators (Andersen, Gaardboe 1993: 677-687). A second

study confirmed this finding, with a U-shaped association between years of employment and myofascial pain syndrome, as well as a linear trend between duration of employment and rotator cuff tendinitis (Kaergaard, Andersen 2000: 528-534). Thirdly, Wang, Rempel *et al.* (2007: 806-813) confirmed that among other factors, the elevated prevalence of upper body pain was associated with age less than 30 years, and working as a sewing-machine operator more than 10 years. Prevalence rates of WRMSDs were higher among the sewing-machine operators older than 45 years, but there was not a trend of increasing pain with increasing age.

In the fourth study, Schibye, Skov *et al.* (1995: 427-434) reported that sewing-machine operators with musculoskeletal symptoms of the neck and shoulders who quitted sewing were more likely to be relieved of their symptoms than were symptomatic sewing-machine operators who continued sewing. Therefore, the results demonstrated that neck and shoulder disorders in sewing-machine operators were reversible and may be influenced by reallocation to other work tasks.

In conclusion, length of employment should be acknowledged as a possible risk factor for musculoskeletal disorders. Specific attention should be given to newly employed sewing-machine operators, as well as sewing-machine operators employed for longer than eight years.

Parenting

When investigating parenting as a possible risk factor for musculoskeletal disorders, the first question asked was regarding marital status. Wang, Rempel *et al.* (2007: 806-813) concluded that among other factors, the elevated prevalence of upper body pain in Los Angeles sewing-machine operators was associated with 'being single'. 'Being single' was compared to 'being married' and 'living with a spouse'. No relationship was found between pain and 'having children at home'. Ekberg, Bjorkqvist *et al.* (1994: 262-266) were of the same opinion, 13 years before in Denmark when they concluded that, among other factors, 'having pre-school children' was not associated with neck disease for the musculoskeletal patients.

On the other hand, Andersen and Gaardboe (1993: 677-687) found that ‘having children’ was a significant factor in sewing-machine operators with shoulder pain in Denmark. Seven years later, Kaergaard and Andersen (2000: 528-534) agreed to this, based on the finding that among other factors, ‘woman living alone with children’ had a higher risk of contracting neck-shoulder disorders.

In conclusion, ‘being single’, ‘having children’ or being a ‘woman living alone with children’ can be a confounding factor to the development of WRMSDs.

Ergonomic risk factors

Posture

The literature review was specifically aimed at distinguishing between sewing-machine operators working in a seated work posture and those working in a stand-up work posture.

- *Seated work posture*

Tartaglia, Cinti *et al.* (1990: 39-44) concluded that: “The cause of spinal disorders appeared to be due to the fact that the sewing work station could not be adjusted to the anthropometric requirements of the individual, and also because the seated position is maintained for long periods.” Blåder, Barck-Holst *et al.* (1991: 39-44) conducted a descriptive study on seated sewing-machine operators and agreed with Tartaglia, Cinti *et al.* (1990: 39-44) by concluding: “In spite of possible psychosocial and work-environmental factors it seems obvious that the work position per se among sewing-machine operators increases the risk for symptoms from the neck and shoulder”. When the work posture of a sewing-machine operator is analysed, attention must be given to the furniture, and the subsequent posture.

In the first place, the furniture for a sewing workstation was described as: a chair with little adjustability (Halpern, Dawson 1997: 429-440; Rempel, Wang *et al.* 2007: 931-938; Wang, Ritz *et al.* 2008: 255-262; Sealetsa, Thatcher 2011: 279-289) and pedals operated either with the feet (Halpern, Dawson 1997: 429-440), or the right thigh

(Sokas, Spiegelman *et al.* 1989: 197-206). Only one study mentioned a height adjustable table for a seated work station (Westgaard, Jansen 1992: 154-162).

Secondly, it was inevitable that this ergonomically unsound furniture would lead to a poor work posture. Postures were described as a forward upper body posture with arms lower and moderately extended in front of the body, upper back curved and head bent over the sewing machine (Westgaard, Jansen 1992: 154-162). Movement of the upper limbs involved abduction and adduction of the shoulders while exerting force (Vézina, Tierney *et al.* 1992: 268-276). Operation of the knee pedal required lateral motion of the right thigh and pressure on a pedal that might be provided by the patella or the lateral thigh (Sokas, Spiegelman *et al.* 1989: 197-206). Sewing-machine operators that worked on chairs that were too low for their anthropometrical dimensions, retained hunched postures. On the other hand, sewing-machine operators that had their seats raised by cones underneath chair legs, or sat on pillows in an effort to increase the chair height, had their necks bent excessively to the 'now relatively low table' and on top of that, their pedal reach distance was seriously compromised (because their feet could not reach the floor) (Sealetsa, Thatcher 2011: 279-289).

Two studies were carried out to evaluate the effect of new task chairs on shoulder and neck pain (Rempel, Wang *et al.* 2007: 932-938), as well as on back and hip pain among sewing-machine operators (Wang, Ritz *et al.* 2008: 255-262). The results of these studies indicated that an adjustable-height task chair with a curved seat pan could reduce neck and shoulder pain severity (Rempel, Wang *et al.* 2007: 931-938) and that a height adjustable task chair with a swivel function could reduce back and hip pain in sewing-machine operators (Wang, Ritz *et al.* 2008: 255-262).

In conclusion, causative factors of WRMSDs in a seated work station might be incorrect table- and chair heights, non-adjustable equipment, or the seated posture per se.

- *Stand-up work posture*

Few studies mentioned the stand-up work posture among sewing-machine operators. Mostert-Wentzel, Grobler *et al.* (2010: 14) did a study to determine the effect of a work-based physiotherapy and ergonomics programme on WRUEMSDs in the same

population as the current study for the period of June 2004 to September 2007. The individual stand-up dates of sewing-machine operators were not captured, therefore the impact of the postural change on WRUEMSDs could not be determined.

A possible explanation for the prevalence of musculoskeletal disorders was provided by Ekberg, Bjorkqvist *et al.* (1994: 262-266) after conducting a case-controlled study in the general population in Sweden. It was concluded, that among other factors:

...long durations of uncomfortable sitting and work with lifted arms were significant determinants for neck and shoulder disease, compared to the larger group. To work standing in uncomfortable positions, monotonous work positions, and physically demanding work (heavy lifting) were not significant determinants for disease in the neck and shoulders.

This positive effect of sewing in a stand-up posture, on the neck and back, was confirmed by Schierhout, Meyers *et al.* (1995: 46-50) and Halpern and Dawson (1997: 429-440). Schierhout, Meyers *et al.* (1995: 48) reported that seated rather than standing work, were significantly associated with pain of the neck and shoulders in the working population in South Africa (1995: 49). Furthermore, Halpern and Dawson reported on the design, implementation and ultimately the performance of a participatory programme in an automobile-accessories manufacturing plant in the USA (1997: 429-440). During the initial worksite analysis, the risk factors of excessive reaching, twisting and bending were identified frequently among seated sewing-machine operators. While seated, the sewing-machine operators usually adopted a forward flexed torso and neck posture (similar to the postures described in the studies of Sokas, Spiegelman *et al.* (1989: 197-206); Vézina, Tierney *et al.* (1992: 268-276); Westgaard and Jansen (1992: 154-162); Sealetsa and Thatcher (2011: 279-289), and did not use their backrest. The chairs themselves had little adjustability (similar to the chairs of the control groups as described in the studies of Rempel, Wang *et al.* (2007: 931-938), Wang, Ritz *et al.* (2008: 255-262), and the chairs in the Botswana study of Sealetsa and Thatcher (2011: 279-289). As part of the implementation of the automobile-accessories manufacturing plant's participatory programme, the sewing operations were converted from sit-down to primarily stand-up operations, leading to

improved posture of the torso and back. The results of the programme were determined by the 85% decrease in the number of musculoskeletal disorders, and an overall reduction in workers' compensation incurred loss costs by approximately 42% (Halpern, Dawson 1997: 429-440).

In conclusion, it seems that a stand-up work posture should lead to a lower prevalence of musculoskeletal disorders than a seated work posture.

Force

Difficult levels of work are often associated with the lifting of heavy objects and performing dynamic movements – compared to a sewing-machine operator traditionally working in a seated posture, manipulating light weights. This stereotype could easily lead to the conclusion that sewing is light work in terms of energy expenditure (Vézina, Tierney *et al.* 1992: 268). The question asked, is: 'Why do sewing-machine operators have such a high prevalence of musculoskeletal disorders?' An ergonomic analysis was undertaken in a trouser factory and the results indicated that these ten seated participants (sewing-machine operators) lifted an average of 406.1 kg of trousers, exerted an average total force of 2 858.4 kg with the upper limbs and 24 267.9 kg with the lower limbs each, per day (Vézina, Tierney *et al.* 1992: 268-276). In connection hereto, Ekberg, Bjorkqvist *et al.* (1994: 262-266) concluded that even light lifting was a strong determinant for neck and shoulder disease.

Furthermore, two electromyogram (EMG) studies performed on the neck-shoulder areas of sewing-machine operators were found. In the first study, Jensen, Schibye *et al.* (1993: 467-475) assessed physiological responses of 29 sewing-machine operators to physical work, and determined that industrial sewing-machine work fatigues the shoulder and neck regions, and that static shoulder muscle load was independent of muscle strength. Secondly, the EMG study conducted by Zhang, He *et al.* (2011: 3731-3737) on 18 sewing-machine operators confirmed these results by concluding that: "Female sewing machine operators were exposed to high sustained static load on bilateral neck-shoulder muscles."

As work posture (seated or stand-up) was not mentioned in either of these two EMG studies, the findings cannot be incorporated into the clinical reasoning on the influence of postural changes on the prevalence of neck and shoulder disorders among sewing-machine operators in the current study.

In conclusion, the high physical workloads should be considered when treating sewing-machine operators as patients or planning workplace interventions for managing work-related disorders among sewing-machine operators (Wang, Harrison *et al.* 2010: 352-360).

Duration

Among other factors, “repetitive movement demanding precision is a significant physical determinant with a dose-response relation showing higher risks for neck and shoulder disease for higher degrees of exposure.” (Ekberg, Bjorkqvist *et al.* 1994: 262-266). Schierhout, Meyers *et al.* (1995: 49) agreed to this statement, by stating: “repetitive work were significantly associated with pain in the neck and shoulder”. Therefore, when investigating the influence of repetition as a risk factor on the prevalence of musculoskeletal disorders among sewing-machine operators, two recommendations are mentioned in the literature; i.e. to reduce work hours, and to implement job rotation.

- *Overtime*

A positive correlation between the tension neck syndrome and working hours per week suggest a daily prolonged static load on the neck and shoulder to be of importance for neck-shoulder problems among sewing-machine operators. The study also indicated the importance of exposure time correlated to the seriousness of the neck and shoulder complaints among the sewing-machine operators. (Blåder, Barck-Holst *et al.* 1991: 251-257)

Wang, Rempel *et al.* (2007: 806-813) did not agree with the correlation in this statement. An assessment was made on the contribution of work-organisational and personal factors to the prevalence of WRMSDs among sewing-machine operators, and it was found that the number of hours or number of days worked per week as singular

measures were not as strongly associated with upper body disorders, as with neck-shoulder disorders.

Although there is no consensus in the literature regarding the relationship between overtime and the prevalence of musculoskeletal disorders among sewing-machine operators, the conclusion is: “having less overtime should be considered when treating patients or planning workplace interventions for managing work-related disorders in this underserved immigrant population.” (Wang, Harrison *et al.* 2010: 352-360)

- *Job rotation*

Although job rotation is a common suggestion in order to reduce and vary repetitive monotonous work, it is easier said than done. The advantage of job rotation lays in the possibility for relaxation of muscles involved during the action of sewing. Rotating between different sewing machines, or changing between different products is not enough.

To obtain a real change in working positions, the real working process has to be reorganised, including varying tasks for the sewing-machine operator. Otherwise relaxation will be achieved only by making possible frequent short rest periods for optimum endurance time. (Blåder, Barck-Holst *et al.* 1991: 251-257)

The association between the implementation of a job-rotation policy and the incidence or prevalence of WRMSDs among sewing-machine operators was not pertinently mentioned in any study. Mostert-Wentzel, Grobler *et al.* (2010: 14) conducted a study on the same population as the population of the current study, evaluating the effect of a work-based physiotherapy and ergonomics programme of WRUEMSDs from June 2004 to September 2007. According to them, job rotation was fully implemented in October 2005, but no association with the incidence of WRUEMSDs could be determined. Sealetsa and Thatcher (2011: 283) in Botswana pertinently mentioned that the factory had “no formal policy on job rotation”.

Psychosocial risk factors

Although the relationship between psychosocial risk factors and the incidence of WRMSDs is not part of the current study, these factors cannot be ignored as a contributing factor for WRMSDs.

“Work-environment factors influence mood, bodily tension and somatic symptoms and load on the loco motor system.” (Theorell, Harms-Ringdahl *et al.* 1991: 165-173). Work-related psychosocial factors that influenced health (specifically the frequency of musculoskeletal disorders) in the general population include:

- Opportunity to influence decisions plays an important and more direct role in absenteeism for sick leave (Theorell, Harms-Ringdahl *et al.* 1991: 165-173).
- Lack of stimulation and variation in the job are associated with neck disease (Ekberg, Bjorkqvist *et al.* 1994: 262-266).
- High quantitative job demands, poor social support from co-workers, low job control, low skill discretion, and low job satisfaction have a positive relationship with neck pain (Ariens, van Mechelen *et al.* 2001: 180-193).
- Adverse psychosocial work environment was associated with increased catabolic metabolism (Hansen, Kaergaard *et al.* 2003: 264-276).

The mechanism that accounts for possible associations between psychosocial factors and musculoskeletal disorders might be: 1) psychosocial demands that exceed an individual’s coping capabilities resulting in a stress response, producing muscle tension; 2) psychosocial demands that affect (increase) the awareness and reporting of musculoskeletal disorders; or 3) in a certain situation, psychosocial demands that correlate with physical demands (Ariens, van Mechelen *et al.* 2001: 190).

Although many authors emphasise the influence of psychosocial risk factors on WRMSDs, the results of Feuerstein, Nicholas *et al.* (2004: 565-574) proved in a randomised secondary prevention trial among office workers, that the benefit from an intervention addressing ergonomic risk factors alone, was as strong as that from an intervention that combined ergonomic and psychosocial risk factors.

In conclusion, all three ergonomic risk factors, individually and jointly, can play a causative role to the incidence and prevalence of WRMSDs (Ekberg, Bjorkqvist *et al.* 1994: 262-266; Wang, Rempel *et al.* 2007: 806-813).

2.3.2 Workplace programmes

Question 4: What are the components of the programmes developed to prevent and manage WRMSDs in the working-population?

Unfortunately, the following statement of Gasset is true:

If WRMSDs are the result of multiple causes, as they appear to be, ergonomic intervention alone will never be “the cure”. Therefore, to effectively manage these problems, it is critical to understand all factors influencing their development, including age, presence of systemic disease, physiologic preposition, work behaviours, type of job and motivation of the worker as well as ergonomic design. (Olson 1999: 234)

Sewing-machine operators are more at risk for developing WRMSDs than workers in other sectors of the workforce (See the answer to Question One in this chapter.), and it seems that the level of exposure to the mentioned risk factors that are applicable to sewing-machine operators are high as well. (See the answer to Question Three in this chapter.) The combination of the high risk to the exposure level demonstrates the need for prevention programmes aimed at reducing the incidence and prevalence of WRMSDs and reducing the associated socio-economic costs in most economic sectors (Roquelaure, Ha *et al.* 2006: 765-778).

The articles reporting on models and outcomes of ergonomics programmes are listed below:

- Three models (Olson 1999: 229-238; Chu, Dwyer 2002: 175-186; Wilson 2002: 71-91);
- One population-based randomised control trial (Loisel, Abenhaim *et al.* 1997: 2911-2918; Loisel, Lemaire *et al.* 2002: 807-815);

- One case study among sewing machine operators (Halpern, Dawson 1997: 429-440);
- One retrospective longitudinal study (Mostert-Wentzel, Grobler *et al.* 2010: 6-18); and
- Two systematic reviews (Maher 2000: 259-269; Williams, Westmorland *et al.* 2007: 607-624).

Three models

“The process to design an organization in order to reduce injuries, illnesses and the associated costs there off, reflects the goal of ‘macro-ergonomics’. On a “micro-ergonomics” level, disagreement surrounding the cause and effect relationships between risk factors and diagnosed musculoskeletal disorders continues among researchers. Therefore, many practitioners recommend a ‘holistic or macro-ergonomic’ approach to identifying and elimination of risk factors. One such macro-ergonomics technique by which a multitude of risk factors can be mitigated in the industrial environment is participatory ergonomics.” (Halpern, Dawson 1997: 430). The participatory approach to ergonomics is based on the assumption that a worker is an expert on his or her job (Russel J 2012: 5).

Participatory ergonomics is often defined as a technique by which employees and management join together to impart ergonomics knowledge and implement procedures in the workplace in order to improve working conditions. The four commonly cited requisites for a participatory ergonomics program include: participation, organisation, ergonomics methods and tools, and job design concept. (Nagamachi 1994, in Halpern, Dawson 1997: 430)

Two models as examples of participatory ergonomics are described below. In the first place, a model for industry (Olson 1999: 229-238) and, secondly, a new model in progress (Chu, Dwyer 2002: 175-186).

Firstly, Olson (1999: 229-238) described an on-site programme as a model for industry in the USA (summarised in Table 2.3)

Table 2.3 A summary of an on-site ergonomics programme as a model for industry (Olson 1999)

Steps in starting an ergonomics programme	Components of each step
1. Identify problem areas	<ul style="list-style-type: none"> o Document accidents and injuries o Physician visits o Work restrictions and time off due to work-related disorders o Absenteeism reports o Worker complaints o Health screens o Ergonomic checklist to identify areas of concern o Confidential employee surveys
2. Ergonomic team members	<ul style="list-style-type: none"> o Employees o Supervisors o Engineers o Medical community
3. The role of the ergonomic team	<ul style="list-style-type: none"> o Implement controls to reduce or eliminate exposure to hazards o Train all staff on ergonomic principles
4. The programme should address	<ul style="list-style-type: none"> o Hazard prevention and control o Education and training o Medical management

A comprehensive on-site ergonomics programme is a team effort, with commitment of the management, workforce, medical providers, engineers, and ergonomic professionals. Once the ergonomics programme is implemented, the team should monitor, evaluate and modify the programme based on outcomes (Olson 1999: 229-238).

Secondly, Chu and Dwyer (2002: 175) conclude that: “Employers need to become change agents and visionary leaders who adopt a proactive, interdisciplinary and

integrative system approach to formulate and develop company policies and workplace culture that facilitates employee participation, professional growth and team work.”

For the success and sustainability of a workplace health management (WHM) programme, it must be integrated into corporate policy and regular management practice, and should be coordinated by members within the work organisation rather than by costly external consultants. WHM strategies should include not only individual-directed measures but also measures to address environmental, organisational, ergonomic and social factors (Chu, Dwyer 2002: 175-186). The strategies, methods and principles for WHM are summarised in Table 2.4.

Table 2.4 The strategies, methods and principles of a workplace health management (WHM) programme

The participatory needs-based	The key principles of WHM
problem solving cycle	
<ul style="list-style-type: none"> ○ Ensure management support ○ Establish a coordination body ○ Conduct a needs assessment ○ Prioritise needs ○ Develop an action plan ○ Implement the plan ○ Evaluate the process and outcome ○ Revise and update the program 	<ul style="list-style-type: none"> ○ Improve work organisation ○ Develop healthy company policy and culture ○ Encourage active participation by all involved ○ Foster personal development, work styles and lifestyles conducive to health ○ Ensure health promotion and disease-prevention strategies become an integral part of management practices

The third model is described by Wilson (2002). The management of the injured patient includes two approaches: 1) the manual therapy model and 2) the clinical-ergonomics model.

The first approach, the *manual model*,

is a series of manual techniques based on identification and removal of musculoskeletal dysfunction and the provision of manual techniques for the removal of pain. Manual techniques are particularly useful in the acute or sub-

acute injury where they address the painful tissues – the most common cause of the patient presentation. (Wilson 2002: 71)

The second approach, the *clinical-ergonomics model*,

is based on looking at the cause of dysfunction and removing the inputs responsible for the injury process. This involves a systematic search for 'exposures', which is ergonomic, psychosocial and personal factors that intersect to create musculoskeletal symptoms; and the subsequent modification of these exposures. (Wilson 2002: 71)

In conclusion, Wilson (2002) describes the clinical management of the injured patient on the basis of the manual model, combined with the clinical-ergonomics model. This combination, as well as both models of Olson (1999) and Chu and Dwyer (2002) have this in common: A multidisciplinary team should be established to evaluate needs, implement solutions and then re-evaluate in order to modify the programme – based on outcomes in order to address environmental, organisational, ergonomic and social factors.

One population-based randomised controlled trial

With the summarised models in mind, a population-based randomised controlled study was found. Loisel, Durand *et al.* (1994: 597-602) conducted a population-based, randomised clinical trial on back pain management (described as the Sherbrooke model). The aim was to determine whether a comprehensive clinical and occupational intervention could reduce progression of low back pain to prolonged disability, by reducing time away from regular work for affected workers. With occupational back pain, persistent disability is linked to prolonged absence from work or frequent recurrences of absence from work. Any intervention that reduces absence from regular work is likely to reduce long-term chronicity, with all of its personal and financial cost implications.

The population sample consisted of 104 participants who had been absent from work for more than four weeks from 31 workplaces in Quebec, Canada. Participants were

allocated and randomised to one of four groups: 1) standard care as provided by the worker's physician alone (control); 2) experimental clinical rehabilitation intervention; 3) experimental occupational intervention; and 4) a combination of the two experimental interventions. The participants in the clinical rehabilitation intervention group received a clinical examination, attended a back school and participated in rehabilitation done by a psychologist and/or occupational therapist. The participants in the occupational intervention group consulted the occupational medicine physician and the ergonomist, in order to participate in a participatory ergonomics intervention (Loisel, Abenhaim *et al.* 1997: 2911-2918).

One case study among sewing-machine operators

One case study conducted among sewing-machine operators, and reporting on the implementation of programmes similar to those described in the literature, was found. A participatory ergonomics programme was designed and implemented by Halpern and Dawson to control and reduce workers' compensation costs within an automobile products manufacturing company between 1993 and 1996 (1997: 429-440). Pareto analysis identified a substantial number of musculoskeletal disorders among 250 sewing-machine operators who manually machine-sewed canvas automobile accessory products. This case study documented the benefits of a comprehensive, integrated programme approach for injury as well as illness reduction. Therefore,

a participatory ergonomics program, with multi-disciplinary participation, is one approach by which a company can weave together its manufacturing objectives of quality, productivity, safety, and cost containment to achieve effective production and injury reduction. (Halpern, Dawson 1997: 429-440)

One retrospective longitudinal study among sewing- machine operators

Mostert-Wentzel, Grobler *et al.* (2010: 6-18) published a study with a retrospective longitudinal design, using a record review to investigate a work-based physiotherapy and ergonomics occupational programme in car-seat seamstresses. The purpose of the study was to determine the effect of the programme on the incidence rate of work-

related upper extremity musculoskeletal disorders over a period of three years, and to investigate possible predictors. Data from 38 sewing-machine operators with 43 work-related upper extremity musculoskeletal disorders were analysed. The intervention comprised ergonomic adaptations, health education and conventional physiotherapy.

Two systematic reviews

The first systematic review included 13 randomised controlled trials on the prevention of LBP. It was concluded that workplace exercise was effective, braces and education were ineffective and workplace modification plus education were of unknown value (Maher 2000: 259-269).

Seven years later, a second systematic review was conducted by Williams, Westmorland *et al.* (2007: 607-624) to evaluate the effectiveness of workplace rehabilitation interventions for injured workers with LBP. The best evidence was that the combination of clinical interventions with occupational interventions was effective in: returning injured workers with LBP to regular work faster, and decreasing pain and disability. The authors concluded that early return to work/modified work was effective in decreasing the rates of back injuries as well as lost-time back injuries, and reducing pain and disability. These studies included early contact with the worker by the workplace and a health care provider intervention at the workplace. The authors also found that ergonomic interventions such as participatory ergonomics and workplace adaptation, adaptation of job tasks and adaptation of working hours were effective in returning injured workers to work.

Although both reviews were carried out on LBP only and, therefore, did not include other WRMSDs, the conclusion can be made that workplace modification proved to be effective, along with workplace exercises in the management and prevention of LBP.

In conclusion, the garment industry employed 11 million workers worldwide by 1998 (according to the International Labour Organisation (ILO)). Three per cent of workers were employed in Africa, while the rest were divided between Asia, America and Europe. Although, these studies published evidence that the combination of medical care and ergonomic intervention was effective in the management of WRMSDs in the

working population and among sewing-machine operators specifically, such health programmes have, however, primarily been limited to large-scale enterprises in developed countries.

Question 5: What are the outcomes of such programmes?

A health-promoting workplace influences many aspects in society – including health and motivation of employees, profitability of companies, and the socio-economic well-being of countries. The work environment is a key determinant of the health of employees. Since the majority of the adult population spend much of their waking life at work, many employers realised that the workplace offers an opportunity for promoting health, and that healthy workers are more likely to be productive workers. Similarly, if neglected, the work environment can have extremely negative consequences to the health of workers, causing stress, injury, illness, disability and even death (The World Health Report (2012)).

Although the study of Mostert-Wentzel, Grobler et al. (2010: 6-18) provided weak evidence that an integrated physiotherapy and ergonomics programme was effective, and recommended that further research with larger samples was considered necessary, other authors reported two major positive outcomes of such programmes.

- The benefit to the employer

Apart from the positive effects of a health-promoting workplace on employees, there is also the benefit to the employer – decreased injury nets fewer costs (Olson 1999: 229-238) and, whilst a healthy workforce is essential to a successful enterprise, it is also fundamental to the socio-economic well-being of countries (Chu, Driscoll et al. 1997: 380).

Furthermore, Halpern and Dawson reported a decrease in the average cost per claim for musculoskeletal disorders of 83% over a period of three years. An initial increase in the numbers of reported WRMSDs can be expected when a programme is implemented, but it should be followed by a decrease (1997: 429-440).

In summary, Loisel, Lemaire et al. reported a cost benefit for the workers' compensation board over a period of 6.4 years. Their results demonstrated that the integrated clinical occupational model of management (a combination of the two experimental interventions) of back pain was effective in increasing the rate of return to regular work more than twofold, compared with the effectiveness of the usual medical care (2002: 813).

- The benefit to the employee

A health-promoting workplace is not only free of hazards, but also provides an environment which is stimulating and satisfying to those who work there. Therefore, apart from health outcomes, it has the potential to promote work satisfaction and morale, improve the quality and productivity of work, and create a supportive social climate and workplace culture (Olson 1999: 229-238).

Question 6: What are the key determinants of such a programme?

The key determinants of such a programme are twofold. In the first place early reporting of strains, and aggressive medical management (Halpern, Dawson 1997: 429-440) and, secondly, close association of occupational intervention with clinical care is of primary importance in impeding progression towards chronicity of LBP (Loisel, Lemaire *et al.* 2002: 813).

Williams, Westmorland *et al.* (2007: 607-624) confirm the benefits of these two determinants to faster return to regular work after LBP and, and decreased pain and disability. In addition to the above, Williams, Westmorland *et al.* also found that ergonomic interventions, such as participatory ergonomics and workplace adaptation, adaptation of job tasks, and adaptation of working hours, were effective in returning injured workers to work (2007: 607-624).

Question 7: Has a programme been implemented in a sewing plant before?

The answer is: "Yes". The implementation of a participatory ergonomics programme with multi-disciplinary representation in the sewing industry has been described by

Halpern and Dawson in Denver, USA (1997: 429-440). Risk management objectives of quality, safety and cost containment were weaved together so as to achieve effective production while simultaneously preventing injuries and illnesses.

2.3.3 Research methodology

Question 8: From a conceptual point of view: How should the current study be conducted?

In the hierarchy of research designs, the results of randomized, controlled trials are considered to be evidence of the highest grade (golden standard), whereas observational studies are viewed as having less validity because they reportedly overestimate treatment effects (Concato, Shah *et al.* 2000: 1887-1892). In randomised controlled trials, subjects are assigned by statistically randomised methods to two or more groups. In doing so it is assumed that all variables other than the proposed intervention are evenly distributed between the groups. In this way bias is minimised (Mann 2003: 54–60).

Concato, Shah *et al.*(2000: 1887-1892) used published meta-analyses to identify randomized clinical trials and observational studies that examined the same clinical topics. They concluded that the results of well-designed observational studies (with either a cohort or a case control design) do not systematically overestimate the magnitude of the effects of treatment as compared with those in randomized, controlled trials on the same topic.

Cohort, and case-control studies are collectively referred to as observational studies. Cohort studies are used to study incidence, causes, and prognosis. Because cohort studies measure events in chronological order they can be used to distinguish between cause and effect. Furthermore, case controlled studies compare groups retrospectively. They seek to identify possible predictors of outcome (Mann 2003: 54–60). An important strength of most retrospective databases is that they allow researchers to examine medical care utilization as it occurs in routine clinical care (Motheral, Brooks *et al.* 2003: 90).

In France, the focus of a study was mainly on the methodological aspects of the surveillance of musculoskeletal disorders (Roquelaure, Mariel *et al.* 2002: 452-458). The two aims of the study included; 1) the assessment of a strategy of active surveillance, and 2) to compare different criteria for deciding whether or not a work-situation could be considered at high risk for musculoskeletal disorders.

In the first aim of the study, Leclerc *et al.* defined surveillance as:

“...the on-going systematic collection, analysis and interpretation of health and exposure data in the process of describing and monitoring a health event. The main objective of surveillance of musculoskeletal disorders is to determine the need for action and to plan, implement and evaluate ergonomic intervention and programmes.” (Roquelaure, Mariel *et al.* 2002: 452-458)

Two systems are available for routine analysis of health and exposure to risk factors: passive and active systems. Passive surveillance is using workers' compensation and sickness data, which is easy to implement. This method will probably be unreliable in South Africa compared to France, because WRMSDs are not reported routinely to the Compensation Commissioner in South Africa, and the probability of abuse of sick leave and/or sickness presenteeism (Aronsson, Gustafsson *et al.* 2000: 502-509) can make sick-note data unreliable.

Furthermore, active surveillance involves a workplace-specific system to identify musculoskeletal disorders and their risk factors. Two levels are available for active surveillance of both health and risk factors. The first level uses questionnaires and checklists, which provide a quick assessment of the situation, and was proven as insufficient to identify cases of musculoskeletal disorders with any precision (Roquelaure, Mariel *et al.* 2002: 452). The second level uses physical examination and in-depth job analysis by a trained health care provider.

The outcome of the study of Roquelaure, Mariel *et al.* (2002: 452-458) was that health and risk factor surveillance must be combined to predict the risk of musculoskeletal disorders in a company, which agrees with the clinical-ergonomics model as described by Wilson (2002: 84-91).

The second aim of Roquelaure, Mariel *et al.* (2002: 452-458) addressed the evaluation of different criteria to decide whether or not a work situation could be considered at high risk of musculoskeletal disorder or not. The conclusion was that incidence data were more valid than those based on prevalence data.

The reasoning for determining incidence in the current longitudinal study, and not prevalence as in the study of Schibye, Skov *et al.* (1995: 427-434), was as follows: in the study of Schibye, Skov *et al.* (1995: 427-434) data on the prevalence of musculoskeletal symptoms among sewing-machine operators were assessed with the use of a questionnaire in 1985, and repeated in 1991. In 1991, the original group of sewing-machine operators was divided in three groups (a third were still sewing, a third changed occupation and a third were unemployed) and this data on the prevalence of musculoskeletal symptoms of three groups were compared with baseline data. Although both studies have a longitudinal design, the current study determine the incidence of WRMSDs over 4.5 years, while the study of Schibye, Skov *et al.* (1995: 427-434), determined the prevalence of musculoskeletal symptoms in two separate time periods (1985 and 1991).

Lastly, a retrospective study was conducted by Sadi, Macdemid *et al.* (2007: 610-622) in an on-site, auto-sector physiotherapy clinic. The purpose of the study was to describe the musculoskeletal disorders and related physiotherapy service utilisation over a 13-year period and to provide preliminary information on the utility of these services. The specific purposes were: 1) to describe the distribution of musculoskeletal injury according to year, age, type of injury, gender, body area affected, cause of injury, working status, Workplace Safety and Insurance Board claims, and job departments within the plant; 2) to identify differences in the rate of musculoskeletal injury and physiotherapy utilization based on gender and job; and 3) to identify differences in body part affected, service utilisation, and work status between disorders attributed to work (industrial) versus those that were not (non-industrial). The study design of this study (Sadi, MacDermid *et al.* 2007: 610-622) was similar to the study design of the current study, due to the fact that the rate and distribution of treatment visits to the physiotherapy clinic were described over a period of a few years.

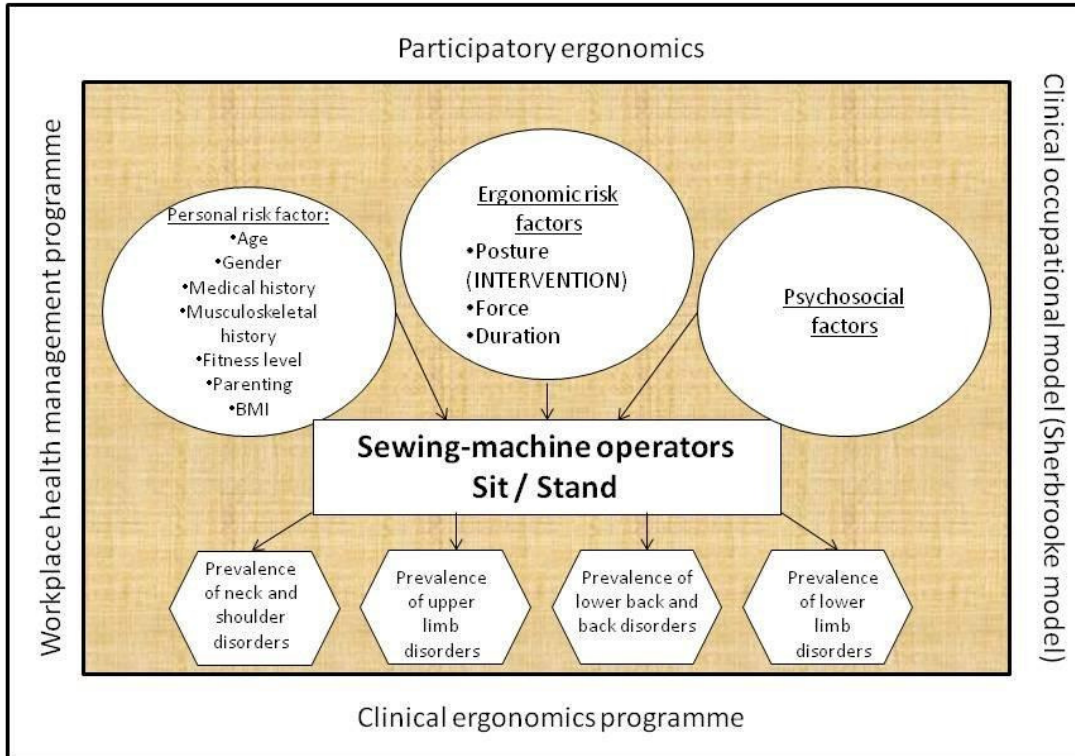
A difference between the two studies is the fact that the study of Sadi, MacDermid et al. (2007: 610-622) included the total number of visits to the physiotherapy clinic. The average number of visits per worker for industrial on-site physiotherapy was 8.3 ± 7.0 visits over a 13-year time period. This is much higher than the average of 2.7 visits per disorder for the current study. In the current study, only the first visit was taken into account when the incidence of WRMSDs was determined. The reason for this was that it often happened that a relatively few cases account for the vast majority of medical expenses (physiotherapy visits) (Pransky, Verma et al. 200: 690-697).

The retrospective study of Sadi, MacDermid et al. (2007: 610-622) also lacked a comparison group as in the current study. This limits definitive conclusions about treatment effects or cost-effectiveness, and in the case of the current study – the impact of the change in work posture on the incidence of WRMSDs. Both studies are therefore limited by its observational nature and lack of a concurrent control group, but are strengthened by the complete and long-term follow-up of a large cohort of workers. These studies provide descriptive information on the characteristics of those using an onsite physiotherapy clinic in an automobile plant in Canada (Sadi, MacDermid et al. 2007: 610-622) as well as in the current study in South Africa.

Therefore, the logical corollary is to follow a retrospective design with active surveillance's level two surveillance methodology (physical examination and in depth job analysis by a trained health care provider) (Roquelaure, Mariel et al. 2002: 452-458), and to determine incidence, rather than prevalence rates for the current study.

2.4 Summary of the literature study

The literature findings on the relationships between ergonomics programmes, risk factors and their influence on the incidence of WRMSDs in a working setting can be summarised in figure 2.1.



2.5 Integration into the conceptual framework of the current study

From the literature review on the relationship between ergonomics programmes, risk factors and their association with the incidence of WRMSDs in a working setting, it was clear that the lack of similar studies in a South African setting, specifically the sewing industry, is a pressing reality.

In the first place, ergonomics programmes can assist companies in educating managers and employees (represented by unions) on: 1) the early detection of risk factors for WRMSDs; 2) early reporting of strains to initiate aggressive medical management; and 3) implementing ergonomic-related recommendations for the prevention of recurrence of WRMSDs in the working population. (See Table 2.3.)

During the process of implementation of ergonomics programmes, data should be collected on the prevalence and incidence of WRMSDs. The value of ergonomics programmes to managers and employees (represented by unions) alike is that these data may motivate the implementation as well as funding for future programmes – based on the proven cost-effectiveness of previously implemented programmes. These results would be useful to the entire industrial sector in South Africa, as well as shareholders, with the aim of increasing profit by preventing WRMSDs.

Secondly, it was also important to realise that many studies were done on specific disorders of the human body; e.g. only the lower back. One must bear in mind that any possible musculoskeletal disorder that an employee can sustain will influence the big picture, including the individual (personal well-being and social implications) and the company (training, profitability, etc.). When the implementation of an ergonomics programme is planned on the prevention and management of a WRMSD of employees, all possible WRMSDs (to the whole body) amidst the interaction among all possible risk factors (personal, ergonomic and psychosocial) should be taken into account.

Therefore, with all the WRMSDs and risk factors in mind, the researcher evaluated the available data for the current study. The methodology is presented in Chapter Three, on the basis of the conceptual framework set out in Chapter One. (See Figure 1.1.)