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to reducing musculoskeletal
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A Stage of Change Approach to Reducing Musculoskeletal Disorders (MSDs) in the Workplace

by

Zara Whysall

Doctoral Thesis

Submitted in partial fulfilment of the requirements for the award of Doctor of Philosophy of Loughborough University.

October 2006

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“Plans are only good intentions unless they immediately degenerate into hard work.”

Peter F. Drucker

“Knowing is not enough, we must apply. Willing is not enough, we must do.”

Johann Wolfgang von Goethe
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ABSTRACT

With a view to improving the efficacy of MSDs interventions, this work examined the applicability of the stage of change approach to occupational health interventions. An initial study explored the current practices of ergonomics consultants in tackling MSDs, and revealed that consultants' recommendations generally focused on physical aspects of the work environment, and did not take explicit account of employees' knowledge or attitudes. A second study evaluated leaflets aimed at helping employers and/or employees tackle MSDs, and revealed that leaflets generally overlooked the maintenance of risk reducing measures. Due to the importance of maintaining risk reducing measures on an ongoing basis, this may be a fundamental limitation to their effectiveness. Tools were developed to assess both managerial and worker stage of change, and were found to possess high levels of reliability.

To evaluate these tools in practice, 24 interventions aimed at reducing MSDs were monitored within a variety of organisations. In half of these cases, approaches were tailored according to managers' and workers' stage of change. Significant reductions were found in self-reported musculoskeletal pain in the upper arm, elbow, forearm, wrist, hand, lower back, and legs. No significant differences in self-reported musculoskeletal pain were identified following standard interventions. To gain qualitative information regarding the intervention process, post-intervention interviews were also conducted with managers. Interviewees identified issues relating to knowledge, attitudes, perceptions, and behaviour change, in addition to structural factors, as the main barriers and facilitators in the process of implementing interventions to tackle MSDs.

Both the quantitative and qualitative findings of this work are compatible with calls for the application of the stage of change approach to the workplace. The findings suggest that scope exists for improving the success of health and safety interventions by tailoring approaches according to stage change. By tackling the attitudes, beliefs, and behavioural intentions that underpin an individuals' current stage, tailored approaches can increase the uptake, implementation, and maintenance of risk-reducing measures.
ACKNOWLEDGEMENTS

Thank you to all of the organisations that took part in this research – both to the managers who made it possible for their organisations to take part, and to the employees within those organisations for their time and their useful comments.

This work wouldn’t have been possible without the support, advice and encouragement from my supervisors, Professors Roger and Cheryl Haslam. I would also like to thank Peter Kelly (HSE) and Sue Brandrick (HSE) for their guidance throughout the project. Thanks also to Dr Fehmidah Munir for acting as the independent rater in the evaluation of materials study.

I am especially grateful to my friends and family for their advice, encouragement, and for listening to me over the last four years... I told you it was almost finished!
Parts of this thesis have been published, or are in the process of being published, in peer-reviewed journals:


Whysall, Z.J., Haslam, C., & Haslam, R.A. A stage of change approach to reducing occupational ill health, Preventive Medicine, in press.

This research also received the American Psychological Association (APA)/National Institute of Occupational Safety and Health (NIOSH) Intervention Evaluation Award 2006. The purpose of this competition was to recognise outstanding evaluations of interventions that "make a difference in the workplace" in preventing occupational injuries and illnesses and in promoting safety and health at work. The review process involved 16 US senior scientists from APA and NIOSH, of which this research achieved the highest rating.
LIST OF ABBREVIATIONS USED

BLS - Bureau of labour statistics (US)
CMM - Criterion measurement model
DWP - Department of Work and Pensions
EMG - Electromyography
EU - European Union
FLTs - Fork lift trucks
HBM - Health Belief Model
HSC - Health and Safety Commission
HSE - Health and Safety Executive
MSDs - Musculoskeletal Disorders
NIOSH - National Institute of Occupational Safety and Health
OSHA - Occupational Safety & Health Administration
PAPM - Precaution adoption process model
PPE - Personal protective equipment
RIDDOR - Reporting of Injuries, Diseases and Dangerous Occurrences Regulations
SME - Small and medium sized enterprise
TPB - Theory of planned behaviour
TRA - Theory of reasoned action
TTM - Transtheoretical Model
ULDs - Upper limb disorders
WHO - World health organisation
WRMSDs - Work-related musculoskeletal disorders
1. INTRODUCTION

1.1 The problem

Musculoskeletal disorders (MSDs) have been the most commonly reported type of work-related ill health in Great Britain for more than a decade (Health & Safety Commission - HSC, 2005; 2004; 2003; 2001; 2000; 1998). In 2004/05, over a million people were estimated to have suffered from a musculoskeletal disorder that they believed was caused or made worse by their work (HSE, 2005). The term musculoskeletal disorder covers a range of problems, described by Buckle and Devereux (2002) as:

'Inflammatory and degenerative diseases and disorders that result in pain and functional impairment, and can affect the neck, shoulders, elbows, forearms, wrists and hands.' (p.207)

Problems can be non-specific such as back pain, for example, or more specific conditions such as carpal tunnel syndrome. MSDs present substantial costs to individual sufferers in terms of pain, potential disability, loss of earnings, or early retirement, but also to employers and health service providers, in terms of lost working days, compensation claims, healthcare costs and incapacity benefit. Whilst a number of MSDs can be treatable in their early stages, their gradual onset may cause individuals to underestimate these types of disorders until problems are substantially developed. Moreover, although in most cases individuals make a full recovery from a given episode, recurrence rates are high (e.g. Andersson, 1999; van den Hoogen et al., 1997), and in some cases these symptoms can even become irreversible (e.g. Keogh et al., 2000).

The ongoing prevalence of MSDs may be related to their complex causality, and the difficulty of determining work-relatedness. These issues can make MSDs particularly challenging problems for employers to manage. Although it is difficult to determine work-relatedness, a considerable body of evidence exists for
associations between many types of MSDs and specific work-related tasks or factors (e.g. repetitive motion, excessive force, non-neutral body postures). This includes evidence from epidemiological reviews (National Research Council, 1998; Bernard, 1997), national surveys (HSC, 2004), experimental studies (Nahit, et al., 2001; Armstrong et al., 1993) and research reviews (Buckle & Devereux, 1999). Work-related risk factors can be classified as relating to three main groups: task-related, environment-related, and worker-related factors (HSE, 2002). Despite these factors relating to a range of disciplines, from biomechanics, to ergonomics, to psychology, and physiology, it is argued that approaches to prevention tend to derive from these individual disciplines in isolation from the others (Marras, 2004). The psychosocial component of MSDs has become increasingly acknowledged over the past decade. A range of psychosocial risk factors have been associated with MSDs, including both individual and organisational variables such as cognitive demands, workload, repetitiveness, job control, job satisfaction, role clarity, the pacing of work, organisational factors such as tall vs. flat organisational structures, incentive schemes, communication systems, interpersonal relationships at work, and job prestige (e.g. Bongers et al., 2002; National Research Council, 2001). However, the failure to take a holistic approach in tackling MSDs could be a crucial limitation to the effective reduction and prevention of these types of problems. Indeed, this could explain why although estimated MSD prevalence rates in England and Wales declined from 1990, they appear to have reached a plateau, failing to diminish further in recent years.

1.2 The role of behaviour

As recognised by the World Health Organisation (WHO, 1988), behaviour is a key causal factor underpinning many of today’s most widespread diseases and health problems, such as obesity, coronary heart disease, skin cancer, and lung cancer. This is also the case for work-related MSDs, as for the risks of MSDs to be reduced, action first needs to be taken by managers to implement risk-reducing measures (e.g. changes to the workplace layout, tools, equipment, or training). These changes then need to be adopted by employees, and integrated into their routine ways of working. Consequently, occupational health and safety
interventions need to integrate both the physical and psychological dimensions, in order to promote the adoption and maintenance of measures to reduce MSDs among individuals across all levels of the organisation. This notion is consistent with previous calls for the application of models of health behaviour to workplace interventions (e.g. Dejoy, 1996; Haslam & Haslam; 2000; Prochaska et al., 2001), in order to improve their effectiveness.

The Stage of Change approach; a component of the Transtheoretical Model (TTM, Prochaska & DiClemente, 1982); has intuitive appeal, as it centres on the change process itself, acknowledging the temporal nature of change. This is of particular importance to occupational health and safety problems, due to the ever changing nature of work, the difficulty of making workplaces completely risk-free environments, and as a result, the need to maintain risk reducing efforts on an ongoing basis. The stage of change approach has been used extensively in connection with various health behaviours such as drinking, smoking, and exercise. It assumes that any behaviour change involves movement through a series of distinct stages: i) precontemplation (resistance to recognising or modifying problem behaviour), ii) contemplation (recognition of the problem, thinking about changing, but not ready to act), iii) preparation (intending to change in the next 30 days, and/or having made specific plans to do so), iv) action (having engaged in behaviour change, no longer than 6 months ago), and v) maintenance (initiated changes over 6 months ago, working to consolidate gains made) or relapse. An individual's stage is considered to be underpinned by their current knowledge, attitudes, and beliefs regarding a particular health problem. Due to the varying dominance of these concepts over time, an individual's stage of change determines their receptiveness to approaches aimed at promoting behaviour change. Given this rationale, therefore, it can be seen why by adopting a 'one-fits all' approach, current organisation-wide interventions aimed at reducing occupational health and safety problems may be less effective than might be hoped. Research adopting the TTM has shown that stage matched interventions increase the likelihood that individuals will take action (e.g. Prochaska et al., 1993; Rakowski et al., 1998).
1.3 The aims of this research

The overarching aim of this research was to explore the process of intervening to address occupational health and safety risks, with a view to identifying opportunities for improving the effectiveness of these interventions. More specifically, this research aimed to develop and test the stage of change approach for use with occupational health and safety interventions, and to examine whether tailoring these approaches according to managerial and worker stage of change can improve the effectiveness such change initiatives.

MSDs were selected as the health issue on which to focus, for a number of reasons. First, MSDs are the most common cause of occupational ill-health in Great Britain (in addition to many other industrialised nations). Second, MSDs have a very complex aetiology, involving both physical and psychological risk factors. As a result, scope may exist for improving the effectiveness of these interventions by developing an approach that incorporates both physical/ergonomics and psychological/behavioural interventions into a coherent, holistic framework.

As a precursor to this work, two preliminary studies were undertaken to assess the current practices of consultants in providing recommendations to organisations for tackling MSDs, and the extent to which HSC/E leaflets aimed at helping organisations tackle these problems provide information reflecting the stages of change. These studies helped to identify potential barriers and facilitators to the reduction of MSDs, and possible weaknesses in current approaches or materials, which provided a basis for the subsequent work.

1.4 Research objectives

The main objectives of this research were to:

- Explore the current practices of ergonomics consultants involved in providing organisations with recommendations for reducing the risks of MSDs. Specifically, to:
- identify the factors that are assessed by consultants in order to make recommendations for the reduction of MSDs
- explore consultants' judgements of the effectiveness of their interventions
- identify the key barriers to, and facilitators of, the effective implementation of recommended changes
- to ascertain the extent to which the effects of consultants' interventions were evaluated

- Evaluate the extent to which leaflets providing information about MSDs reflect the stages of change outlined by the Transtheoretical Model of behaviour change (Prochaska & DiClemente, 1983). This was achieved by:
  - performing a content analysis to identify the nature of the information contained within the leaflets
  - measuring (objectively) the percentage coverage of each leaflet according to the stages of change
  - rating (subjectively) the quality of information provided, in terms of relevance to the stages of change

- Develop the stage of change approach for use in the occupational domain. Specifically:
  - to design tools to assess both individual worker and managerial stage of change in relation to reducing the risks of MSDs in the workplace, based on the traditional set of questions developed in previous work
  - to develop sets of likert style questions to assess individual worker and managerial stage of change in relation to reducing the risks of MSDs in the workplace, to enable comparison of alternative methods of assessing stage in this context
  - to identify factors that may influence the implementation or effectiveness of interventions, and to generate a set of likert style questions to assess these factors
  - to design a questionnaire incorporating the above items, in addition to sections regarding relevant demographic or background information
- Test the reliability (and as far as possible, validity) of these tools in a range of organisations where workers are considered at risk in terms of MSDs, and explore the factors relating to stage of change in this context.

- Apply the tools in practice, to evaluate whether interventions can be made more effective by tailoring approaches according to worker and manager stage of change. This was achieved by:
  - conducting pre-intervention assessments within a range of organisations intending to take action to tackle MSDs. A number of measures were used, including demographic/background information, stage of change, musculoskeletal pain (in the case of workers only), and safety climate
  - in half of these cases, providing tailored feedback to managers involved in implementing changes, to help them tailor their interventions according to workers' stage of change
  - evaluating the effectiveness of tailored interventions compared to non-tailored interventions, according to the range of measures taken pre-intervention (stage of change, workers' self-reported musculoskeletal pain, and safety climate)

- Qualitative exploration of the intervention process, through in-depth interviews with managers directly involved in the implementation of interventions. Including:
  - identification of the key barriers experienced when implementing changes
  - identification of factors facilitating the change process
  - identification of managers' perceived outcomes of the interventions

1.5 Research methodology

A combination of research methods was used to achieve these objectives, including quantitative and qualitative elements. This combination of approaches was considered most appropriate for a number of reasons. First, although the traditional experimental approach (particularly the randomised control design) is well established as the 'gold standard', a number of problems with this approach
can be identified, especially in the evaluation of workplace interventions. For instance, Griffiths (1999) argued that attempts to confirm cause-and-effect relationships and allow prediction (maximise internal validity) are often made at the expense of generalisability (external validity). Second, the aim of this research was to assess both the impact and process of interventions. Whilst quantitative approaches can determine the size of an effect, qualitative methods enable more in-depth exploration of the nature of the effect, the process by which it takes place, and its potential causes. The range of methodologies chosen also allows comparison of results derived from a range of methods, often termed triangulation (e.g. Pope & Mayes, 1995). Triangulation is used as a means of improving the power of research, due to the acknowledgement that all types of research are likely to be flawed in one way or another, but that findings from a number of different sources that do not share the same flaws decrease uncertainty about specific associations and likely causal relationships (Cook & Campbell, 1979). In terms of evaluation research, the purpose of qualitative approaches has been described as measuring the process, and quantitative approaches as more appropriate to estimate net effects of interventions (Rossi & Freeman, 1993).

1.5.1 The research programme
Two initial studies were conducted to explore the nature of advice and information currently available to employers. The first was conducted to identify the current practices adopted by ergonomics consultants in tackling MSDs. In-depth semi-structured interviews were conducted with 14 consultants representing a range of employers, from sole-practitioners to directors of consultancy firms. The second study consisted of an evaluation of guidance materials produced by HSC/E to help employers and employees tackle MSDs. Both objective and subjective measurement techniques were employed. A content analysis was conducted to identify the nature of the messages contained in the leaflets. Objective measurements were undertaken by calculating the percentage (area) of the document that was devoted to information pertaining to the stages of change. Subjective ratings (1 = good, 2 = moderate, 3 = poor) were also made of the quality of this information, in terms of the extent to which it conveys the key messages relating to each stage.
The next phase of research concerned the development of tools to assess both individual worker and managerial stage of change. The main components of this study are represented in Figure 1. Questionnaires were designed to assess stage of change, in addition to attitudes towards health and safety, and in the case of individual workers, musculoskeletal pain. The questionnaires were administered to 100 managers and 168 workers in a range of organisations in different industry sectors.

**Figure 1. Tool development phase methods overview**

The subsequent phase of research involved testing these tools in practice, which was achieved by monitoring a range of workplace interventions aimed at reducing the risks of work-related MSDs. A range of measures were taken both prior to, and following the implementation of interventions. As conceptualised in Figure 2, in half of the cases, organisations were provided with pre-intervention feedback and advice to help them tailor their interventions according to both managerial and worker stage of change. For example, in cases where managers and/or workers were identified as being in the precontemplation stage, the organisation was advised of the importance of first promoting risk awareness among both groups, by highlighting the detrimental effects of MSDs. In order to do this effectively, emphasis was placed on the need for targeting this information specifically to the primary concerns of these two different groups (i.e. managers and workers), as their attitudes and concerns are likely to be qualitatively different. For example:
Managerial concerns
- Reduced productivity
- Reduced product/service quality
- Employee suffering
- Damage to company reputation
- Increased absence
- Early retirement through ill health
- Increased turnover
- Higher recruitment and training costs
- Compensation claims
- Increased insurance premiums

Workers' concerns
- Pain
- Numbness, tingling
- Temporary or permanent disability
- Lost time from work
- Loss of earnings
- Treatment/healthcare costs

Tailored health promotion materials for both managers and workers were developed to assist organisations in this task, including bespoke leaflets, posters, presentations, and CD-ROMs.

**Figure 2. Implementation phase methods overview**

A final study was conducted following the implementation of interventions, to obtain qualitative information regarding the implementation process. Semi-structured interviews were undertaken with the managers directly involved in implementing the interventions, between 4-8 months post-intervention.

**1.6 Structure of the thesis**

The work is presented over a further eight chapters, which are briefly summarised below, and displayed in a flow chart on the following page. This flow chart is
presented before each chapter throughout the thesis, in order to orient the reader to each chapter's location within the thesis as a whole.

This chapter, Chapter One, has provided a general introduction to the thesis as a whole. It is followed by two subsequent chapters ( Chapters Two and Three) providing reviews of the literature in the key subject areas to which the research relates. Substantial background information is necessary due to the cross-disciplinary nature of the thesis. Chapter Two consists of an overview of existing research and knowledge relating to musculoskeletal disorders (MSDs), the work-related factors associated with MSDs, and a critical review of evidence for the effectiveness of interventions to tackle these problems in the workplace. Chapter Three concerns behaviour change theory, appraises the main models that have been proposed to predict health behaviour, and discusses the potential application of such models to health-related behaviour in the workplace.

Chapters Four to Eight describe the five studies conducted, including the methodology adopted for each study, the results, and implications. Owing to the complexity of the methodology adopted, particularly for the studies described in Chapters 6 and 7, this was considered the most optimal way of presenting the research. Presenting all of the methodology first, followed by all of the results may have caused confusion as to the specific methodology followed within each study, and is likely that the reader would need to continuously refer back to each relevant section of the methodology chapter when reading the results.

The final chapter, Chapter Nine discusses the results of these studies, identifies the key implications of the research presented in the thesis, and outlines recommendations for the development of future theory and practice.
Overview of the thesis

Chapter 1: Introduction

Chapter 2: Literature review: MSDs

Chapter 3: Literature review: Behaviour change

Chapter 4: Exploration of current practices
- 14 Semi-structured interviews with ergonomics consultants

Chapter 5: Evaluation of materials
- Content analysis of HSE materials
- Evaluation of coverage of stages of change

Chapter 6: Tool development
- Worker questionnaire (n = 168)
- Managerial questionnaire (n = 100)

Chapter 7: Implementation
- 24 interventions monitored
- Half tailored according to stage
- Worker & managerial assessments pre & post intervention

Chapter 8: Exploration of the change process
- Post-intervention interviews with managers following tailored & non-tailored interventions (n = 17)

Chapter 9: Discussion, implications and recommendations
2. MUSCULOSKELETAL DISORDERS

2.1 Introduction

This chapter provides an overview of the health problem at issue in this thesis, musculoskeletal disorders (MSDs). Although the central focus of the thesis is the process of implementing workplace interventions in general, and more specifically, the development of an approach to improve the effectiveness of interventions to tackle occupational health and safety problems, it is important to understand this in the context of the specific health issue of concern. Consequently, this chapter will first define MSDs, and the range of problems encompassed by this term, before going on to evaluate evidence for the work-relatedness of MSDs, and the risk factors that are associated with their onset. Interventions to tackle MSDs are then discussed, followed by appraisal of the evidence for the effectiveness of these interventions.

2.2 Musculoskeletal Disorders: Definition

Although some researchers have dealt with back pain separately, reference to MSDs within this thesis includes not only problems affecting the neck, shoulders, and upper limbs, but also the back and lower limbs. This is consistent with the more lengthily definition of MSDs provided by Punnett and Wegman (2004):

"...a wide range of inflammatory and degenerative conditions affecting the muscles, tendons, ligaments, joints, peripheral nerves, and supporting blood vessels. These include clinical syndromes such as tendon inflammations (tenosynovitis, epicondylitis, bursitis), nerve compression disorders (carpal tunnel syndrome, sciatica), and osteoarthritis, as well as standardised conditions such as myalgia, low back pain, and other regional pain syndromes not attributable to known pathology." (p. 13)

MSDs are typically cumulative, developing gradually over time, possibly leading to discomfort, impairment, disability and/or persistent pain in the joints, muscles,
tendons and other soft tissues, with or without physical manifestations (Kroemer, 1989). However, as highlighted by McAtamney and Corlett (1992), the term MSD is 'not a diagnosis, but an umbrella term describing a range of conditions amongst which are a number of specific diagnoses.' (p.965). The most common types of problems are those affecting the back, followed by the upper limbs or neck, followed by problems affecting the lower limbs (HSC, 2004). Descriptions of some of the most common upper limb disorders are given in Table 1. Back disorders are particularly complex, and cannot always be identified as specific types of disorder, relating to specific causes. Commonly, back disorders are described as “nonspecific” (Bernard, 1997), although the European Agency for Safety and Health at Work (De Beeck & Hermans, 2000), made the broad distinction between two main types of disorder: intervertebral disc-related disorders, relating to the degeneration of disks resulting from compressive loads on the vertebrae (through normal activities and accelerated by excessive loads), and soft tissue-related disorders. Soft tissue-related disorders are often linked to disk degeneration, as this exposes the soft tissues to higher mechanical burden. Due to the high density of pain receptors in the soft tissues, back pain can result (Kroemer, 1989). However, according to De Beeck and Hermans (2000), on average, 95% of low back disorders are called “non-specific” or “strain/sprain” because the source of the pain cannot be identified. Reflecting the variation between non-specific types of MSD such as back pain, and specific disorders such as carpal tunnel syndrome, Hutson (1997) distinguished between type 1 disorders (those with relatively clear cut clinical characteristics and established treatment controls) and type 2 disorders (regional pain syndromes with widespread symptoms and an apparent paucity or absence of physical signs and recognisable pathology).

The plethora of terms that exist to describe MSDs also tend to differ geographically. In Canada and Europe, for example, the term repetitive strain injury (RSI) and upper limb disorder are commonly used, in Australia both RSI and occupational overuse syndrome, and cumulative trauma disorder in the USA (Putz-Anderson, 1988). The term ‘MSDs’ is used in this thesis, as the research is concerned not only with disorders of the upper limbs, but also problems affecting the upper and lower back. Some of the alternative terms can also be misleading.
<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
<th>Association with occupational activity</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bursitis/Cellulitis (beat hand, beat elbow)</td>
<td>A distension of the fluid sac (bursa) and/or infection of the subcutaneous tissues. The bursa and the overlying skin may also become infected. Beat hand is an infection in the palm of the hand. Redness, heat, swelling and pain at relevant anatomical site.</td>
<td>Associated with repeated local trauma from prolonged leaning, or pressure, friction over elbow. Use of hand tools e.g. hammers and shovels, together with abrasion from dirt/dust.</td>
<td>Inflammation, bruising of the palm.</td>
</tr>
<tr>
<td>Carpal tunnel syndrome</td>
<td>A peripheral nerve disorder resulting from compression of the medial nerve as it enters the palm of the hand.</td>
<td>Associated with: highly repetitive work, forceful work, hand-arm vibration. Strong association with a combination of risk factors e.g. force, repetition and posture.</td>
<td>Pins and needles in wrist/hand, loss of power in hand. Tingling, numbness, tenderness can occur several hours after activity. Weakness of gripping and clumsiness.</td>
</tr>
<tr>
<td>De Quervain's disease</td>
<td>A localised swelling involving two tendons that move the thumb and which pass through a fibrous tunnel in the wrist.</td>
<td>Associated with: repetition, force, posture. Can be associated with direct trauma of the radial aspects of the wrist.</td>
<td>Activity related discomfort is experienced over the radial aspect of the wrist and forearm. Use of the hand and thumb for grasping becomes increasingly painful.</td>
</tr>
<tr>
<td>Dupuytren's Contracture</td>
<td>A thickening of tissue below the skin in the palm of the hand which results in a progressive contracture appearing, especially of the ring and little finger of one or both hands.</td>
<td>No generally accepted associations.</td>
<td>Thickening is painless, possibly with a palpable nodule in the pulmar crease. One or more fingers can curl up and cannot be straightened.</td>
</tr>
<tr>
<td>Condition</td>
<td>Description</td>
<td>Associated with</td>
<td>Comments</td>
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</tr>
<tr>
<td>Epicondylitis (tennis elbow/golfer's elbow)</td>
<td>A degeneration or inflammation of the short tendonous attachments from the forearm muscles to the bone at the elbow.</td>
<td>Associated with forceful work activities. Strong association with combinations of risk factors; force, repetition, posture.</td>
<td>Pain can radiate into the forearm and is activity dependent, tenderness in forearm and elbow at the attachment of the tendon, weakness of grip.</td>
</tr>
<tr>
<td>Ganglion</td>
<td>A cyst filled with synovial fluid arising from a joint or tendon sheath, usually found on the back of the hand or wrist.</td>
<td>No generally accepted associations.</td>
<td>The swelling can vary in size and be tense and firm or soft and squeezable and is usually painless.</td>
</tr>
<tr>
<td>Occupational cramp of hand or forearm</td>
<td>A focal dystonia, which affects the control and coordination of muscle activity.</td>
<td>Association with prolonged periods of repetitive movements of the fingers, hand, or arm.</td>
<td>Spasm of the muscles in the hand or forearm is observed, often when initiating specific movements and the effect may impair the entire limb. Cramp, pain in arm, hand, loss of function.</td>
</tr>
<tr>
<td>Rotator cuff tendonitis – bicipital tendonitis</td>
<td>An inflammation or degeneration of the tendons in the region of the shoulder joint.</td>
<td>No generally accepted associations.</td>
<td>Aching and pain in the shoulder, limitation of certain shoulder movements.</td>
</tr>
<tr>
<td>Shoulder capsulitis (frozen shoulder)</td>
<td>An inflammation or degeneration of shoulder joint tissue.</td>
<td>No generally accepted associations.</td>
<td>Inflammation of shoulder joint tissue, stiffness, pain, increasing restriction of shoulder movements.</td>
</tr>
<tr>
<td>Tenosynovitis, tendonitis</td>
<td>An inflammation of the tendon sheaths at the wrist.</td>
<td>Associated with:</td>
<td>Local tenderness and swelling, aching and pain worse on movement (e.g. shoulder, wrist), grasping and pinching may be weak depending upon the tendon affected.</td>
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<tr>
<td></td>
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<td>- repetition</td>
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<td>- posture.</td>
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<tr>
<td>Vibration white finger</td>
<td>A disorder arising from impairment of blood circulation in the fingers and appears in periodic attacks usually provoked by the cold.</td>
<td>Associated with exposure to vibration transmitted to the hand and arm from work processes.</td>
<td>Fingers turn white with associated numbness and tingling. Restoration of blood flow results in painful red throbbing fingers. In severe cases coordination and dexterity is impaired.</td>
</tr>
</tbody>
</table>
(e.g. repetitive strain injury), in light of the numerous and diverse conditions that can bring about MSDs. Specifically, this work focuses on work-related MSDs (WRMSDs); those problems that are caused by, and/or made worse by work. Although it can be difficult to determine the precise contribution of work to the development of an MSD (as opposed to non-work activities such as sports or gardening, for example, which can play a role in bringing about MSDs), established associations exist between many types of MSDs and specific work tasks or characteristics (e.g. Luttmann et al., 2003; Buckle & Devereux, 2002; HSE, 2002; NIOSH, 1997). Consistent with this, the World Health Organisation (WHO, 1985) defined disorders as work-related when the work activities and work conditions significantly contribute to their development and exacerbation but are not the sole determinant of causation. In addition, it could be argued that due to the omnipresence of MSD risk-factors in the workplace, regardless of their cause, employers are legally required take steps to protect their employees from developing problems (and indeed themselves from potential litigation); even if these problems may also be related to non-work activities.

2.3 History of MSDs

MSDs are not a new phenomenon. Evidence of work-related MSDs can be traced back to at least the 1700s, when Ramazzini, known as the founder of occupational medicine, published De Morbis Artificium (illness of artisans), noting that 'incessant writing caused fatigue of the hand and arm, with eventual failure of power in the right hand – writers' cramp' (Brennan, 1985). According to Brennan, specific disorders such as tenosynovitis began to be recognised by the medical profession in the 19th and 20th centuries. However, it was not until the 1970s and 80s that musculoskeletal complaints began to be associated with specific types of work (McPhee, 1990). Although initially largely related to blue collar workers (through continuous or repeated loading of the tissue structures), musculoskeletal problems also began to be identified among white collar workers. This was particularly noted in Australia in the mid- and late 1980s.
where an 'epidemic' of upper limb disorders among white collar workers was observed, for which many reasons were speculated. Differences were found between offices of workers performing very similar tasks, with a large number of workers reporting problems in one office, for example, but not another. Some partly attributed to the rapid increase in word processing operators combined with streamlining of the workforce resulting in increased workload for many workers (Hopkins, 1990; Hocking, 1987). However, Awerbuch (1986) considered a primary cause of the 'epidemic' to be medical practitioners' readiness to diagnose RSI, which he claimed rested upon 'only one medical criterion: namely, the complete absence of objective clinical signs of abnormality.' A large number of successful compensation claims during this period were also attributed to having exacerbated the 'epidemic', following the classification of RSI problems as compensatable (Hagberg et al., 1995; Spillane & Deves, 1987). Factors such as these led Lucire (1986) to label the RSI epidemic in Australia as simply an 'epidemic of hysteria'. Reflecting claims such as these, more recently it has been argued that society's provision of systems such as workers' compensation schemes may lead to over reporting of MSD symptoms; the "perverse incentive" view (Frank et al., 1995).

Aside from the Australian 'epidemic' discussed above, the growing prevalence of MSDs has also been attributed to our evolution, due to a large proportion of our history having depended on hunting and gathering activities, yet the advancement of science, technology and industry having resulted in substantially different occupational stressors, for which the body is not designed (Kumar, 2001). Excessive repetition, exertion of force, and the maintenance of static postures for long periods of time are all common aspects of contemporary occupational roles, and such tasks can be seen as at odds with our natural anatomical make-up.
2.4 The extent of the problem

MSDs remain the most common form of work-related ill health in Great Britain. In 2004/05, an estimated 1,012,000 people suffered from an MSD that they believed to be caused or made worse by their work, leading to the loss of around 11.6 million working days. On average, each worker suffering from such a problem took an estimated 20.5 days off work in that 12 month period (HSC, 2005). Unsurprisingly, the costs to employers resulting from these problems are substantial. The HSE has estimated that work-related musculoskeletal disorders cost employers between £590 million and £624 million (1995/96 prices), although these costs are only intended to be broadly indicative (HSE, 1999). Of this, between £315-335 million are related to back disorders, and £208-221 million for upper limb disorders (HSC, 2003). Furthermore, MSDs are not just a UK problem. High prevalence rates exist internationally, at least across industrialised nations. In the European Union for example, over 44 million workers are believed to suffer from back problems related to their jobs - approximately 30% of the entire workforce, and a similar proportion from work-related upper limb disorders (O'Neill, 1999). Estimates of prevalence for a number of European countries are displayed in Figure 3 (European Foundation 1996). These concerns are further heightened by the finding that work in the European Union is becoming even more intense, with the risk factors associated with MSDs commonplace in the contemporary European work environment (O'Neil, 1999). On a global scale, WHO (1999) estimated that around 30% of the workforce in developed countries, and between 50-70% in developing countries, may be exposed to heavy physical workloads or poorly designed workplaces and work tasks, putting them at risk from MSDs.

A similar picture is evident in the US, where MSDs are among the most prevalent lost-time injuries and illnesses in almost every industry, and as in the UK, among the most costly occupational health problems (Bureau of Labour Statistics - BLS, 2004; NIOSH, 1997; National Safety Council, 1995). In 2002, MSDs accounted
for two thirds of all reported occupational illnesses in the USA, and 34% (487,900) of injuries and illnesses in the US involving days away from work, the costs (both direct and indirect) of which are estimated at around $2 billion annually (BLS, 2004). There is also evidence to suggest that the BLS statistics considerably underestimate incidence rates, possibly as they only consider cases resulting in lost workdays (rather than those resulting in medical treatment alone). Further complicating measurement, some cases, of course, may involve neither lost days nor treatment. Silverstein et al. (1998), for example, observed an incidence rate for disorders associated with repetitive trauma of 2.2 times greater than that reported by the BLS. Other estimates suggest that MSDs account for between 56-65% of all occupational health problems in the US (Tittiranonda et al., 1999; Melhorn, 1998). WHO (1999) findings also suggest that the global burden of occupational diseases and injuries is underestimated, due to the scarcity of reliable reporting systems and diagnosis in most developing countries, and even industrialised nations. In Latin America for example, it is estimated that only 1-4% of all occupational diseases are reported.

These problems are likely to be further aggravated in developed countries due to the ageing population. Within the next quarter-century, the proportions of working and retired populations are expected to change dramatically, due to people living longer and bearing fewer children (WHO, 1999). By the year 2010,
approximately 20% of the population of the EU and other developed countries will be aged over 60 (Rabbitt, 1997). Not only has age been implicated as a potential risk factor for MSDs (as discussed in Section 2.9.2), but this will also result in a situation where a restricted workforce is under pressure to be more productive, and to make greater contributions to pension funds. As a result, what is currently a major problem is likely to be further exacerbated by future workforce demographics.

2.4.1 Trends in MSD prevalence
Comparisons between HSE surveys of self-reported work-related illness show that although the estimated prevalence of MSDs in England and Wales has declined since 1990 and 1995, rates appear to have plateaued (even increased slightly) in recent years (see Figure 4). A number of speculations can be made about the rise and fall of MSD prevalence over the past one and a half decades. The gradual increase in MSDs in recent years may, for example, be related to increased global competition, the implementation of increased and new technologies, increased integration of women and older workers into the workplace, improved awareness of problems, and improved record keeping. The reason for the sharp rise in prevalence in 1995 is unknown, although HSE statisticians highlight that there are a number of anomalies with the 1995 survey, including certain differences in measurement criteria. Other than methodological factors, it could be speculated that the rise in MSDs between 1990 and 1995 was related to the introduction of a number of regulations in 1992 (i.e. Manual Handling Operations Regulations, Workplace Regulations, Display Screen Equipment Regulations), which may have prompted the identification of a large number of existing problems. A list of MSD-related regulations is shown in Table 2. The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR, 1995), is another important consideration, which came into force on 1 April 1996. However, as RIDDOR is a reporting system used by managers its effect on workers' self-reported MSDs is likely to be limited by the
Figure 4. Rates of self-reported illness caused or made worse by work, for people working in the previous 12 months in England and Wales (HSE, 2006)

extent to which managers communicate information regarding these reporting requirements to workers. The increasing litigious nature of our society could also be held as a contributing factor for increased numbers of people presenting with musculoskeletal symptoms. As documented by Baptiste-Destouche and Kaye (2001), access to legal advice has never been so easy, many offering 'no win no fee' legal assistance. Furthermore, following a comparison of back pain prevalence surveys at an interval of ten years, Palmer et al. (2000) discovered that whilst outpatient attendances for back pain rose fivefold, and the number of days of incapacity from back disorders for which social security benefits were paid more than doubled between 1983 and 1993, these increases were not explained by a greater incidence of severe back disease. Instead, they suggest, a more likely explanation is that cultural changes have led to a greater awareness of minor back symptoms and a willingness to report them, and this cultural shift may also have rendered back pain more acceptable as a reason for absence attributed to sickness.

Although a reduction in prevalence was observed in 1998/99 (possibly as a result
Table 2. Key MSD related regulations

- **Health and Safety at Work Act (1974):** Imposes duties on employers to ensure, so far as is reasonably practical, the health, safety and welfare at work of all employees.

- **Manual Handling Operations Regulations (1992):** Requires employers to attempt to avoid, so far as is reasonably practical, the need for undertaking manual handling operations that could lead to injury. Where this is not reasonably practicable, to carry out risk assessments and take appropriate steps to reduce the risk of injury.

- **Workplace Regulations (1992):** Requires employers to ensure that workplaces meet the health, safety and welfare needs of employees including aspects such as workstations and seating, maintenance of workplace, equipment, devices and systems, and temperature and lighting.

- **Display Screen Equipment Regulations (1992):** Requires employers to assess and reduce the risks of workers habitually using display screen equipment, including the potential for upper limb pains.

- **Provision and Use of Work Equipment Regulations (1998):** Requires employers to ensure that work equipment is suitable for the purpose, including taking account of ergonomic risks when selecting work equipment.

- **Management of Health and Safety at Work Regulations (1999):** Requires employers to conduct risk assessments of work activities, plan, organise, monitor and review any required measures that follow, and give employees information about health and safety matters.

of improved knowledge and intervention measures), the failure for prevalence to diminish further in 2001/02 and 2003/04 may be indicative of a plateau, with further ergonomics improvements failing to have any notable effect. A similar pattern has been described by Donald and Young (1996), in relation to accident
reduction. They speculated that this was due to a failure to tackle attitudes, the underpinning link that enables the deeper, more fundamental shift necessary to effectively reduce health risks. According to Snook (e.g. Snook, 2003; Snook & Webster, 1999; Snook, 1987) on the other hand, back pain is an inevitable part of the ageing process, which will never be completely eliminated.

In response to the escalating problem of MSDs, in their Strategic Plan set out in ‘Revitalising Health and Safety’ on 7 June 2000, HSC and HSE agreed targets to reduce the incidence of work related illness caused by MSDs by 20% by 2010; and to reduce the number of working days lost due to MSDs by 30% by 2010. Prevalence rates shown in Figure 4, however, suggest that large improvements are needed over the four years if these targets are to be achieved.

2.5 The effects of MSDs: Individual, organisational, societal

The detrimental effects of MSDs are evident not only at the individual level, but also organisational, and even societal levels. As discussed, at the individual level, MSDs can not only cause pain and suffering, but can also potentially prevent sufferers from performing certain tasks at work or in their social and leisure activities. The fact that MSDs tend to have a gradual onset can also exacerbate problems, as their slow development means that these disorders often go untreated (Yassi, 1997). Whilst a number of such disorders can be treatable in their early stages, their gradual onset may cause individuals to underestimate their own susceptibility to, and the severity of, these types of disorders until problems are substantially developed. Moreover, although in most cases individuals make a full recovery from a given episode, recurrence rates are high (e.g. Andersson, 1999; van den Hoogen et al., 1997), and in some cases these symptoms can even become irreversible (e.g. Keogh et al., 2000). Each person forced to stop work due to work-related illness loses an average £51,000 before retirement age (HSE, 1999).
For organisations, MSDs represent the most economically costly occupational health problems (National Safety Council, 1995), estimated to cost employers between £590 million and £624 million (1995/96 prices, HSE 1999). Ascertaining the exact financial costs related to MSDs is difficult however, as the indirect costs such as reduced productivity and quality, recruitment and training costs, and increased absence, are thought to be under acknowledged. Hagberg et al. (1995) estimated that direct costs from compensation of affected workers account for only 30-50% of the total costs. Employee absence is likely to be a substantial contributor to the total cost, due to the prevalence of MSDs. WHO (2003) report that across all industrialised countries worldwide, approximately one-third of health-related absences from work are due to MSDs. In addition to absence, MSDs are also likely to result in increased staff turnover, with employees choosing to leave jobs that involve MSD risk factors such as repetitive or strenuous work, to find alternative work. Other workers may be forced to leave their job as they are no longer able to perform the work. Both of these factors are likely to subsequently incur further costs in recruiting and/or retraining staff. The average cost of retraining employees due to injury, long-term illness, of early retirement due to MSDs is between £3,000-£4,000 per employee, according to the RSI Association (RSIA, undated). For experienced staff, such as NHS professionals, these figures are thought to be as high as £8,000-£10,000. MSDs can also have effects on those employees remaining at work, including decreased productivity, efficiency, and impaired quality of products or services. Illustrative of this, for example, one case study involving ergonomics changes to fine assembly workstations in a US electronics plant generated a 15% increase in productivity; translating into a $2250 - $3000 increase per shift, per worker (Hendrick, 1996).

MSD related compensation claims are also becoming increasingly common, as are prosecutions for failure to comply with HSE regulations. Details of both HSE prosecutions and improvement notices are publicly available on the HSE website (www.hse.gov.uk), examples of which are shown in Table 3. A separate
database detailing information on over 200 Court Judgments in personal injury claims in which the alleged injury was some type of work-related upper limb disorder was also established in November 2005 (www.humanetechnology.co.uk/registered/intro.php). Although injuries were not identified in all of these cases, or problems were not all identified as work related, many others resulted in substantial fines. In March 2005, for example, damages of £121,803 were awarded to a legal secretary who developed pains in hands, wrists, arms and shoulders due to administrative work using visual display screen equipment. In 1992, the direct cost paid out in compensation by EU countries for work-related diseases and injuries reached 27 million Euros (WHO, 1999). A similar picture exists in the US, where work-related MSDs are believed to account for 35% of all compensable claims (Silverstein et al., 2002). Such claims are not only inherently costly, but also often result in increased insurance premiums for the organisation concerned, in addition to generating bad publicity, which in turn may trigger further losses for the organisation (e.g. loss of custom, difficulty recruiting employees).

MSDs also present a major cost to society. WHO (1999) report that in 1997, the overall economic losses resulting from work-related diseases and injuries were approximately 4% of the world’s gross national product. Griffiths (1998) claimed that in 1996, MSDs accounted for one quarter of claims for incapacity benefit in the UK. According to the Department for Work and Pensions (DWP, 2002), 2.7 million people of working age in the UK are on state incapacity benefits, and 20% of people of working age have a long-term disability (7.1 million people). Each year 7% of the population visit their GP regarding musculoskeletal complaints, amounting to 12 million GP consultations, 7 million physical therapy sessions, and 800,000 in-patient bed days, at an estimated cost of almost £500 million to the NHS (HSE, 1998). Combined with the potential effects of the ageing workforce, and the possible pensions crisis, worklessness is increasingly becoming a major public health issue, with MSDs one of the major contributors.
<table>
<thead>
<tr>
<th>Organisation</th>
<th>Date</th>
<th>Nature of offence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooper-Avon Tyres Ltd</td>
<td>11/2001</td>
<td>Poor management of the manual handling of cap strip reels. Two recent lost time accidents. Considerable previous advice. Prosecuted: £15,000 fine.</td>
</tr>
<tr>
<td>UK Safety Group Ltd</td>
<td>03/1999</td>
<td>Footwear manufacturer, Wales. Large history of musculoskeletal injury in workforce caused by poor work design, work organisation, and lack of management controls such as investigation. No risk assessments conducted. Prosecuted: £3000 fine.</td>
</tr>
</tbody>
</table>

2.6 Work-relatedness of MSDs

Trends in the prevalence of specific types of MSDs according to job role or industry sector may be considered reflective of their work-relatedness. Whilst MSDs are common across all industries and job types, evidence has identified certain industries and occupations with particularly high rates of prevalence. In terms of work tasks, for instance, it is generally accepted that heavy physical work involving bending, lifting, or twisting, constitute risk factors for lower back pain (e.g. Waddell & Burton, 2001), whereas both repetitive and static force tend to be related to upper limb disorders (e.g. Buckle & Devereux, 1999). In terms of occupation, WHO (1999) identified miners, farmers, lumberjacks, fishermen, construction workers, warehouse workers, and healthcare personnel, as the most
affected groups worldwide. A similar pattern of prevalence is evident in Great Britain, where the agriculture and construction industries show particularly high prevalence rates of MSDs (around 3.7%), followed by health and social work and manufacturing, with rates of around 2.5% (HSE, 2002). Some similarities are evident in the US, where the highest incidence rate for MSDs is among workers in the service industry, followed by the manufacturing industry (BLS, 2004).

Moving beyond occupation types, a considerable body of evidence is thought to exist in support of associations between MSDs and specific work-related tasks or factors (e.g. repetitive motion, excessive force, non-neutral body postures), including epidemiological reviews (National Research Council, 1998; Bernard, 1997), national surveys (HSC, 2004), experimental studies (Nahit, et al., 2001; Armstrong et al., 1993) and research reviews (Buckle & Devereux, 1999). A review of the epidemiological evidence by NIOSH (1997), however, identified evidence of varying strength for the associations between different work-related physical factors and MSDs, with strong evidence found only for a small number of associations (as shown in Table 4).

Unsurprisingly, due to the complex and interactive nature of MSDs, stronger research evidence tended to support combinations of risk factors. Indeed, the multifactorial etiology of MSDs is well established (Sherehiy et al., 2004; Burton et al., 1997; Armstrong et al., 1993). For instance, biomechanical load from a combination of repetition, force, and posture has found to increase the risk of MSDs affecting the elbow, and specific hand disorders such as carpal tunnel syndrome (Viikari–Juntura & Silverstein, 1999). The varied strength of such associations, however, also highlights the difficulties of identifying these problems as directly work related. Illustrative of this, carpal tunnel syndrome is estimated to be identifiable as work-related in between 43-90% of cases, depending on the setting (Hagberg, 1992).
Table 4. The work-relatedness of musculoskeletal disorders: physical work risk factors (NIOSH, 1997)

<table>
<thead>
<tr>
<th>Body part, risk factor</th>
<th>Strong evidence</th>
<th>Evidence</th>
<th>Insufficient evidence</th>
<th>Evidence of no effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neck/shoulder</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetition</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Force</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posture</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibration</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulder</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetition</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Force</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posture</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibration</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elbow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetition</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Force</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Posture</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Combination</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hand/wrist - Carpal tunnel syndrome</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetition</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Force</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posture</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Vibration</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combination</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tendonitis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetition</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Force</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posture</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combination</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hand-arm vibration syndrome</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibration</td>
<td>✓</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

The specific work factors that have been associated with MSDs are discussed in more depth below, according to three main groups of risk factors outlined by HSE (2002):

- task-related factors (e.g. repetition, awkward and/or static postures, excessive force, long duration of exposure)
- environment-related factors (e.g. vibration, cold temperatures, poor lighting, psychosocial factors)
2.7 Task-related factors

2.7.1 Repetition
Repetition rate is defined as the average number of movements or exertions performed by a joint or body link within a unit of time (Hedge, 1998). A number of studies support the association of repetitive work and MSDs (e.g. Barnhart et al., 1991; Ulin et al., 1990; Arndt, 1987; Salvendy & Smith, 1981). Ulin et al. (1990) for example, found that increasing the rate of screw driving tasks resulted in increased discomfort ratings. Repeated motions performed over a period of time can cause over-exertion or overuse of certain muscle groups, leading to muscle fatigue. Although many variations exist in the literature with regard to the degree of repetition considered to be a risk factor for the development of MSDs, Silverstein et al. (1986) defined highly repetitive tasks as those with a work cycle time less than 30 seconds, or with more than 50% of the cycle time involved in performing the same motion pattern. Kilbom (1994), however, suggests that different frequencies of repetition should apply for different joints in the upper limb; frequencies of more than 2.5 per minute for the shoulder, and more than 10 per minute for the upper arm, elbow, forearm and wrist as high risk. Such ambiguity led Li and Buckle (1999) to suggest that the repetition frequency would be more usefully described by the pattern or manners of movement rather than cycle time. However, it has also been argued that cycle time/repetitiveness alone is not a sufficient predictor of problems (Thompson, 1992), but that stronger associations exist between MSDs and highly repetitive work when combined with high forces (e.g. Armstrong, 1986).

2.7.2 Posture
Posture as an MSD risk refers to the position of a part of the body relative to an adjacent part, measured by the angle of the joint connecting them. MSDs have consistently been linked to poor or non-neutral posture (e.g. Ulin et al., 1990;
McKenzie et al., 1985; Armstrong & Chaffin, 1978), neck problems in particular, due to long durations of sitting, twisting and bending of the trunk (Ariens et al., 2001). Moreover, posture is not only important in relation to the neck and trunk, but poor wrist, elbow, shoulder postures have also been related to MSDs in these areas. Each joint has what is deemed a neutral range of motion, a range that does not require high muscular force or cause undue discomfort. The degree at which posture is considered to become a risk-factor is specific to each joint, determined by the deviation of that posture from what is considered 'neutral'. For instance, Keyserling (1986) identified a neutral trunk posture as within 20 degrees of the vertical, with axial twisting no more than 20 degrees. In addition, work involving forward trunk flexion of over 60 degrees is considered unacceptable (McAtamney & Corlett, 1992; Punnett et al., 1991). Despite this however, some degree of movement is encouraged, as static posture has also been identified as risk factor due to lactate accumulation and muscular fatigue (e.g. Kilbom, 1990).

The effects of bent or twisted postures on sciatic pain have been identified among workers in a number of different occupations (longshore workers, earth moving operators, carpenters, and office workers) (Riihimaki et al., 1989). As with repetition, poor posture becomes a particularly high risk factor when combined with force. In relation to the shoulder, Aaras et al. (1988) found that less than 15 degree median upper arm flexion and 10 degree abduction for continuous work with low loads was associated with increased sickness absence due to MSDs. Similarly, non-neutral wrist and forearm postures and force exertion at the fingertips have been found to increase pressure within the carpal tunnel in a cumulative dose-response manner, if prolonged or involving very high pressure, this can prove potentially irreversible (Viikari-Juntura & Silverstein, 1999).

In addition, the ability to perform other tasks (e.g. lifting, pushing) in awkward postures is also compromised, due to reduced mobility, stability, and balance.
Work involving restricted postures has been found to increase the prevalence rates of low back pain among construction workers (Holmstrom et al., 1992), as well as MSDs of the lower extremity (Lavender & Andersson, 1999). Moreover, the vast majority of ergonomics research has focused on standing or sitting postures (Gallagher, 2005), despite many jobs (e.g. central heating engineers, primary school teachers, plumbers, baggage handlers) involving awkward postures such as kneeling, stopping, crouching, and lying down.

2.7.3 Force

Force relates to the mechanical or physical effort to accomplish a specific movement or exertion (Hedge, 1998), excessive exertion of which has been related to a number of types of MSD, including musculoskeletal problems of the hand and wrist (Silverstein et al., 1986). The risk of force is substantially increased when combined with high repetitiveness (e.g. Moore et al., 1991). As with repetition, what constitutes an acceptable level of force is debatable (Kroemer, 1989), and the risk of lifting loads also depends on factors such as the distance of the load's centre of gravity away from the body. Mital et al. (1993) developed guides of recommended weights which deal with two handed symmetrical lifting, lowering, carrying, pushing and pulling for both males and females, including recommended times for holding loads. However, some consider 4 kg as the lower limit from which a lifted load becomes a significant risk, and pinch grips of more than 1 kg as posing an increased risk of developing MSDs affecting the hand or wrist (Keyserling et al., 1993; Stetson et al., 1991). In terms of how force is linked to the development of MSDs, Hagberg et al. (1995) speculated upon a number of mechanisms. Namely, that high forces may create rupture of tendons and ligaments or damage to muscle tissue, and the application of force over long periods of time may result in permanent fraying of tendons, or the development of contact stresses in nerves.
2.7.4 Duration
Difficulties also exist in the definition of risk according to duration, due to interacting factors while performing tasks. As highlighted by Graves et al. (2004), long task duration may be acceptable for tasks where other factors such as force, repetition, or posture, have minimal influence. A short duration of task may, however, be unacceptable if these other risk factors are present. Following a review of the evidence, Winkel and Westgaard (1992) concluded that support exists for the association of daily exposure times of over 4 hours with increased MSD complaints in the back, shoulder, and neck, particularly for seated tasks such as driving or VDU operation.

2.8 Environmental factors

2.8.1 Vibration
Muggleton et al. (1999) cited the link between vibration white finger and vibration as one of the most firmly established links between occupational diseases and risk factors. This is consistent with the NIOSH (1997) review (see Table 4), which identified strong evidence for the link between vibration white finger and vibration. Vibration has also been found to contribute to a number of other disorders, including carpal tunnel syndrome (Conner & Kolisek, 1986) and rotator cuff tendonitis (Stenlund, 1993). Although it is known that exposure to vibrating tools or equipment at work can lead to permanent nerve injury, the process by which this occurs is not fully understood (Buckle & Devereux, 2002). Alterations to the vascular system of the upper limbs (characterised by whitening of the fingers) as a result of exposure to vibration has been documented (Bovenzi, 1998), and in addition, Lundborg et al. (1990) argued that vibration causes structural damage to the small nerves and damage to the tactile receptors in the hand. Vibration may also impair muscle strength, leading to osteoarthritis (e.g. Stenlund et al., 1992).
2.8.2 Temperature

Working in a cold environment and handling cold objects has also been linked to the development of MSDs (Kroemer, 1989). Cold temperature is thought to act as a risk factor for MSDs both directly, due to the effect of the cold on body tissue, and indirectly, from potential problems caused by personal protective equipment used to alleviate the effects, such as gloves requiring additional grip force (Hagberg et al., 1995). In general, however, evidence for the direct effect of temperature on MSDs is relatively weak (Muggleton et al., 1999).

2.8.3 Lighting

There is thought to be an indirect association between lighting and the development of MSDs (Reynolds et al., 1994). This is likely to arise as a result of poor lighting, shadow, glare, or flickering light, which can encourage workers to adopt bent neck or poor shoulder postures in order to see their work.

2.9 Psychosocial factors

Psychosocial factors are perhaps the factors most rarely tackled in practice (Whysall et al., 2004), despite the importance of these factors having become increasingly evident over recent years, in the academic research community at least. A large body of evidence supports the association between MSDs and psychosocial factors. Recently, for instance, Eriksen et al. (2004) assessed a large sample of health-care workers over a 15-month period, and found that lower back pain symptoms and sick leave associated with these problems were related to both frequent mechanical exposures, and organisational, psychological, and social work factors such as perceived lack or support from superiors. Amongst a sample of newly employed workers in a range of occupations, followed over a period of 24 months, Harkness et al. (2003) found psychosocial factors to be in general stronger predictors of lower back pain than mechanical factors. By using newly employed workers, the results of this study should also be less influenced by the healthy worker effect. Moreover, consistent
with the findings of Harkness et al., Feyer et al. (2000) claimed that whilst the relation between physical load and MSDs has 'often been weak or contradictory... by contrast, association of non-physical factors with lower back pain has been one of the more robust findings in the scientific literature.' (p.116). Ijzelenberg et al. (2004) found strong associations between both physical and psychosocial factors and MSDs, but found absence to be associated with psychosocial factors only.

A range of psychosocial risk factors have been associated with MSDs, pointing to both individual and organisational variables such as cognitive demands, workload, repetitiveness, job control, job satisfaction, role clarity, the pacing of work, organisational factors such as tall vs. flat organisational structures, incentive schemes, communication systems, interpersonal relationships at work, and job prestige. In a review examining the relative contributions of both physical and psychosocial factors, the National Research Council (2001) identified high perceived job demands, job stress, pain coping style, and low perceived job support as the psychosocial factors most frequently associated with work-related ULDs. A subsequent review by Bongers et al. (2002) identified high perceived job stress as the most strongly empirically supported psychosocial factor, but also identified consistent associations between upper extremity problems and non-work-related stress factors (a component not often assessed).

Associations have been identified between MSDs and a range of psychosocial factors, including organisational downsizing, for example (Vahtera et al., 1997). After controlling for age, sex, and sickness absence, MSDs were found to have increased by approximately 6 times following the downsizing. Electronic performance monitoring has also been associated with MSDs (Smith et al., 1992), among telecommunications workers in a number of organisations in the US. Workers who had their performance electronically monitored perceived the work as more stressful, and reported higher levels of tension, anxiety, fatigue, and more general health complaints. A positive association between
musculoskeletal and monotonous work has also been identified (e.g. Ekberg et al., 1994; Hopkins, 1990; Linton, 1990). However, it is difficult to discern whether these results are due to the psychological aspects of monotony, or the physical effects of repetitiveness that tend to equate to monotony. Finally, the availability of social support at work has also been related to a range of musculoskeletal symptoms, as identified by the National Research Council (2001). However, some studies have identified supervisors as the crucial influence (e.g. Linton, 1990), others have provided evidence for co-workers as an important source of social support (e.g. Ryan & Bampton, 1988). Work environments where supervisors are non-supportive of workers, and aggressively pursue production have been found to not only cause psychological stress among workers, but also musculoskeletal problems (Smith et al., 1992). Other studies, however, have found no evidence of an association between MSDs and social support (e.g. Karasek et al., 1987). It is highly likely that the effect of social support, as with other psychosocial and task or environment-related factors, operates as part of a complex interaction, and as a result moderates symptoms in some situations more than others, and for some individuals more than others. A similar situation appears to exist for the role of job satisfaction, as whilst a number of studies support the relationship between job satisfaction and musculoskeletal symptoms (e.g. Hopkins, 1990; Tola et al., 1988), others have failed to find such an association (e.g. Viikari-Juntura et al., 1991). Conflicting findings regarding the relationship between psychosocial factors and low back pain was also identified in a recent review by Hartvigsen et al. (2004). However, this may depend on the types of psychosocial factors assessed. An influential review of the evidence regarding the management of work-related lower back pain (Waddell & Burton, 2000), for instance, identified that although physical demands of work are a risk factor for the incidence of lower back pain, overall, the size of the effect is less than that of other individual, and non-occupational and unidentified factors. Alternatively, strong evidence was found for the role of individual and work-related psychosocial factors in persisting symptoms and disability, response to treatment and rehabilitation. Workers' own beliefs that their lower back pain was
caused by their work, and their own expectations about inability to return to work were found to be particularly important.

Devereux et al. (2002) also found evidence for an interaction between physical and psychosocial risk factors, with workers highly exposed to both physical and psychosocial factors significantly more likely to report MSD symptoms than workers highly exposed to one or the other.

2.9.1 Pathways of influence
The specific route or routes by which psychosocial factors operate to influence MSDs are unclear, a number of different paths having been proposed. Often, psychosocial factors are seen as influencing MSDs indirectly, through the physiological and biological systems. Lundberg (2002), for example, concluded that psychosocial factors may contribute to MSDs by inducing physiological stress and muscle tension. It has also been speculated that psychosocial factors such as mental load and job demands may result in adverse changes in immune system response (e.g. Aptel & Cnockaert, 2002).

The National Research Council (2001) put forward a conceptual model identifying three potential pathways. The first specified that the presence of psychosocial risk factors may cause individuals to perform tasks differently, producing variation in biomechanical loads. The second suggested psychosocial factors may influence individuals’ internal tolerances for the physiological response (mechanical strain and fatigue) to biomechanical loads. Third, psychosocial factors may introduce variation in the experience of pain, impairment, and disability (through different behavioural and cognitive responses). Others have proposed similar theories. For instance, Theorell (1996) suggested that psychosocial factors lead to physiological changes (in adrenaline or noradrenaline, for example) that can cause changes in various tissues of the body, but also through hormonal changes, influencing the perception of pain. The National Research Council model also identifies individual factors as
mediating the effect of workplace factors, possibly explaining why different individuals often respond to the same physical risk factors in different ways.

In contrast to theories such as those outlined above however, Feuerstein et al. (2004) criticised the view of psychosocial factors as 'confounders', or mediators, of the relationship between MSDs and physical work exposures, with psychosocial factors being portrayed as simply introducing noise into the (presumably more critical) relationship between MSDs and physical workplace factors. Instead, Feurenstein et al. argued that psychosocial factors are important independent risk factors, and proposed that the tendency for epidemiological studies to select certain psychosocial factors as control variables has impeded identification of the true complexity of the interactions between psychosocial factors and MSDs, particularly the possibility that some physical factors (e.g. repetition) may be the effect of psychosocial risk factors (e.g. monotony). Findings by Devereaux et al. (2002) are consistent with this notion. In fact, Devereaux et al. argued that psychosocial factors such as poor social support from coworkers and managers, may cause frustration or anxiety, which may in turn actually promote the reporting of musculoskeletal symptoms.

2.10 Additional worker-related differences

Owing to the complex causation of MSDs, identification of the cause-effect relationships between work-related factors and specific problems is extremely difficult, and may partially explain the mixed evidence for certain risk-factors. Some of this variance may also be explained by independent variables, such as gender, age, and workstyle, which have also been found to be significantly related to MSDs. These factors may affect the way that work is performed, and as a result, the amplitude, duration, force exerted, and movements executed in doing so (Buckle & Devereux, 2002), in addition to the extent to which an individual is exposed to risks, and their perception or reaction to psychosocial factors.
2.10.1 Gender

Prevalence rates show that significantly more males reported suffering from work-related MSDs in 2004/05; an estimated 584 000 (58% of reported sufferers) compared to 428 000 (42% of reported sufferers) females (HSC, 2005). However, this should be considered in light of the gender profile of the working population, of which 53% are males, and 47% females (Wilson et al., 2004). However, when looking solely at people working in the last 12 months, incidence rates for males and females are similar. This could relate to the increase in the proportion of working women over time, due to their increased exposure to risk factors in the workplace. Additionally, some experimental studies have identified higher prevalence of musculoskeletal complaints among female workers (de Zwart et al., 2001; Zetterberg & Ofverholm, 1999; Bergqvist et al., 1995).

The reason for such gender differences remains a matter of debate. Although it has been argued that women may be simply more susceptible to MSDs than men due to biological differences in size, muscular capacity, and anaerobic capacity, the evidence for such differences is mixed (e.g. Strazdins & Bammer, 2004; Messing & Kilbom, 1998), and could be confounded by a number of factors. For example, women are thought to be between two and five times more likely to report having experienced such problems than men (Ariens et al., 1999; LeResche, 1999). Alternatively, exposure to risk factors could differ greatly between a woman in full-time employment and a man in full-time employment, due to the enduring gender imbalance with regard to domestic and parental activities, for instance (Hunt & Annandale, 1999). As a result, women may be exposed to additional risk factors through these non-work related activities. Indeed, Strazdins and Banner (2004) found motherhood to be significantly related to having less time to relax or exercise, whereas fatherhood did not appear to greatly influence men’s time. Differences in exposure to risks are likely to exist not only in the home, but also in work roles and conditions. A woman’s work role has been found to be more likely to involve physically repetitive work demands (Strazdins & Bammer, 2004), which Strazdins and Bammer argue is
because women still tend to be clustered in lower status jobs; typically sedentary or repetitive roles, with less control over their work, and little task variation. This could be related to the time constraints imposed by motherhood, resulting in more women adopting casual or low-skilled jobs (Webster, 1996). The argument for differences in the qualitative nature of work performed by men and women is supported by statistics showing that the types of problems most commonly experienced by men and women are qualitatively different. Around 48% more cases of musculoskeletal conditions affecting the hand, wrist, or arm (excluding Raynauds, hand-arm vibration, and vibration white finger) were reported for women than men. Males on the other hand, were reported to experience more conditions affecting the lumbar spine or trunk, and lower limbs than females, in the period 1998-2003 (HSC, 2003).

Dahlberg et al. (2004) concluded that the higher prevalence of MSDs among women than men was due to a combination of higher workload both at work and in the home. Women tended to be at higher risk in the workplace, working more frequently and for longer periods with their hands above shoulder height than men, due to the workplace design, but women also spent more time performing household duties than men, resulting in a higher total workload in both paid and unpaid work. De Zwart et al. (2001), however, found no evidence for the higher risk among women being due to gender segregation according to occupation type. The explanation presented by de Zwart et al., among others (e.g. Karlqvist et al., 1999; Morse & Hinds, 1993), is that further inequalities exist due to the fact that both the tasks performed, and the equipment used in the workplace, are typically designed for men, without taking into account differences in women’s build or physiology. In conclusion, although it could be argued that women are simply more vulnerable to these types of disorders than men, due to biological or physiological factors, evidence for such a link appears to be questionable (Strazdins & Bammer, 2004). Instead it seems that the gender gap is more likely to be explained by women’s greater exposure to risk factors, either in the workplace alone, or in both the workplace and the home.
2.10.2 Age
As with ill health in general, evidence exists to support the relationship between older age and increased prevalence of MSDs, for both men and women (e.g. Cassou et al., 2002; Leclerc et al., 1999; de Zwart et al., 1997; Hildebrandt, 1995; Putz-Anderson, 1988). However, due to the difficulties associated with longitudinal studies, such research tends to be cross-sectional in design. A cross-sectional design such as that used by Hildebrandt, is vulnerable to the “survivor bias”, due to the increasing severity of problems as effects cumulate over time, combined with a high physical workload, resulting in fall-out from the sample in the older age categories (through sickness absence, disability, or choosing to leave the job), leaving those older workers that are still able to perform their tasks. As a result, work-related problems may be underestimated in the older age groups. This could explain the trend found by Hildebrandt (1995) that the prevalence of MSDs among male workers increases until the age of 54, but then begins to decline between the ages of 55-64.

A number of reasons can be speculated for the typical increase in MSDs prevalence with age. First, the ageing process involves related biological changes, such as the degeneration of intervertebral disks and general wear and tear, which may contribute to the onset of MSDs. As a result, overload experienced due to the mismatch between physical workload and physical capacity over time, has been identified as a potential link between MSDs and age (e.g. de Zwart et al., 1995). As described in relation to the ‘survivor bias’, older workers are likely to have spent more years in service, and as a result, have experienced greater exposure to MSD risk factors. Dieppe (2006), on the other hand, argued that socio-economic factors are key determinants of chronic bone and joint disorders. Consequently, Dieppe argued that such problems are more common among older people (in addition to women and other more marginalised groups in society), due to the influence of socio-economic factors (including geographic location) on access to optimal healthcare.
A review of the factors associated with musculoskeletal problems in epidemiological studies (Malchaire et al., 2001) revealed that for MSDs of the neck/shoulder region, age was found to be an associated factor in only 40% (14 of 36) studies. For disorders of the hand/wrist, was found to be an associated factor in only 8 of 30 studies. In a study of over 3000 workers over a 15 month period, Devereux et al. (2004) identified age as associated with self-reported shoulder pain and self-reported elbow/forearm pain. Jensen et al. (2002) found age to be associated with symptoms in the neck and hands/wrists in computer users, although the difference was observed when comparing the youngest age group (<30 years) with the other three age groups (30-39, 40-49, and >50). As mentioned, it is possible that these findings may be affected by the fall-out of older workers experiencing problems from the workforce, and transferring into other jobs perceived to be less physically demanding. Alternatively, this may be indicative of a habituation effect, whereby older workers have developed more effective strategies for performing tasks, or for coping with problems. Indeed, it has been argued that this is particularly common among nurses suffering from back pain. Due to the issue of the ageing population, it is becoming increasingly important to clarify the relationship between age and MSDs, and to develop strategies to combat the increasing prevalence of MSDs amongst older workers. A small number of studies, however, have found MSD symptoms to be more common among younger workers (e.g. Ong et al., 1991, with VDU operators; Skovron et al., 1987, with nurses).

2.10.3 Workstyle
It must also be considered that with regard to many of the risk factors described above, the effects of a given risk will be modified by the behaviour of the worker undertaking the tasks. Workers conducting the same tasks, using the same equipment, often perform work tasks differently (Occupational Safety & Health Administration - OSHA, 1991; Kilbom et al., 1986). For instance, if a worker adopts non-optimal techniques, or fails to follow best practice procedures when using tools, lifting objects, or manipulating materials, it is more likely that poor
postures, excessive repetitions, excessive force, or excessive tool gripping forces could result. The adoption of non-optimal procedures or habits is not only well-documented in many workplaces, but has also been identified as a risk factor for MSDs (Feuerstein et al., 1999; Feuerstein, 1996; Grandjean et al., 1983; Armstrong et al., 1982).

As remarked by Hagberg et al. (1995), the adoption of non-optimal procedures or techniques may be prompted by a variety of factors, including poorly designed workplaces, tools, or work task methods, inadequate training, worker preference for the alternative method, or perceived work pressure. Feuerstein et al. (2004) also suggested that workstyle may also be influenced by individuals' cognitions resulting from increasing work demands, including perfectionism, perseverance, and fears of making errors – cognitions that they suggest may also be directly related to MSDs. Furthermore, the adoption of adverse workstyles is thought to exacerbate problems by initiating a feedback loop, whereby the experience of symptoms can limit workers' functioning at work and alter workers' reactions to work demands, further increasing their exposure to both physical and psychosocial stressors, thereby encouraging the maintenance of adverse workstyles (Feuerstein et al., 1999; Feurestein et al., 1997; Feuerstein, 1996).

2.10.4 Previous history of MSDs
A final consideration in terms of MSD risk factors, is a previous history of MSDs. Those returning from sickness absence following illness or injury (particularly work-related MSDs), are likely to be less able to cope with the demands of work on their return. As a result, interventions to modify work have been identified as a key factor in facilitating the re-integration of these individuals back into the work environment (van Duijn et al., 2004; Elders et al., 2000).
2.11 Causation

Although the risk factors discussed above are presented individually, their effects on an individual’s experience of MSDs are interactive. Many theorists have proposed models aimed at capturing the multifactoral nature of MSDs, and the ways in which risk factors may act or interact to bring about MSDs. Typically, these specify a dose-response relationship between the strain on the body and the outcome (MSD). Armstrong et al. (1993), for example, claimed that external work requirements produce an internal dose (e.g. tissue loads, metabolic demands, etc), which triggers a physiological response. Within this model, an individual’s capacity to withstand and react to external demands is considered an effect-modifying factor. A more complex depiction of the dose-response relationship was presented by Kumar (2001), who proposed a multivariate interaction theory of musculoskeletal injury precipitation, involving genetic, morphological, psychosocial and biomechanical factors, as outlined in Figure 5). Kumar cites a number of specific theories that could explain how injury occurs. The first reflects differential fatigue theory, which reasons that during occupational tasks, muscles and joints are not employed equally, or for equal periods of time, as the tasks are not generally designed to optimise biological functioning, but rather production demands. As a result, in the short-term this introduces different levels of fatigue on the different muscles and joints, which in the long-term can result in the movement and loading patterns of joints developing in ways that are different from the natural, or optimal patterns (Kumar & Narayan, 1998). Cumulative load theory, on the other hand, centres on the notion that all biological tissues have a finite life span, and as they are subject to wear and tear through repeated and prolonged usages, undergo potentially permanent degradation. Repeated loading of tissues is also thought to result in cumulative fatigue, reducing their stress-bearing capacity, and the threshold at which they fail, a view concordant with the National Research Council (1999). Indeed, evidence of both biomechanical load and exposure time over working life supports an association between cumulative load and lower back pain (Kumar,
Figure 5. A multivariate interaction theory of musculoskeletal injury (Kumar, 2001)
1990), and of the association between force and fatigue failure of the lumbar spine (Brinckmann et al., 1987, 1988). However, as discussed in previous sections, the link between biomechanical loads and MSDs is highly complex, involving many other factors relating to both the individual and their environment. It is clear that not all individuals exposed to biomechanical loads develop problems. Individual differences are to some extent acknowledged in the final explanation postulated by Kumar, the theory of overexertion, assumed to apply when physical effort exceeds the tolerance limit of the body, in terms of force, duration, posture, and motion. This reflects the Cinderella Theory (Hagg, 1991), which specifies that during sustained manual work, short time intervals with a totally relaxed muscle are essential to relieve the muscle, a notion that has since received further support (Hagg & Astrom, 1997; Veiersted et al., 1990). Kumar (2001) argued that problems may occur as a result of events from any of the theories outlined above.

In addition to the biomechanical, physiological and structural changes that can lead to musculoskeletal pain, the conceptual model proposed by Kumar (shown in Figure 5) also identifies genetic, morphological and psychosocial factors as influencing an individual's musculoskeletal system. Inclusion of the psychosocial profile is intended to reflect that problems are not necessarily entirely underpinned by physical causes. However, the influence of psychosocial factors is depicted as indirect, via the biological route of the musculoskeletal system. As a result therefore, although the model is portrayed as reflecting a biopsychosocial approach, it could be argued that it remains a largely biologically oriented model, not fully acknowledging the potential direct influence of psychosocial factors. As discussed in Section 2.8, others have argued that psychosocial factors can influence an individuals' experience of MSDs more directly (e.g. Feuerstein et al., 2004). Kumar's model is also linear in nature, neglecting the influences of feedback and reinforcement on individuals' perceptions of, and reactions to, both physical and psychosocial risk factors.
Smith and Carayon-Sainfort (1989) aimed to integrate the psychological and environmental aspects of work in their 'balanced model of a work system' (see Figure 6), with work tasks, technology, the environment, and organisational conditions interacting to collectively influence worker health and well being. Although the model presented in Figure 6 can be criticised in terms of its ambiguity and vagueness, the theory describes poorly designed aspects of the workplace as producing a 'stress load' on the individual. This stress load is thought to have both physiological and psychological effects such as biomechanical loading of muscles or joints, or adverse psychological mood states. The extent of the stress load is believed to be moderated by an individual's perception of the job demands, which are in turn influenced by the objective properties of the work, the individual's personality and past experience, and the social environment at work. As a result, it is speculated that an individual's negative perceptions of their work can lead to both psychological and physiological strain, both of which can result in physical problems such as MSDs.

Figure 6. A balanced model of a work system (Smith & Carayon-Sainfort 1989)

More recently, Karsh et al. (2001) put forward a model specifically describing MSD causation, in which psychosocial factors relating to work organisation are portrayed as having a direct influence on the individual, irrespective of physical demands (as shown in Figure 7). Similarly to the approach advocated by Smith and Carayon-Sainfort, this model illustrates that both the tasks and technologies
available affect the nature of the work and the demands required to carry out the job. However, Karsh et al. also go on to specify that the organisational structure and work environment will define the nature and level of individual involvement, workload, working hours, and levels of interaction and control, which all combine to define the load exerted on an individual, and if exceeding the individual's capacity to deal with these loads, can result in a misfit leading to musculoskeletal strain. Emphasis of the interactive nature of physical, environmental, organisational, and psychosocial risk factors is an important feature of the model, as it acknowledges that physical work characteristics, such as repetition, may be inherently interlinked with psychosocial factors. For instance, repetition is often measured by task cycle time, which is also likely to be closely related to time pressure, perceived job demands, low job control, low decision latitude, and high monotony.

Figure 7. MSD causation (Karsh et al., 2001)

Regardless of the pathways by which psychosocial factors may influence the development of MSDs, the approaches described above serve to highlight the complex causation of MSDs, and the importance of taking a broad view of
potential antecedent factors for MSDs, particularly regarding the potential role of psychosocial influences in the effective prevention of MSDs.

2.12 Approaches to prevention

This section will briefly describe the range of approaches that can be adopted to tackle MSDs, which relate to the work tasks, technology, work environment and work organisation. In order to guide the implementation of interventions to tackle such factors, both NIOSH (1997) and HSE (2002) produced integrative frameworks depicting the key elements of an effective programme for preventing MSDs, or in the case of the HSE, upper limb disorders (ULDs). Both combine approaches to tackle the organisational, psychological, and physical elements, as depicted in Table 5.

Table 5. NIOSH and HSE frameworks for preventing MSDs

<table>
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<tr>
<td>1. Look for signs of potential musculoskeletal problems in the workplace</td>
<td>1. Understand the issues and commit to action</td>
</tr>
<tr>
<td>2. Set the stage for action (management commitment, employee participation)</td>
<td>2. Create the right organisational environment</td>
</tr>
<tr>
<td>3. Training – building in-house expertise (worker ability to evaluate potential musculoskeletal problems)</td>
<td>3. Assess the risk of ULDs in the workplace</td>
</tr>
<tr>
<td>4. Gather and examine evidence of MSDs</td>
<td>4. Reduce the risks of ULDs</td>
</tr>
<tr>
<td>5. Identify effective controls (and evaluate their effectiveness)</td>
<td>5. Educate and inform the workforce</td>
</tr>
<tr>
<td>6. Establish health care management (emphasise early detection and treatment)</td>
<td>6. Manage any episodes of ULDs</td>
</tr>
<tr>
<td>7. Create proactive ergonomics program (accent on prevention)</td>
<td>7. Carry out regular checks on programme effectiveness</td>
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In terms of the aspects in the middle of these programmes, a range of ergonomics control measures have been implemented in organisations to reduce the risks of MSDs, from workstation redesigns, changes to working methods/procedures, introduction of assistive devices, tool redesign, training, organised exercise, and personal protective equipment to reduce exposure. These methods can be classified into 3 main categories:

- **Physical/engineering controls**
  Engineering (or physical) controls are considered the preferred types of approach to reducing the risks of MSDs (HSE, 2002; NIOSH, 1997). Examples of such controls include attention to workstation design and layout and the tools and equipment used to perform the job. The implementation of adjustable tables and realignment of controls to improve postures are specific examples.

- **Administrative controls**
  Changes in work practices and management policies are also thought to reduce the risks of MSDs, often with the aim of reducing the duration of exposure to risk factors. Administrative controls can also help to reduce psychosocial risk factors such as highly monotonous work, or excessive cognitive demands. For instance, changes in job rules and procedures can include the introduction of rest breaks, reduction in working hours, job rotation, role diversification, adjustments to the pacing of work.

- **Personal equipment**
  Personal Protective Equipment (PPE) is defined in the Personal Protective Equipment at Work Regulations (1992) as 'all equipment (including clothing affording protection against the weather) which is intended to be worn or held by a person at work and which protects him [or her] against one or more risks to his [or her] health or safety.' A variety of types of personal equipment can be introduced into the workplace with the aim of reducing the risks of MSDs. In the office environment, for instance, cushioned wrist rests are often provided with the
aim of alleviating wrist pain. Back belts have been implemented as a means of protecting workers’ backs when performing heavy lifting and handling, and gloves for reducing the impact of vibrating equipment or cold temperatures, for example. The effectiveness of such controls, however, is mixed, as discussed in the following section. PPE should not be used as a substitute for engineering, and/or administrative controls to prevent exposure to MSD risk factors, although can work in conjunction with such preventative measures or when such controls are not possible.

In addition to these three main areas, is training. Whilst training is generally considered an important element for any health and safety programme (e.g. Colligan, 1994), the HSE (2002) argue that training should not be relied upon as the primary means of controlling MSD risks. However, evidence does suggest that training can effectively facilitate the implementation of other ergonomics changes (McKenzie et al., 1985). Green and Briggs (1989), for example, found that failure for the introduction of adjustable workstations to significantly reduce MSDs, could have been due to a lack of information given to workers using the equipment.

2.12.1 Participation

In more generic terms, the adoption of a participatory approach to ergonomics has, for the past decade or so, been cited as a means for improving the effectiveness of ergonomics interventions (e.g. Evanoff et al., 1999; Haims & Carayon, 1996; Gjessing et al., 1994; Noro & Imada, 1991). Participatory ergonomics refers to workers’ active involvement in the implementation of ergonomics knowledge and procedures aimed at improving their working conditions, supported by their supervisors and managers (Nagamachi, 1995). Wilson and Haines (1997) defined this approach as “the involvement of people in planning and controlling a significant amount of their own work activities, with sufficient knowledge and power to influence both processes and outcomes to achieve desirable goals.” (p. 492). Participation can be achieved through a
variety of methods, including quality circles, labour-management committees, and self-managed work teams (Gjessing et al., 1994).

2.13 Effectiveness of interventions

2.13.1 Initial considerations
Due to the many and varied approaches that exist for tackling MSDs, it is appropriate to evaluate evidence for the effectiveness of these interventions, and to determine the components that make interventions effective. This need is further highlighted by the ongoing prevalence of MSDs. As argued by Douillet and Aptel (2000), despite being a priority area across Europe, the reduction of MSDs is 'making slow progress'. However, relatively few such intervention studies have been published (NIOSH, 2001), and a large proportion of those that do exist describe office-based interventions, neglecting the many other industries within which MSDs present significant risks. It is possible that the predominance of office based-interventions is at least in part due to the tighter control that can be exerted within these environments. It is also suggested that many occupational health interventions are unsuccessful, and because of this, are not reported in journals (Briner & Reynolds, 1999).

A large proportion of the studies that are published describe multi-component interventions, making it difficult to identify the specific variables that are fundamental to their success or failure. Furthermore, such studies tend to measure reductions in biomechanical risk factors such as posture angles, without any investigation of workers' actual symptoms (e.g. Mirka et al., 2002; Johansson et al., 1998). Due to the complex relationship between exposure to risk factors and the experience of symptoms, reduction of physical risk factors does not necessarily equate to a reduction in symptoms. As a result, the individual's subjective experience of MSD symptoms appears to be an important criterion.
The following sections evaluate the evidence for specific interventions to tackle MSDs (engineering controls, administrative controls, personal protective equipment and training), followed by a number of reviews involving a range of multi-component studies.

2.13.2 Engineering controls

Despite being the recommended approach to tackling MSDs (HSE, 2002; NIOSH, 1997) evidence for the effectiveness of engineering controls is mixed. Keyserling et al. (1993), for instance, evaluated the effectiveness of a programme of ergonomic interventions to improve trunk, shoulder, and neck postures within the manufacturing industry. The specific changes implemented ranged from the installation of lift tables and elevated racks to raise objects off the floor, elimination of horizontal obstructions (e.g. moving guard rails) to reduce reach distances, and the reduction of overhead reaches by lowering the height of items (e.g. storage shelves, monorail conveyors). Changes were generally effective in reducing awkward trunk and shoulder postures, although not awkward neck postures (which actually increased). Symptoms were not assessed in this study, however. Smedley et al. (2003) evaluated the introduction of lifting and handling equipment (including hi/lo baths, hoists, sliding sheets and transfer belts) in a UK hospital, aimed at reducing back pain among nurses. No reduction in the prevalence of symptoms had occurred 32 months following the changes.

Mixed findings also exist for interventions within the office environment. Aaras et al. (1999) evaluated the effects of an ergonomically designed mouse for office workers, and found a significant reduction in the intensity and frequency of wrist/hand, forearm, shoulder and neck pain compared to a control group using the traditional mouse, 6 months post-implementation. With any intervention, however, consideration must be given to the potential influence of a Hawthorne effect, although it may be argued that the period of 6 months is sufficient time for any such effects to have dissipated. Rempel et al. (2006) on the other hand, found significant reductions in neck/shoulder pain and right upper extremity pain
among call centre workers provided with forearm supports, compared to a control group without supports, 12 months following implementation. Aaras et al. (1998) also conducted a two-part study of visual and musculoskeletal discomfort incorporating a longer-term follow-up. The redesign of office workstations to support workers’ forearms resulted in a significant reduction in shoulder pain, but no significant changes in forearm and hand pain, two years post-intervention. Six years following the intervention, only one of the two experimental groups still showed a significant reduction in shoulder pain (Aaras et al., 2001), suggesting that these were only relatively short-term improvements (and potentially also related to the Hawthorne effect). Conflicting evidence also comes from Rempel et al. (1999) and Tittiranonda et al. (1999), who examined the efficacy of 6 different keyboards on reduction of complaints. Whilst Rempel et al. reported positive results in pain reduction in 12 weeks, Tittiranonda et al. found no significant differences between keyboards over a 6 month study period. Focusing solely on the keyboard, the interventions conducted by Rempel et al. and Tittiranonda et al. (and to some extent, those of Aaras et al. described above) may be considered too limited, neglecting the many other risk factors that may be present within an office environment. However, other more extensive office interventions have also failed to generate significant effects. Gerr et al. (2005), for instance, conducted an evaluation of office re-design, and re-design with postural training, compared to a control group receiving no intervention. No significant differences were found in the incidence of musculoskeletal symptoms among these three groups. Interestingly, Gerr et al. noted that compliance with all components of the intervention was attained for only 25-38% of individuals. This may be an important barrier to the effectiveness of interventions.

Ergonomics interventions have also been suggested as offering the potential for improving worker productivity. Improvements of the physical ergonomics working conditions within a call centre however (including workstation ergonomics analyses, customised adjustments for each worker, specific workstation accessories to improve worker fit if needed, and improved chairs), resulted in
improved worker performance for 50% of participants, and decreased performance for 50% (Smith & Bayehi, 2003). The authors concluded that individual differences need to be considered when making ergonomics improvements for productivity enhancement. Indeed, the limited success of engineering intervention studies focusing only on the 'physical' risk factors may be due to the role played by psychosocial variables in the onset of MSDs, this may be because these studies have failed to tackle the 'administrative', or work organisation factors (e.g. Bigos et al., 1991).

2.13.3 Administrative controls
Few studies have evaluated the impact of administrative controls in isolation from other changes, perhaps as they rarely are implemented in isolation from other forms of intervention (e.g. engineering controls or training). This is consistent with the findings of NIOSH (2002), that “the scientific literature provides relatively few examples of occupational safety and health interventions that feature the reorganisation of work.” (p.19). One of the few such studies that do exist reported an evaluation of the effects of implementing job rotation in a number of manufacturing organisations (Jonsson, 1988). Improvements were observed in EMG measurements of shoulder and back muscles, more notably in relation to dynamic heavy-duty tasks rather than light-duty tasks. Furthermore, Jonsson did not assess reported symptoms, and as previously discussed in relation to the complex causality of MSDs, biomechanical strain is neither a necessarily nor sufficient determinant of an MSD. In a study of the design of check-out stations, Hinnen et al. (1992) found that job rotation had a beneficial impact on the prevalence of MSD symptoms in cashier work using barcode scanners. Obviously, however, firm conclusions of the effectiveness of job rotation as a method of reducing MSD symptoms cannot be made on the basis of such limited evidence. Indeed, the scarcity of studies evaluating the effect of job rotation on MSD complaints was recently highlighted by Kuijer et al. (1999), who evaluated the implementation of job rotation among refuse collectors (rotating between collecting two-wheeled containers and driving a refuse van). However, Kuijer et
al. found those groups rotating between tasks had more than two times higher risk of low back complaints, and rotation had no effect on sickness absence. However, the authors speculate that the failure for the intervention to have a significant beneficial effect on back complaints within this sample may be because the rotation had no effect on the peak mechanical loads for the two tasks, only the cumulative load. A second possibility is that the rotating workers were exposed to whole body vibration as a result of driving the van, which is also a potential risk factor for MSDs, as discussed. Clearly, more studies are needed to confirm the effects of job rotation on MSD symptoms.

2.13.4 Personal protective equipment
A number of different types of personal protective equipment have been proposed for the reduction of MSDs (e.g. wrist supports, neck rests, foot rests, back belts, gloves). Evidence for their effectiveness, however, is mixed. Following a review of evidence for the effectiveness of lumbar supports (commonly referred to as back belts) in the prevention of back pain for example, Linton and Tulder (2001) concluded that strong evidence exists to suggest that they are ineffective in preventing such problems. One of the studies involved in this review examined the effectiveness of back belts among 60 healthcare workers, who wore the belts at work for 3 months. Neither work-related back injuries nor workers’ perception of physical strain differed significantly between those wearing the belts and the control group (Alexander et al., 1995). It could be speculated, however, that 3 months is not a sufficient period of time to reliably evaluate the effects of the equipment, although other studies reviewed by Linton and Tulder, with longer evaluation periods reached the same conclusion. Furthermore, in a randomised controlled trial, Reddell et al. (1992) not only evaluated the use of back belts, but also the use of back belts in combination with a training session on spine anatomy and body mechanics, in reducing back problems. Neither group demonstrated any positive outcomes in terms of back injury incidence rate, lost work days, or workers’ compensation rates. Similarly, van Poppel et al. (1998) found no significant effects of back belt use combined
Finally, in a prospective cohort study, Wassell et al. (2000) found no significant differences in either back injury claim rates or self-reported back pain among workers in the retail industry who wore back belts every day and those that never wore back belts over a two-year period. A number of reasons can be speculated for the failure for back belts to demonstrate any significant benefits. As argued by Dorinson et al. (2001), it is not yet known whether back belts actually give any external mechanical support, and furthermore, the belts are often loosely worn, not properly buckled to give any mechanical support, and rarely are workers given any instruction about the reasons for the back belt or how to use it properly.

Other types of personal protective equipment supported by a stronger evidence base are vibration attenuation gloves (NIOSH, 1989), and knee pads for carpet layers (Bhattacharya et al., 1985). However, the use of gloves for reducing hand-arm vibration appears to only attenuate the vibration of tools with vibration frequencies above the British standard weighting recommendation (Griffin, 1998). Additional evidence for the effectiveness of PPE is discussed below, in relation to empirical reviews of the evidence for MSDs interventions.

2.13.5 Training
Evidence regarding the effectiveness of training is also mixed, some studies finding no positive effects of training on musculoskeletal symptoms (e.g. Morken et al., 2002; Lagerstrom et al., 1998; Daltroy et al., 1993; Feldstein et al., 1993). St-Vincent et al. (1989), for example, found that manual handling training has often been unsuccessful in changing workers' lifting techniques. However, such evidence may be confounded by the finding that the period of delay between training interventions and follow-up can have important implications on outcome effectiveness (Faucett et al., 2002). Faucett et al. found that ergonomics training to prevent MSDs resulted in improvements in workers' symptoms at 6 weeks, but symptoms had returned to baseline by thirty-two weeks. Training to reduce muscle tension had no effect at six weeks, but at 32 weeks symptoms among this
group had worsened. Such findings are consistent with the recommendation that training is provided as supplementary to other engineering or administrative changes (HSE, 2002). Further reinforcing this, King et al. (1997) demonstrated that lecture-based training alone had no significant effects upon risk knowledge, and in fact increased job dissatisfaction among factory workers within the manufacturing plant in question. However, when the training was accompanied by ergonomics job redesign, knowledge of the risks significantly improved. No significant differences were found in either group according to satisfaction with human factors elements of their jobs, and musculoskeletal symptoms were not assessed.

Training is thought to be a crucial component in the prevention of MSDs by increasing workers' knowledge of the risks and how they can be avoided, as reflected by the HSE's (2002) recommended management cycle, which highlights the importance of educating the workforce in the effective management of MSDs. Green and Briggs highlighted the importance of training supervisors in addition to workers, to ensure that they are able to identify and encourage 'healthy' habits among workers. Better information flow is also thought to improve the speed at which ergonomics interventions are adopted in practice (Chapman et al., 2003). Indeed, worker training has also been found to be effective by generating discussion between workers and management about the risks and suggestions for improvement (Wands & Yassi, 1992). Luopajarvi (1987) made a number of suggestions for improving the effectiveness of training, including an emphasis on active participation as opposed to passive listening, and 'learning by doing', vocational training in real work environments, training that is tailored to the individual’s specific abilities, needs, and problems, positive reinforcement and feedback, integration of audiovisual methods, and the adoption of workers as trainers.
2.13.6 Reviews of intervention effectiveness research

A number of reviews have been conducted aimed at evaluating evidence for the effectiveness of interventions to tackle MSDs. Karsh et al. (2001), for example, analysed 101 intervention studies to control MSDs in the workplace, including the implementation of personal protective equipment (PPE), ergonomics and/or lifting training, assistive tools or technologies, exercise interventions, job redesign, and multiple intervention components. According to Karsh et al., the majority (84%) produced mixed results. For instance, one of the studies reviewed reported positive results following ergonomics posture training, but no improvements following the use of a new tool or exercise training aimed at reducing the risks of upper extremity problems (Melhorn, 1996). Another found that a one year back injury programme involving health risk assessments, education, and training in back safety, was related to reductions in back pain prevalence, but did not affect workers’ reports of daily or monthly pain (Shi, 1993). Karsh et al. concluded that the most effective type of interventions were multi-component interventions.

A similar conclusion was reached by Lincoln et al. (2000), following an examination of 24 studies involving engineering controls, administrative controls, and a range of multi-component interventions. The most promising evidence was found for the multi-component interventions, these being most commonly associated with reduced incidence of upper extremity disorders. One such study, for example, reported an effective intervention to tackle back pain in the metal industry, combining risk education, advice on ergonomic working techniques, and physical changes to the workplace aimed at reducing biomechanical strain. Biomechanical evaluation of the work tasks showed the tasks to have improved, and sick leave due to low back disorders fell from 3.1 to 1.9 days on average per person per year (Wickstrom et al., 1993). Wickstrom attributed the study to the multi-faceted approach adopted, reasoning that due to the large number of factors thought to be involved in the causation of low back disorders:
'we considered it very uncertain whether we would be able to achieve any measurable effects by applying only one or a few approaches.' (p.31)

The reason for the success of multi-component interventions is unclear, however, as it is difficult to determine the impact of any single element (e.g. Demure et al., 2000). As a result, it could be argued that the multi-component approach essentially reflects a trial and error approach. Alternatively, participation was also common to most multi-component interventions reviewed by Karsh et al., and could be the reason for their success rather than the specific components of the interventions per se. In light of such criticisms, Karsh et al. proposed that multi-component interventions should be evaluated in terms of the extent to which each specific component meets its goal. For instance, whether lifting aids improved postures and reduced loads borne by individuals, whether training increased employees' knowledge of the risks and risk reducing methods, and whether exercise increased employees' strength and/or flexibility. The importance of such specificity is highlighted due to the fact that the success of interventions depends substantially on the outcomes against which success is measured. As a result, Karsh et al. suggested that different types of interventions should be carefully selected according to injury and hazard surveillance and analyses of the specific jobs to be targeted.

A third review, by Konijnenberg et al. (2001) questioned the effectiveness of both individual and multi-component interventions. This review evaluated 15 studies providing evidence for a range of interventions including physiotherapy, exercise, behavioural therapy, the use of an energised wrist splint, component rehabilitation, chiropractic treatment, and the introduction of ergonomic keyboards. Konijnenberg et al. concluded that 'there is no strong evidence for the efficacy of any of the forms of intervention', although emphasised that this does not imply that there is strong evidence that such interventions have no effect.
Westgaard and Winkel (1997) reached a similar conclusion in their review of 92 studies of interventions for improved musculoskeletal health. Although some studies yielded positive results, the authors of the review claimed that all were methodologically flawed, and consequently could not be relied upon as supporting evidence. Criticisms included the lack of control groups, insufficient delays between intervention and follow-up, and the neglect of psychosocial influences. Indeed, Morken et al. (2002), provided support for this claim, finding no effects of training when post-event evaluations were undertaken immediately after the intervention, an outcome that they speculated was due to insufficient latency periods. A number of researchers have also noted that musculoskeletal symptoms may not be immediately reduced by measures such as new working techniques (e.g. Linton & van Tulder, 2001; Lagerstrom et al., 1998; Berg et al., 1988), suggesting that studies with short-term follow-up periods may be inappropriate for assessing intervention effectiveness. Further criticisms regarding the methodology of evaluation studies were put forward by Volinn (1999), who argued that any workplace intervention study can be seen as effective if taken at face value, and held methodological problems as the reason why interventions of seemingly different principles can also be found to be consistently successful.

Despite these criticisms however, the difficulty of conducting randomised control studies in applied settings should also be acknowledged. As recognised by Karsh et al., companies that are sufficiently accommodating to permit research to be conducted within their workplace, may be reluctant to consent to the use of a control group, due to the ethical and practical (financial) implications of not providing some employees with the expected benefits of interventions. Whether or not this is the case, even where control groups are established, it is often difficult to isolate these individual from the influence of new information, knowledge, or physical workplace changes (e.g. Morken et al., 2002). Other potential contributors to the lack of empirical support include the difficulty of demonstrating effectiveness in occupational settings due to problems such as
sample size, rapid turnover, and multiple simultaneous interventions, and the complex causality of MSDs, meaning that risk factors are heavily interdependent (Hagberg et al., 1995).

In light of the mixed evidence for the effectiveness of interventions to tackle MSDs, and the tendency for seemingly identical interventions for tackling MSDs to be effective in some instances but not in others, Karsh et al. argued that future efforts to explore the effectiveness of interventions may be more valuably focused on the intervention process itself. In the words of Karsh et al.,

'...study of the implementation process is crucial both for our understanding of future research results and for understanding the variance in outcomes...' (pp.89-90)

Following their review of intervention studies, Westgaard and Winkel proposed that the implementation process could be optimised by the adoption of a two part strategy. The first involves the implementation of measures to tackle both physical and psychosocial risk factors, in the presence of highly committed stakeholders. It is argued that this should then be followed by the implementation of specific 'modifier' interventions to tackle specific problems relevant to the individuals at risk, including methods such as physical training or active training in work techniques. The effectiveness of the two strategies is strongly determined by the level of active involvement and participation of both the individual workers at risk and other key stakeholders in the organisation.

The varying effectiveness of training may also depend on the way in which it is implemented, in addition to the characteristics of the workers. For example, the training needs of new employees are likely to differ from those of experienced workers. In support of this, Parenmark et al. (1988) found that ergonomics training for assembly workers reduced sick leave among new workers, but not among the more experienced workers. The authors suggested that more
experienced workers had developed habits that were more resistant to change, thereby highlighting the importance of initial training for new employees in preventing MSDs. Indeed, literature regarding workstyle (see Section 2.10.3) is also consistent with this notion.

2.13.7 Participative approaches

Participation has been identified as an important component in the effective implementation of interventions. The benefits of involving employees more fully in organisational operations have been identified by research in the fields of ergonomics, organisational psychology, and management (e.g. Wilson & Haines, 1997; Nagamachi, 1995; Cascio, 1991; Schermerhorn et al., 1985). Reflective of this, HSC (2004) highlighted worker involvement and consultation as a key element in their “Strategy for workplace health and safety in Great Britain to 2010 and beyond”. As stated in this report:

“...an organisation's greatest asset is its workforce. Employees are often best able to spot issues and bring about real improvements. They can also influence health and safety through their own actions and by accepting personal responsibility.” (p.9)

Participatory approaches have been associated with the increased likelihood of successful implementation of ergonomics solutions (Imada, 1991), with additional reported benefits of adopting participatory approaches to ergonomics interventions including:

- Improvements in psychosocial factors (Evanoff et al., 1999; Laitinen et al., 1998)
• Reductions in self-reported pain or musculoskeletal complaints (Evanoff et al., 1999; Maciel, 1998; Moore & Garg, 1998; Halpern & Dawson, 1997; Vink & Kompier, 1997)
• Enhanced communication (Haims & Carayon, 1998; Kuorinka & Patry, 1995)
• Increased motivation, job satisfaction, and commitment (Maciel, 1998)
• Decreased work absenteeism (Moore & Garg, 1998; Vink & Kompier, 1997; Garg & Owen, 1992)
• Increased productivity (Maciel, 1998; Nagamachi, 1998, 1995)

The benefits of participatory approaches, however, are dependent upon workers perceiving the issue as one in need of attention, and also the extent to which both education level and knowledge of the issue enable them to offer meaningful contributions (Gjessing et al., 1994).

Examples of participatory elements in ergonomic programmes are particularly well documented within the automotive industry. LaBar (1989), for example, described the introduction of Employee Involvement Groups (EIGs) in different departments of a US tire manufacturing plant, involving workers in developing ergonomic improvements to tackle a variety of safety, production, and quality issues. In the four-year period following the initiative, the incidence of worker injury rates reduced five-fold, which managerial and union representatives credited to the process of listening to workers' suggestions and the increased involvement of employees in company activities. Less success, however, was reported by Laing et al. (2005), regarding a participatory ergonomics programme within an automotive parts manufacturing firm. Following a process of consultation with workers, despite changes to the workplace intended to reduce worker exposures to physical demands being rated by workers as improvements, and the changes successfully reducing peak and cumulative mechanical exposures, few systematic changes were noted in perceived effort or pain severity levels.
The increased adoption of participatory approaches in industry is believed to have been promoted by companies' recognition of the scope for improvement of working methods, without having the resources to consult ergonomics specialists (Haines et al., 2002). Despite the increased adoption of such approaches, however, there remains a lack of any agreed structure or framework for implementing such a process, perhaps contributing to the mixed evidence of its effectiveness. It has also been argued that participatory ergonomics is not a unitary concept, but instead an umbrella term covering a broad range of ideas and practices (Haines et al., 2002). Whilst this may be true, speculation can be made as to the specific components that are critical to the effectiveness of participatory approaches, based upon identification of the elements that are common to such programmes. The implementation of participatory programmes, for example, requires commitment from senior management, a crucial element of an effective ergonomics programme, according to NIOSH (1997) and HSE (2002). In addition, in order to enable workers to participate in decision-making and problem solving regarding issues such as MSDs, training in order to improve communication skills and increase understanding of the issues may be necessary. As a result, the effectiveness of participation may at least in part be due to such factors.

2.13.8 Generic process issues
It has been suggested that a crucial weakness of many ergonomics interventions is that they have traditionally focused at the micro level of organisations, such as human-system interfaces, rather than taking an holistic view of the interactive systems operating in the organisation as a whole (Hendrick, 1995). Despite the complex nature and causality of MSDs, involving factors relating to a range of disciplines from biomechanics, to ergonomics, psychology, physiology, and organisational psychology, approaches to prevention tend to derive from these individual disciplines in isolation from the others (Marras, 2004; Whysall et al., 2004). In fact, Marras (2004) considered the failure to take a holistic approach to
the problem as a fundamental limitation to our understanding of the causality and prevention of MSDs. Consequently, Marras argued that in order to effectively control MSDs, their causality needs to be viewed as a system, integrating the evidence from each of these fields. Similarly, Ingelgard and Norrgren (2001) argued that the implementation of new technology affects the functioning of the system as a whole, and therefore cannot be considered as an isolated issue. This could also apply to the implementation of new equipment or working practices, and other interventions typically implemented to tackle MSDs.

From a macro ergonomics perspective, it is crucial to ensure that the individual components of the organisation (e.g. technology or personnel) are consistent with the system’s overall structure. As a result, the ability of an organisation to successfully manage the change process is a key factor in the success of interventions. In light of this, Ingelgard and Norrgren (2001) argued that interventions should be evaluated on a variety of levels, and proposed a path of meaningful indicators including management or workforce attitudes to practices of changing work conditions, workplace changes, mechanical exposures, reporting of pain or discomfort, disability at work, and lost-time disability. This framework incorporates both broader organisational determinants and specific impacts at more micro-levels. Evaluating outcomes across these levels may detect more subtle changes, particularly in the absence of long latency periods. For instance, although Daltroy et al. (1993) found no observable improvements in working methods following a 'back school' for workers, improvements were evident in workers' knowledge. It could be argued that the latter of these outcomes is an important prerequisite for the former, as discussed in relation to behaviour change in Chapter 3. Consistent with this, Douillet and Aptel (2000) speculated that prevention efforts are thwarted by an ongoing reluctance to recognise MSDs, not only in terms of the slow development of relevant legislation, but also problems with 'social recognition'. This includes employers' reluctance to accept MSDs as work-related, or even the concept of a health problem with such a wide range of contributory factors. In turn, this affects
employees' willingness to report problems, both of which make it less likely that employers will address the issue of MSDs. Consistent with this, the compliance of management and employees to ergonomic advice is believed to be less than 60% (Loisel et al., 2001). Closer attention to the process of implementing changes in order to reduce the risks would enable such barriers to be identified and addressed, consequently increasing the likelihood that ineffective are effective.

2.14 Chapter summary

This chapter has highlighted that despite the growing body of knowledge regarding MSDs and the risk factors associated with these problems, in addition to the ongoing mechanisation and automation of industry, the problem of MSDs remains the most common cause of occupational ill-health in the UK. As documented by Douillet and Aptel (2000), reduction of MSDs is 'making slow progress'. Due to the substantial costs related to these problems (at the individual, organisational, and societal levels), it is important that interventions to tackle MSDs are made more effective. Despite this, however, evaluation of interventions is thought to be relatively infrequently undertaken. As a result, research into the effectiveness of interventions to tackle MSDs has become increasingly essential, as not only is evaluation of such interventions scarce, but where evaluation has been carried out, it tends to reveal evidence of mixed effectiveness.

A fundamental challenge for the reduction of MSDs, is the complex nature of these types of problem, and the range of factors that are associated with their onset. These include both physical factors such as force, repetition, and posture, and psychosocial factors such as perceived control, social/supervisory support, and role clarity. The association between MSDs and psychosocial factors has received particular support in recent years, an association that has even described as one of the more robust findings in the scientific literature (Feyer et
al., 2000). Despite this however, few attempts to tackle these factors in practice have been observed (Loisel et al., 2005). Consequently, psychosocial factors may present potential leverage for the reduction of these problems, which has not yet been fully explored.

Indicative of this, it has been argued that interventions of this type are unlikely to be informed by relevant evidence (Colarelli, 1998), a notion reflected by the World Health Organisation's Director General, Dr Lee Jong-Wook, who argued that many of today's health problems persist because:

"There is a gap between today's scientific advances and their application: between what we know and what is actually being done" (as cited by Abbasi, 2004, pp. 1120)

Further illustrative of this point, despite the assumed complexity of MSDs, interventions to tackle such problems tend to be focussed at the micro level of organisations, aimed at tackling physical workplace factors, rather than taking a holistic view of the interactive systems operating in the organisation as a whole. It is therefore, perhaps unsurprising that these types of problems remain common. Indeed, inadequate implementation has been identified as a fundamental reason for the ineffectiveness of these interventions (e.g. Aborg et al., 1998).

Consequently, on the basis of this review, it is suggested that in order to reduce MSDs, interventions not only need to be designed to tackle both physical and psychosocial factors, but such attempts should also be embedded in a wider process involving gaining stakeholder commitment, educating change recipients about the risks, and encouraging ongoing evaluation of interventions. Indeed, this reflects the type of approach advocated by HSE (2002) and NIOSH (1997). However, such an approach does not appear to have been widely adopted in practice. This may be due to change agents' failure to perceive the need for or
benefits of such an approach, or the difficulty of implementing such an approach in the absence of tools or techniques to facilitate this type of approach. Clearly, further investigation of the process of implementing interventions to tackle MSDs is needed in order to clarify such points, and to identify potential ways of improving their effectiveness.
Overview of thesis

Chapter 1: Introduction

Chapter 2: Literature review: MSDs

Chapter 3: Literature review: Behaviour change

Chapter 4: Exploration of current practices
- 14 Semi-structured interviews with ergonomics consultants

Chapter 5: Evaluation of materials
- Content analysis of HSE materials
- Evaluation of coverage of stages of change

Chapter 6: Tool development
- Worker questionnaire (n = 168)
- Managerial questionnaire (n = 100)

Chapter 7: Implementation
- 24 interventions monitored
- Half tailored according to stage
- Worker & managerial assessments pre & post intervention

Chapter 8: Exploration of the change process
- Post-intervention interviews with managers following tailored & non-tailored interventions (n = 17)

Chapter 9: Discussion, implications and recommendations
3. BEHAVIOUR CHANGE

3.1 Introduction

Although there has been a gradual decline in their prevalence over the past decade, MSDs remain the most common form of work-related ill health in Great Britain (HSE, 2005). In the UK, MSDs (upper and lower limb conditions and back pain) are estimated to lead to the loss of approximately 11.6 million working days each year (HSC, 2005), despite developments in both understanding and regulation regarding the management of these conditions. A similar picture exists in other industrially developed countries. Consequently, there remains a pressing need to examine why the prevalence of work-related MSDs remains so high and, furthermore, how attempts to alleviate risks can be made more effective. Undoubtedly, the complex causation of MSDs poses a significant obstacle to their control. Karsh et al. (2001), for example, presented a conceptual framework for understanding MSDs describing the work environment, work organisation, technologies and task as factors which interact with individual personal capacity (biomechanical, physiological, and psychological) to lead to MSDs. As a result, approaches to tackling MSDs often need to be directed at various different levels, as also highlighted by Snook (1988) in relation to the management of back pain in industry.

As a general framework for the management of upper limb disorders (ULDs) in the workplace, HSE (2002) proposed a seven staged management cycle:

- Understand the issues and commit to action
- Create the right organisational environment
- Assess the risk of ULDs in the workplace
- Reduce the risks of ULDs
- Educate and inform the workforce
- Manage any episodes of ULDs
• Carry out regular checks on programme effectiveness

Outlining the procedure for undertaking an ergonomics intervention in industry, Haines and McAtamney (1995) suggested a similar framework, including:
• Clarify the aims of the investigation
• Secure commitment
• Identify and prioritise the problems for assessment
• Structure the assessment procedure
• Collect data
• Analyse and interpret the data
• Make recommendations
• Implement changes
• Review changes

The extent to which ergonomics consultants incorporate the aspects of such frameworks into their work, for example how often they ensure that the issues are understood and that commitment to action is obtained, is unknown. There have also been few attempts to evaluate the effectiveness of such interventions (Griffiths, 1999), and as highlighted by Volinn (1999) the small number of studies that have evaluated interventions are limited by methodological problems. This is a matter of concern, not only due to the importance of improving employee health, but also in light of the ever increasing number of consultants engaged in this type of work.

When advising on MSDs, it is frequently the case that consultants will indicate that changes are required, such as modifications to equipment, workplace layout and/or working practices (i.e. changes in an organisation’s mode of operation or behaviour). Acceptance of such advice depends on attitudes and beliefs surrounding MSDs held by the client and their employees. If the client does not believe MSDs to be a genuine problem or that suggested changes are really necessary, the likelihood of implementation is reduced.
However, understanding surrounding the relationship between attitude and behaviour change has proved a matter of contention, with longstanding debate. For example, whilst evidence suggests that a uni-causal relationship of attitudes predicting behaviour (or action) is too simplistic (e.g. Glendon & Hale, 1984), Ajzen and Fishbein (1980) demonstrated that it is possible to predict behaviour on the basis of attitudes, but only providing that the attitudes are highly specific in relation to that behaviour. A contrary speculation has been that behaviour influences attitudes. Thus, if behaviour is altered, attitudes will match either due to the need to preserve cognitive consistency, or the notion that individuals determine their attitudes by monitoring their behaviour. Whilst is it difficult to demonstrate that a change in behaviour has influenced a person's attitudes, theoretical and empirical work suggests that behaviour is likely to be among the factors which play a role in defining attitudes (Kleinke, 1984).

The previous chapter highlighted the importance of behaviour change in the reduction of occupational health problems such as MSDs. In order to reduce MSDs for instance, action first needs to be taken by managers to implement risk reducing strategies (e.g. changes to the workplace layout, tools, equipment, or training), and these changes then need to be adopted by employees, and integrated into their routine ways of working. Moreover, some work environments are innately hazardous, in addition to rapidly changing and unpredictable (Peters, 1991). These factors make it difficult, if not impossible, to completely 'engineer out' the risks. Consistent with this, both WHO (1988) and HSE (2002) recommended that interventions to tackle MSDs combine ergonomics improvements with health promotion activities aimed at modifying behaviour.

Indeed, resistance from employees has been identified as the primary reason for the failure of organisational change initiatives (Deloitte & Touche, 1996). Moreover, in contrast, managers tend to be action orientated, becoming frustrated when their employees do not comply (Prochaska et al., 2001a). Consequently, it is perhaps unsurprising that the probability of failure for any
organisational change effort is estimated at around 50% (Fullan et al., 1981). Further exacerbating this situation, rather than using mistakes or ineffective interventions as learning opportunities on which to build, it seems that such failures are more likely to result in cynicism and scapegoating (Argyris, 1990).

Consistent with the ongoing prevalence of MSDs, many organisations’ accident figures have been found to plateau at a persistent level with further improvements seeming to have little effect (Donald & Young, 1996). Similarly, Channing (1999) argued that behavioural approaches are likely to be key in achieving further progress in reducing workplace accidents, the effectiveness of attention to design, systems and procedures having reached a ceiling. Donald and Young argued that attitudes are the underpinning link that enables the deeper, more fundamental shift necessary to effectively reduce health risks. It is argued that ‘For change to occur, the routines and their associated meanings have to evolve.’ (Balogun & Jenkins, 2003, p.248). It would seem, therefore, that substantial potential exists for improving the efficacy of occupational health and safety interventions by ensuring that recipients (for the reduction of occupational health problems such as MSDs, these include both managers and workers) hold attitudes, values, and beliefs that are consistent with the intended changes. It is argued, however, that the tendency for ergonomics practitioners to neglect the psychological/behavioural side of the intervention process, is due to the absence of reliable tools or techniques for assessing and responding to these factors in practice (Haslam, 2002).

The apparent failure for organisational interventions to have effectively addressed these issues has been related to the state of theory and research in the area of organisational change, which has been criticised as ‘underdeveloped’, ‘fragmented’, and ‘inconclusive’ (Prochaska et al., 2001a; Van de Ven & Poole, 1995; Pfeffer, 1993; Beer & Walton, 1987; Faucheux et al., 1982). For instance, organisation change theories have been criticised as being ‘almost entirely’
conceptual rather than empirical (Prochaska et al., 2001a), a notion echoed by Porras and Silvers (1991), who stated that:

'...change should be guided by generally accepted and unified theories or organisations and organisational change – neither of which currently exists.' (p.51)

Moreover, relating to organisational change, Nytro et al. (2000) argued that:

'...interventions of this type provide management consultants with ongoing business precisely because they rarely work or are principally designed to secure short-term gains...' (p.215)

The lack of any widely accepted model for achieving organisational change is held as a crucial limitation to the field (Porras & Robertson, 1992). In addition, those models or theories that do exist are criticised for not taking sufficient account of the complexity of the change process from the viewpoint of the change recipient (Balogun & Jenkins, 2003), over emphasising isolated, episodic events (Beer & Walton, 1987), and failing to take into account the psychology of change (Winum et al., 1997).

For these reasons, the organisational change literature will not be discussed further in this thesis. Instead, the remainder of this chapter will focus on the more developed area of behaviour change theory, and will assess its potential applicability to organisational change interventions. The subsequent section of this chapter outlines the foundations of behaviour change, including the close relationship between attitudes and behaviour, before going on to evaluate the most widely adopted models of health behaviour; the Health Belief Model (HBM; Rosenstock, 1974, 1966), the Theory of Reasoned Action (Fishbein & Ajzen, 1975), the Theory of Planned Behaviour (TPB, Ajzen & Madden, 1986; Ajzen, 1985), and the Transtheoretical Model (TTM, Prochaska & DiClemente, 1982).
3.2 Fundamentals of behaviour change

A central tenet of behaviour change theory is that for behaviour change to be successful, change agents must take change recipients' attitudes into account (e.g. Glendon & Hale, 1984; Ajzen & Fishbein, 1980). The reason for this is that attitudes, beliefs, and knowledge are believed to underpin our routine ways of behaving. Thus, before continuing, clarification will be made of what is meant by the term “attitudes”, and how attitudes are thought to be composed.

Aronson et al. (2004) loosely defined an attitude as a general evaluation or assessment, of the people, objects and ideas that surround us. As a result, an attitude is seen not just a concept used to explain our response to certain stimuli, but is itself “an effect and cause of external observational events” (Eiser, 1986, p. 47). However, the precise role played by attitudes in determining behaviour remains a point of contention. For instance, although it is commonly assumed that attitudes determine behaviour, others (e.g. Bem, 1967) argued that attitudes are often actually developed in light of perceptions of our past behaviour. Such an inference reflects the notion of cognitive dissonance (Festinger, 1957), which contends that people strive to maintain consistency between their attitudes and behaviour. An alternative (and now generally accepted) view is that attitudes and behaviour are mutually influential (e.g. Fishbein & Ajzen, 1975). Perhaps the only tentative conclusion that can be made therefore, is that whilst there must be some degree of correspondence between attitudes and behaviour, this relationship may hold true for some situations more than others, and for some individuals more than others (Rajecki, 1990).

The specific ways in which attitudes influence behaviour, and indeed, the types of attitudes that are most predictive of health-related behaviour, have been characterised in many different ways in the numerous theoretical models that have been put forward to explain the attitude-behaviour relationship. Indeed, Glanz et al. (2002) claimed that the range of health behaviour change
approaches today is 'nearly limitless'. Consequently, this review will focus on the most widely adopted models; the Health Belief Model (HBM; Rosenstock, 1974, 1966), the Theory of Reasoned Action (Fishbein & Ajzen, 1975), the Theory of Planned Behaviour (TPB, Ajzen & Madden, 1986; Ajzen, 1985), and the Transtheoretical Model (TTM, Prochaska & DiClemente, 1982). These models are often termed ‘cognitive’ or ‘social cognition’ models, due to their acknowledgement of the role of cognition in determining behaviour (aside from the TTM, which is more commonly referred to as a stage-based model). It is argued that health-enhancing behaviour can be promoted by targeting interventions to tackle the cognitions specified by these models as predicting behaviour. Indeed, regardless of the differences between the models, interventions based on social cognition models have been shown to be more effective than interventions without such theoretical underpinnings. Of the large number of interventions and campaigns rapidly designed to tackle HIV-preventative behaviour, for example, few were based on theory, and almost none were found to influence sexual behaviour (Oakley et al., 1995; Fisher & Fisher, 1992).

### 3.3 The Health Belief Model

Like other cognitive models, the Health Belief Model (HBM; Rosenstock, 1974) emphasises the importance of an individual’s understanding and processing of health risks information. The cognitive evaluation of this information, in turn, is believed to prompt action. Specifically, according to the HBM there are two classes of variables that are important in determining health behaviour: i) an individual’s psychological state of readiness to take action regarding a particular health problem, and ii) the perceived efficacy of a particular course of action in reducing the threat. Both variables are two-dimensional. An individual’s state of readiness is believed to be determined by their perceived susceptibility to the health risk, and their perception of the severity of the health problem. The extent to which prevention efforts are perceived to be effective, or beneficial, is thought
to be dependent upon an individual's weighing up of the perceived benefits of, and barriers to (e.g. time, money, effort, pain), engaging in preventative activities. In addition to perceived susceptibility, severity, barriers and facilitators, the HBM predicts that for behaviour change to take place, individuals also need to be exposed to cues to take action, such as media attention to the issue, or personal experience of the health problem. More recently, self-efficacy was also included as a key predictive variable in the HBM (Rosenstock et al., 1988), suggesting that individuals are more likely to change their behaviour if they feel they are capable of effectively reducing the risk. The model is represented diagrammatically in Figure 8.

Figure 8. The Health Behaviour Model (HBM, Rosenstock, 1974; 1966)

3.3.1 Evaluation of the HBM
A substantial body of research exists in support of the variables of the HBM, in relation to health behaviours such as dietary compliance (Polly, 1992; Becker & Janz, 1985; Becker et al., 1977), sexual health (Maguen et al., 2000; Steers et al., 1996), vaccinations (Zimet et al., 1997a; Zimet et al., 1997b), mammography screening (Duan et al., 2000; Phillips et al., 1998; Aiken et al., 1994), cycle helmet use (Arnold & Quine, 1994) and exercise (Mirotznik et al., 1995). Evidence suggests that the HBM can also be used to identify differences

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between health behaviours in multicultural settings (e.g. Tang et al., 2000; Tang et al., 1999).

However, not all studies adopting the HBM incorporate all of the components of the model, instead tending to select just one or two individual components. Moreover, those studies that examine the model as a whole tend to identify perceived barriers as the most powerful single predictor of the model, and perceived severity as only a weak predictor (Harrison et al., 1992; Norman & Fitter, 1989; Janz & Becker, 1984). Quine et al. (2000) found only perceived benefits and perceived barriers to be significantly related to helmet use among child cyclists. Support for the perceived barrier component of the model was also demonstrated by Damron et al. (1999). In this study, women's attendance at a nutritional education programme aimed at increasing fruit and vegetable consumption was related to the presence or absence of barriers, specifically the availability of transportation and child care. Increasing the barriers to unhealthy behaviours has also been shown to be effective in preventing such behaviour. Increases in taxation on tobacco, for example, appear to be successful in reducing consumption rates, with an estimated 4% reduction in consumption for every 10% rise in price (Brownson et al., 1995). However, it must also be considered that consumers may also be driven to purchase their tobacco from elsewhere (i.e. on the black market) following an increase in price.

In general though, the amount of variance accounted for by the components of the HBM has been found to be small, only 0.1% to 0.9% of the variance in outcome (Harrison et al., 1992). Although others have cited higher figures, these studies have also identified other weaknesses. Wilson et al. (1990), for instance, reported the HBM to account for 15% of intended condom use among men, and 12% among women in Zimbabwe. Not only is this still only a relatively small amount of the variance in practical terms, but the variables that contributed significantly to behaviour for men were different than those for women. Obviously, in the case of condom use, it is crucial to understand how the behaviour or attitudes of one
individual interact with those of their partner. As the HBM does not account for such influences, this example highlights a key limitation.

Aside from weaknesses in terms of predictive value, other practical limitations of the HBM can also be identified. First, as the model does not specify the relationships among the variables – how different beliefs influence one another, or how the variables combine to influence behaviour. This has led some critics to suggest that the HBM is more reflective of a list of variables than a theoretical model (Weinstein, 1993), and as a result it offers little guidance for applying the model in practice. This weakness is also likely to be closely related to the poor predictive validity of the model, as some studies have used additive models, in which the combined weight of the variables is used to predict outcomes, whereas others have combined specific factors, either by adding severity and vulnerability (e.g. Wyper, 1990), multiplying the variables (e.g. Conner & Norman, 1994), or subtracting the barriers form the benefits (e.g. Rutledge, 1987). The last decade has seen progress in this respect, however, with the development of scales to measure the constructs of perceived risk, benefits, and barriers in relation to breast screening (Champion, 1999; Champion & Scott, 1997). In addition to lack of clarity regarding the relationships between the HBM variables, a second major limitation of the HBM is the absence of specific operational definitions for the variables, leaving researchers to develop their own ways of defining and measuring them (Champion, 1984). Unsurprisingly, this has led to inconsistent measurement of HBM concepts (such as self-efficacy), and variation in the ways in which the variables of the model have been treated in different studies. Finally, the HBM has been criticised for focusing too greatly on the individual, and neglecting the influence of environmental and social barriers to performing behaviours (e.g. time, resources). Consequently, although the HBM incorporates a range of variables, some of which appear to be to some extent predictive of health behaviour, the model provides little practical guidance for bringing about behaviour change, and as a result, the scope for applying the model to improve health is limited.
The Theory of Planned Behaviour (TPB; Ajzen, 1988; 1985), and its predecessor, the Theory of Reasoned Action (Fishbein & Ajzen, 1975), have been broadly used to model a variety of health behaviours, being arguably the most widely researched models of health behaviour. The TPB not only emphasises the importance of attitudes in predicting health behaviours, but unlike the HBM, also acknowledges the influence of perceived societal norms. The TPB holds an individual's behavioural intentions as providing the key link between underlying attitudes and behaviour. According to Ajzen (2005), intention is 'an indication of a person's readiness to perform a given behaviour, and is considered to be the immediate antecedent of behaviour'. Behavioural intentions are thought to be influenced by an individual's health beliefs, perceived subjective norms regarding the health issue, and perceived control over the behaviour. The latter of these factors, perceived behavioural control, also indirectly acknowledges the role of past behaviour, as this is likely to be determined at least in part by their previous behaviour. In more recent times, Ajzen (1985) modified the theory slightly, denoting perceived behavioural control as directly influencing behaviour (as displayed in Figure 9). Consequently, the theory suggests that the more resources and opportunities individuals believe they posses, and the fewer obstacles that they anticipate, the greater the perceived control over the behaviour in question. According to the TPB, this may be influenced by internal control factors such as knowledge, skills, and attitudes, in addition to external control factors such as opportunities, resources, and barriers. By acknowledging the influence of the social and environmental context on an individual's behaviour, in the form of normative beliefs and external barriers, the TPB is able to explain why knowledge alone does not necessarily lead to action.

Although the TPB holds that all behaviours are determined by the same limited set of variables, each behaviour is also considered substantively unique (Fishbein, 2000). For a given population or culture, the relative importance of
Attitudes, subjective norms, and perceived behavioural control is thought to vary according to different behaviours. For instance, some behaviours may be primarily influenced by attitudinal factors, whereas others may be influenced largely by subjective norms.

Figure 9. Conceptual framework relating beliefs, attitudes, intentions, and behaviours

3.4.1 Evaluation of the TPB

The TPB has been used to predict a variety of health behaviours such as drink driving (Aberg, 1994; Parker et al., 1992), vaccinations (Farquharson et al., 2004), clinic attendance (Rutter, 2000), exercise (Armitage & Connor, 2001), breast cancer screening (Steadman et al., 2002), and condom use (Montano &
Kasprzyk, 2002). However, it is claimed that there have been remarkably few experimental tests of the TPB or its predecessor, the TRA (Sutton, 2002). Abraham et al. (1999), found that in terms of sexual health, messages tackling the intention to change had the strongest impact on behaviour, followed by attitudes towards the behaviour, social norms, and self-efficacy to change. Furthermore, factors specified by the HBM, including knowledge and information regarding the issue, susceptibility to disease, and severity of disease were all found to have little impact on behaviour, despite being the most common forms of information in UK health leaflets. Similarly, although unable to find any substantial support for the HBM, Quine, et al. (2000) found cycle helmet use among children to be significantly related to 4 of the 5 relationships outlined by the TPB, the exception being the path between attitudes towards the behaviour and behavioural intention, overall explaining 43% of the variation. Further support was provided by Armitage and Conner (2001), in a meta-analysis of 185 studies applying the TPB to a range of behaviours. The TPB accounted for 27% of the variance in behaviour, and 39% of the variance in behavioural intention. In light of the similarities between the TPB and the HBM, it has been suggested that a principal reason for the stronger finding of the TPB is due to its more clearly defined concepts and measurement criteria (Van der Pligt, 1994). Indeed, more recently, guidelines on how to measure the TPB factors have also been published (Ajzen, 2002).

Others, however, have questioned the value of particular elements of the model. McCaul et al. (1993), for example, found that perceived behavioural control added little predictive value to the TPB, while some have argued that the subjective norm component is a poor predictor of behavioural intention (Godin & Kok, 1996; Sheppard et al., 1988). In their previously cited review, Armitage and Conner (2001) also identified subjective norms as being only weakly related to intentions. Johnson and Hall (2005) on the other hand, found that the attitudinal dimension of the TPB did not significantly contribute to the prediction of safe lifting behaviour in the workplace, as predicted by the TPB, but that instead the
effect of attitudes was mediated by subjective norms and perceived behavioural control. The primary predictor of behaviour identified by Johnson and Hall was perceived behavioural control, followed by subjective norms. Consistent with these findings, Ogden (2003), highlighted that many studies applying the TPB have found one or other of the three determinants of intention (attitudes towards the behaviour, subjective norms, and behavioural control) to be redundant.

The perceived behavioural control component of the TPB has also received criticism in terms of its definition (e.g. Terry & O'Leary, 1995). Within the TPB, perceived behavioural control is defined as the perceived ease or difficulty of performing a particular behaviour, a concept that others have argued is ambiguous. Indeed, it can be seen that an individual may be confident in their own ability to perform a particular behaviour, but perceive the behaviour change as difficult to accomplish due to environmental barriers such as available resources. Terry and O'Leary (1995) have characterised this distinction as internal control representing self-efficacy, and external control reflecting perceived control over behaviour. Consequently, the evidence suggests that whilst the components of the TPB have been found to be valuable predictors of behaviour in some circumstances, mixed evidence such as that outlined above suggests that these components are not always essential nor necessary factors in behaviour change. In defence of the model, Ajzen (1991) stipulated that not all elements of the TPB will significantly predict all target behaviours. However, without specifying the circumstances under which certain elements (e.g. attitudes, subjective norms, or perceived behavioural control) are more likely to predict certain behaviours, this claim seems to substantially weaken the model. It has also been claimed that the primary goal of the TPB is to predict behavioural intentions, rather than actual behaviour (Fishbein & Ajzen, 2005). Indeed, a large proportion of studies applying the model use behavioural intention, rather than actual behaviour change, as the outcome variable. Other theorists attribute the failure of the model to translate intention into action as due to the absence of a planning stage in the model (e.g. Schwarzer, 1992). In certain circumstances or
for certain individuals, producing desired intentions is not sufficient for changing behaviour. In these situations, Fishbein and Ajzen (2005) suggest that two very different types of intervention may be necessary, one to generate intentions, and one to facilitate actual performance of the desired behaviour. Due to the omission of a temporal element in the TPB, however, it is not possible to determine when or under what particular circumstances this may be the case, or how this might be achieved.

A further criticism of the TPB is that it over rationalises behaviour, due to the perception of behaviour as a direct result of behavioural intentions. Not all behaviour is the result of rational decision making, nor is the failure to act necessarily due to lack of awareness of the risks. In fact, it is argued that much behaviour tends to be habitual, and relatively ‘thoughtless’ (Hunt & Martin, 1988). This may be particularly so in the workplace. Indeed, Engels et al. (1997) cited that ‘This is certainly true for working postures which almost come as reflex.’ (p.142) This notion is further supported by Verplanken and Aarts (1999), who argued that everyday behaviours performed in stable contexts are more controlled by habits than intentions. Recognition of the irrationality of behaviour emphasises the need for such models to identify how behaviour can be modified when the individual is seemingly ‘thoughtless’ in their actions, and how habitual behaviour can be made more conscious.

As mentioned above, neither the TPB nor the HBM acknowledge the temporal element that typifies real-life behaviour change. In addition, neither theory includes a feedback loop, nor is there any description of the order in which beliefs contribute to behaviour. As a result, it can be seen why existing models have been criticised for not taking sufficient account of the complexity of the change process from the viewpoint of the change recipient (Balogun & Jenkins, 2003). Clearly, complex behaviour change such as that required to improve health and safety risks in the workplace is not an immediate, nor uni-directional process, but often occurs gradually, and can involve lapses back to previous ways of behaving.
or thinking. Indeed, it has been suggested that the TPB fails to take past behaviour into account (De Vries et al., 1995), although it could be argued that perceived behavioural control is based on an appraisal of past efforts.

Neither the TPB nor the HBM provide guidance on how to promote behaviour change, making the application of these theories in practice difficult (e.g. Hobbis & Sutton, 2005; Uutela et al., 2004). Translating health behaviour change theories into feasible strategies that can be used in practice poses a crucial barrier for both the progression of health psychology as a discipline, and the effective reduction of health problems. As stated by Kok et al. (2004):

‘While a broad range of social and behavioural science theories are available, the actual application of these theories in programme design remains a real challenge ...’ (p.85)

It can also be argued that the above models assume that individuals are ready to embark on changing their behaviour. What is perhaps most important is to motivate behaviour change among those who resist health information or participation in health programmes. Following a review of 110 health promotion initiatives in the workplace, Harden et al. (1999) concluded that

‘many programmes seem to ignore the needs and views of the target population in the planning and implementation of workplace health promotion programmes.’ (pp. 546-547)

Consequently, approaches may be more effective if they acknowledge the recipient population's readiness to change (e.g. Murphy & Bennett, 2004).
3.5 The Transtheoretical Model

It has been argued that stage models provide both order and direction for health initiatives (e.g. Laitakari, 1998), factors that appear to be in great need according to the review outlined above. Arguably the most widely researched stage model, cited as 'the most influential framework of behaviour change' (Anatchkova et al., 2005), is the Transtheoretical Model (TTM; Prochaska & DiClemente, 1983). As the name suggests, the TTM is an integrative model of behaviour change, using the concept of stages of behaviour change to integrate processes and principles of change from across other major theories. The rationale for this approach is that no single theory can account for all of the complexities of behaviour change. Thus, the model involves three key dimensions in describing the behaviour change process: the temporal dimension, represented by the stages of change; the dependent variable dimension, consisting of the decisional balance and temptation stages, and behavioural measures; and the independent variables construct, the processes of change.

As with the other models outlined above, the TTM centres around the individual's emotions and cognitions, which involves reliance on self-report. However, self-report has been demonstrated to be very accurate in terms of the TTM (Velicer et al., 1992). This may be partly due to the short, unambiguous question set used to assess the constructs (particularly stages of change), which integrate both attitudinal and behavioural changes (the latter of which are perhaps more objective). The TTM has been applied to a wide variety of problem behaviours, including smoking cessation (e.g. Andersen & Keller, 2002; Jaekle et al., 1999; Fava et al., 1995; Velicer et al., 1995; DiClemente et al., 1991; Prochaska et al., 1988; Prochaska & DiClemente, 1983), exercise (e.g. Marshall & Biddle, 2001; Burn et al., 1999; Nigg & Courneya, 1998; Cardinal, 1997; Clarke & Eves, 1997; Wyse et al., 1995), dietary behaviours (Prochaska et al., 2004; Povey et al., 1999; Rossi et al., 1995), diabetes management (Gambling & Long, 2006), blood donation (Ferguson & Chandler, 2005), weight control (O'Connell & Velicer,
1988), use of sunscreens to prevent skin cancer (Rapley & Coulson, 2005; Prochaska et al., 2004), bulimia (Franko, 1997), substance abuse (Al-Otaibi, 2000) and mammography screening (Champion & Skinner, 2003; Rakowski et al., 1998). Each of the dimensions of the model is outlined in the following sections.

3.5.1 Stages of Change: The temporal dimension
The stage construct is the key organising construct of the model, and arguably the most widely known. Despite the fact that change implies phenomena occurring over time, the temporal dimension is largely ignored by alternative theories of change, which typically use the moment of overt behaviour change (i.e. giving up smoking, drinking, or overeating) as the sole outcome measure. However, such measures have low power, as they are insensitive to the changes that take place prior to, and following, overt changes to behaviour. Clearly, attitudinal changes are also important, as absence of intention almost certainly leads to lack of behaviour, because positive intentions are important (although not necessarily sufficient) conditions for behaviour (Sheeran, 2002).

The TTM construes change as a process involving progress through a series of five stages, encompassing both attitudinal and behavioural changes: precontemplation, contemplation, preparation, action, and maintenance (see Figure 10). Thus, assessing progress towards smoking cessation, for example, using overt behaviour change would only detect the transition into the action stage, neglecting the changes from precontemplation to contemplation or from contemplation to preparation or from action to maintenance. The more sensitive measure of stage progression also enables the assessment of progression for all individuals, rather than just those ready to take action, and assuming the others failed. As a result, stage progression within the initial stages should be considered an intermediate successful outcome (Tones, 1998). The importance of this is highlighted by the finding that the majority of smokers are situated in the precontemplation and contemplation stages (Fava et al., 1995), which means
that focusing on the transition from preparation to action, is inappropriate for the majority of smokers.

Figure 10. The stages of change

Individuals in the precontemplation stage are defined as not intending to take action in the foreseeable future, usually measured as the next six months. This may be because they are uninformed or under-informed about the consequences of their behaviour, and as a result are unconcerned about the risks involved. Alternatively, individuals in this stage may have tried to change a number of times, but have relapsed, perhaps having become demoralized about their ability to change. According to Velicer et al. (1998), both of these groups tend to avoid reading, talking or thinking about their high risk behaviours. As a result, traditional health promotion programmes are often not designed for such individuals and are inappropriate for their needs.

Individuals in the contemplation stage are those intending to change in the next six months, having become more aware of the benefits of changing. Contemplators are also acutely aware of the detrimental effects of changing, a balance that can produce ambivalence keeping individuals stuck in this stage for long periods of time. Individuals in the preparation stage are defined as those
intending to take action in the immediate future, usually measured as the next month, and who often have a specific plan of action for achieving the desired behaviour change. These are the people that should be recruited for action-oriented interventions.

Individuals in the action stage are defined as those that have made specific overt modifications aimed at reducing the risks within the past six months. However, not all modifications of behaviour are classified as action in the TTM. As explained on the website for the Cancer Prevention Research Centre ('home' of the TTM), 'people must attain a criterion that scientists and professionals agree is sufficient to reduce risks for disease'. Criteria for action are also cited in a number of publications (Velicer et al., 1998; Prochaska & Velicer, 1997; Prochaska et al., 1992). Consequently, this may change according to current scientific knowledge regarding the particular health risk. The action stage is also the stage in which avoidance from relapse is most critical.

Individuals in the maintenance stage are those that took action over six months ago, and are working to prevent relapse, but do not apply change processes as frequently as do people in action. These individuals are less tempted to relapse and increasingly more confident that they can continue their change.

Individuals are classified into the above stages using a 'staging algorithm', based on their responses to a small number of dichotomous questionnaire items (Prochaska et al., 1994). Consequently, an individual's stage is underpinned by their current knowledge, attitudes, beliefs and intentions regarding the health problem in question. The key constructs believed to influence movement between stages are decisional balance and habit strength (discussed in more detail below). Due to the varying dominance of these concepts over time, an individual's stage of change determines their receptiveness to health information and education aimed at promoting behaviour change. Indeed, qualitative differences or 'discontinuity patterns' have been identified between the cognitive processes adopted in the earlier stages (experiential and contemplative.
cognitions such as self-evaluation) as opposed to the later stages (behavioural processes), denoted by a significant non-linear effects across groups in different stages (e.g. Ferguson & Chandler, 2005). Furthermore, according to Ferguson and Chandler, the stages showed incremental validity over intentions in terms of predicting past behaviour, suggesting that the stages are 'not just surrogates for intentions, but add something qualitatively different.' Jaffe et al. (1999), for example, discovered that attempting to promote physical exercise among women, those in the precontemplation stage tended to have few positive expectations regarding exercise, and contemplators had positive expectations but reported a higher number of perceived barriers. Donovan et al. (1998) assessed the test-retest reliability of scale measuring Prochaska's stages of change. The study revealed high levels of reliability (kappa = 0.72, 0.73 and 0.52 for quitting smoking, reducing alcohol and doing more exercise, respectively). Velicer et al., 1995) demonstrated that the distribution of smokers across the first three stages of change was approximately identical across three large representative samples. Approximately 40% of the smokers were in the precontemplation stage, 40% were in the contemplation stage, and 20% were in the preparation stage. Although the distributions may be different in different countries, and for different health issues, this study provides further evidence for the reliability of the stage of change scale. Recent research has also identified four distinct cluster subtypes of the preparation stage (classic, progressing, early preparation, and disengaged), each related to different patterns according to the pros and cons and the situational temptations measures (Anatchkova et al., 2006).

Research adopting the TTM has shown that stage matched interventions increase the likelihood that individuals will take action (e.g. Rakowski et al., 1998; Prochaska et al., 1993), instead of "one fits all" approaches that are typically adopted (Norman et al., 2000).
Despite some misconceptions (e.g. Bandura, 2000, discussed in Section 4.6.6), individuals are not typically expected to progress through the stages in a linear sequential pattern, but rather progress forward for a time and later regress back to an earlier stage (Velicer et al., 1999). Evidence suggests that regression, or backwards state transition, is related to specific variations in certain processes of change (De Vries & Muddle, 1997; Prochaska et al., 1985), as discussed in more detail below.

Progress across the stages has also been found to relate directly to the stage in which individuals were at the start of interventions. For example, Prochaska et al. (2001b) found that smokers in the contemplation stage were two-thirds more successful than those in the precontemplation stage at 6, 12, and 18 months following tailored health promotion programmes. Those in the preparation stage were approximately two-thirds more successful than those in the contemplation stage at these follow-ups.

3.5.2 Decisional balance and habit strength: Determining why and when change occurs
Following the recognition that little attention had been paid to the dependent criterion variables that underpin behaviour change, Velicer et al. (1996) developed the criterion measurement model (CMM), which incorporates the key constructs for measuring stage progression. These key constructs were identified as decisional balance (Velicer et al., 1985) and habit strength (Velicer et al., 1990), in relation to which predictable patterns can be found with movement across the stages. As previously stated, due to the varying dominance of these concepts over time, an individual’s stage of change determines their receptiveness to health information and education aimed at promoting behaviour change.

**Decisional Balance.** The Decisional Balance construct reflects an individual's relative weighing of the pros and cons of changing their behaviour in relation to a
particular health risk. This construct is derived from the Janis and Mann's model of decision making (Janis & Mann, 1985), which included four categories of pros (instrumental gains for self and others, and approval for self and others). However, an empirical test of the model resulted in a much simpler structure, consisting of only two factors, the pros and cons of changing (Velicer et al., 1985). This structure has also been supported by subsequent studies (Prochaska et al., 1994), and the decisional balance inventory (Velicer et al., 1985) has been found to demonstrate factorial invariance across age groups.

A predictable pattern has been observed of the pros and cons across the stages of change in relation to a range of health problems (Dijkstra et al., 2003; Velicer et al., 1999; Prochaska et al., 1994), as demonstrated in Figure 11 in relation to smoking cessation. In precontemplation, the pros of smoking are perceived as high (i.e. the benefits gained from smoking) and the cons (i.e. the costs associated with smoking) are perceived to be low. However, as an individual progresses into contemplation, they become more aware of the cons of smoking, to a point where the cons of smoking are equal to the pros. This crossover effect has been observed in relation to 12 different health-related behaviours (Prochaska et al., 1994). The individual's appreciation of the cons of smoking continues to increase as they progress into the preparation stage, from which point the pros of smoking begin to decline. However, both the pros and cons are believed to become less important as individuals move into action and maintenance, because they have already committed to changing their behaviour.

A different pattern of pros and cons has been observed for the acquisition of healthy behaviours. Figure 12 illustrates this pattern for exercise. The pattern is similar to that of giving up unhealthy behaviour (such as smoking, depicted above) across the first three stages but, the pros of exercising remain high in the last two stages. It is speculated that this may reflect the fact that maintaining a
Figure 11. The Relationship between Stage and the Decisional Balance for smoking cessation (Velicer et al., 1999)

Figure 12. The Relationship between Stage and the Decisional Balance for a healthy behaviour
programme of regular exercise requires a continual series of decisions and actions, while smoking eventually becomes irrelevant.

Habit strength: Self-efficacy/Temptations. Habit strength, the second construct of the CMM, represents the situation specific confidence that people have in their ability to cope with high-risk situations without relapsing to their unhealthy or high-risk habits. This construct was adapted from Bandura's theory of self-efficacy (Bandura, 1982; 1977), and is represented either by a temptation measure or a self-efficacy construct, which are both measured by the Situational Temptation Measure (Velicer et al., 1990; DiClemente, 1986, 1981). This measure assesses temptations to perform 'unhealthy' behaviours such as smoking in three domains: positive/social, negative/affective, and habit/addictive. The Situational Temptation Measure is a particularly good predictor of relapse, in that those still reporting high levels of temptation (to smoke, for instance), or those reporting low levels of self-efficacy have been found to be at a high risk of relapsing (De Vries & Muddle, 1997; Prochaska et al., 1985). Studies have shown that temptation and self-efficacy and an inverse relationship across stages of change, with temptation highest during the earlier stages of change and lowest during the latter stages, while equal levels of temptation and self-efficacy are shared in the action stage (Fallon & Hausenblas, 2004; Patten et al., 2000). For those maintaining healthy behaviours, the self-efficacy and temptation constructs can be represented by monotonically increasing and decreasing functions across the five stages (as shown in Figure 13).
Velicer et al. (1999) tested a range of predictions regarding changes in the decisional balance and habit strength constructs with progression over the stages of change. Thirty-six of forty predictions regarding smoking cessation were supported. The cons of smoking increased from precontemplation to contemplation, and the pros of smoking remain the same, reductions in temptation to smoke were found to be associated with progression through the stages, as were reductions in the pros of smoking. However, the expected increase in the cons of smoking with progression through the stages was not supported. Movement from the precontemplation stage to the contemplation stage was found to be characterised by changes on the cons scale only. In terms of progression from the contemplation stage, those who had stopped smoking were found to be much less tempted to smoke than those who had progressed but
were still smoking. A reduction in temptation was also a significant predictor of those who progressed from preparation into the action and maintenance stages, in addition to reductions on both the pros and cons scale. In conclusion, several suggestions can be made for promoting behaviour cessation:

- For forward stage movement from precontemplation to contemplation or preparation, it is important to raise the cons of smoking
- Reductions in the pros of smoking are important for the transition from preparation to action
- Reducing the temptations to smoke is an important factor in preventing relapse

Using the psychological determinants of Bandura's (1986, 1977) social cognitive theory in relation to smoking (the pros of smoking, the pros of quitting, and self-efficacy expectations), Dijkstra et al. (2003) provided further (indirect) support for the different behavioural and experiential processes that promote change among individuals in the different stages. For precontemplators, higher scores in relation to the pros of quitting significantly predicted forward stage transition. None of the three criteria were found to be significantly related to progression from the contemplation stage, however. For individuals in the preparation stage, higher scores on the self-efficacy dimension significantly predicted stage progression. Trends were found for the relationship between lower scores on the pros of smoking, and higher scores on self-efficacy and progression from the action stage into maintenance. Lower scores on the self-efficacy dimension significantly predicted backward stage transition from the preparation stage. Trends were also found for backward stage transition for other stages and dimensions.
It has been argued therefore, that the CMM overcomes a number of criticisms aimed at other models of health behaviour, in terms of the lack of well defined components or measurement criterion for the dependent variables of behaviour change.

3.5.3 Independent Measures: How Change Occurs

The processes of change component of the TTM describes the covert and overt activities that relate to individuals’ progression through the stages; the independent variables that people need to apply, or be engaged in, to move from stage to stage. Ten processes have been identified (Prochaska et al., 1988; Prochaska & DiClemente, 1983), and are described below. The first five are classified as experiential processes and are used primarily for the early stage transitions, and the second five are labelled behavioural processes and are used primarily for later stage transitions (Perz et al., 1996; Prochaska et al., 1988).

**Consciousness Raising** involves increased awareness about the causes, consequences and ‘solutions’ for particular problem behaviour. Interventions that can increase awareness of these factors include feedback, education, confrontation, and media campaigns (Velicer et al., 1998; Prochaska & Velicer, 1997; Prochaska et al., 1992). Interestingly, evidence suggests that individuals do not differentiate between experiential or environmental sources in this respect (Prochaska et al., 1988).

**Dramatic Relief** involves the process of initially increasing negative emotions (e.g. fear, anxiety) that are associated with the unhealthy behavioural risks, followed by demonstration of how these feelings can be reduced if appropriate action is taken. Role playing, personal testimonies and media campaigns are examples of techniques that can achieve this (Velicer et al., 1998; Prochaska & Velicer, 1997; Prochaska et al., 1992). Patten et al. (2000) suggest that life events such as the death of a family member or close friend can also have this effect, particularly if the death was related to the problem behaviour.
**Environmental Re-evaluation** combines both affective and cognitive assessments of how the presence or absence of a personal habit affects an individual’s social environment. It can also include the awareness on behalf of the individual that they can serve as a positive or negative role model for others (Prochaska & Velicer, 1997). Empathy training, documentaries, and family interventions can lead to such re-assessments (Velicer et al., 1998; Prochaska & Velicer, 1997; Prochaska et al., 1992).

**Social Liberation** refers to the realisation that the social norms (opportunities or alternatives) are changing in the direction of supporting the healthy behaviour, and so is believed to be especially important for people who are relatively disadvantaged. Advocacy, empowerment procedures, and appropriate policies can produce increased opportunities for health promotion amongst these individuals (Prochaska et al., 1992).

**Self-reevaluation** combines both cognitive and affective assessments of self-image with and without the problem behaviour, and involves the realisation that the behaviour change is an important part of the individual’s personal identity. Value clarification, healthy role models, and imagery are techniques that can promote such self-reappraisal (Velicer et al., 1998; Prochaska & Velicer, 1997; Prochaska et al., 1992).

In terms of the behavioural processes, **Stimulus Control** consists of removing cues for unhealthy habits and adding prompts for healthier alternatives. Avoidance, restructuring one’s own environment, and self-help groups can provide stimuli that support change and reduce risks for relapse (Velicer et al., 1998; Prochaska & Velicer, 1997; Prochaska et al., 1992). Planning car parks with a two-minute walk to the office and putting art displays in stairways are examples of reengineering that can encourage more exercise, for example.

**Helping Relationships** combine caring, trust, openness and acceptance as well as support for the healthy behaviour change. Rapport building, a therapeutic alliance, counsellor calls and buddy systems can provide sources of social support (Velicer et al., 1998; Prochaska & Velicer, 1997; Prochaska et al., 1992).
**Counter Conditioning** requires the learning of healthier behaviours that can substitute problem behaviours. For instance, relaxation to counter stress; assertion or positive self-statements to counter peer pressure; and nicotine replacement to substitute cigarettes, all enhance counter conditioning (Velicer et al., 1998; Prochaska et al., 1992).

**Reinforcement Management** involves rewarding positive behaviour change, and decreasing the rewards for unhealthy behaviour. Overt and covert reinforcements, positive self-statements, self-reward, and group recognition are procedures for increasing reinforcement and the probability that healthier responses will be repeated (Velicer et al., 1998; Prochaska & Velicer, 1997; Prochaska et al., 1992).

**Self-liberation** is both the belief that one can change and the commitment and recommitment to act on that belief. New Year's resolutions, public testimonies, and multiple rather than single choices can enhance self-liberation (or what may be commonly termed willpower) (Velicer et al., 1998; Prochaska & Velicer, 1997; Prochaska et al., 1992).

Differential patterns of these processes across the stages of change have been documented both cross sectionally (Prochaska & DiClemente, 1983) and longitudinally (Prochaska et al., 1991). For example, Prochaska and DiClemente (1983), found that consciousness raising was particularly emphasised in the contemplation stage, self-reevaluation tended to bridge contemplation and action, with self-liberation, counter conditioning, stimulus control, reinforcement management, and helping relationships all being adopted in the action stage. Counter conditioning and stimulus control were processes that continued to be important in the maintenance stage. In general, precontemplators were found to utilise fewer of the processes, as predicted, due to their resistance towards change.

Similar patterns have been found in relation to a range of health behaviours, including alcohol treatment (Share et al., 2004), smoking among adolescents.
(Otake & Shimai, 2001), and mammography screening (Champion & Skinner, 2003), to name but a few. The current empirical integration of the stages and processes of change is summarised in Table 6 (Prochaska et al., 1992), suggesting that in the earlier stages, individuals engage in cognitive, affective, and evaluative processes to progress through the stages, as opposed to in the latter stages, when they rely more on commitments, conditioning, contingencies, environmental controls, and support.

Table 6. Processes of change that mediate progression between stages of change (Prochaska et al., 1992)

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<thead>
<tr>
<th>Stages of Change</th>
<th>Precontemplation</th>
<th>Contemplation</th>
<th>Preparation</th>
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<td>Consciousness raising</td>
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3.5.4 Support for TTM

Evidence for the components of the TTM (processes of change, self-efficacy, and pros and cons), and their relationships with the stages of change has been described above, within the sections outlining each element of the model (Sections 3.6.1 to 3.6.3). Indeed, following a meta-analysis of studies testing the assumptions of the TTM in relation to physical exercise, Marshall and Biddle
(2001), found all of the effect sizes for self-efficacy with movement between stages were positive and significant. The effect sizes for the pros of changing were all positive and significant except for contemplation to preparation. The cons of changing showed significant decreases across successive stages. On the basis of this review, Marshall and Biddle concluded that 'there are now sufficient data to confirm that stage membership is associated with different levels of physical activity, self-efficacy, pros and cons, and processes of change.' (p.229) As a result, they suggested that further studies that simply examine cross-sectional differences between core constructs of the TTM are of limited use.

In addition to evidence supporting the TTM constructs, discussed above, a large number of studies have demonstrated that tailoring interventions according to stage of change can increase the likelihood that individuals will take action, in addition to demonstrating increased recruitment and maintenance levels (e.g. Clark et al., 2004; Champion & Skinner, 2003; Rakowski et al., 1998; Fava et al., 1995; Campbell et al., 1994; Prochaska et al., 1994; Prochaska et al., 1993; DiClemente et al., 1991; DiClemente & Prochaska, 1985; Prochaska et al., 1985). Recently, for example, Prochaska et al. (2005) conducted a stage-based intervention to tackle multiple health-related behaviours (smoking, diet, skin cancer, and mammography screening). Significant improvements were found in relation to all of these behaviours, compared to a non-staged based comparison group. Stage-matched materials have even been found to be more effective than standard materials when delivered by post (Rakowski et al., 1998), suggesting that approaches involving minimal contact can also be made more effective. Further support for the TTM was provided by Peterson and Aldana (1999), who evaluated an exercise intervention involving 527 corporate employees, among half of which messages were tailored according to individuals' stage of change. At follow-up 6 weeks after the intervention, the group receiving a stage-based message had increased activity by 13%, and had progressed significantly across stages, in comparison to groups receiving
generic messages. Again, this study suggests that messages tailored to stages of change may be an effective strategy for physical activity interventions, at least in the short-term. However, it could be argued that 6 weeks is not a sufficiently long period to detect reliable changes, particularly as a time frame of 6 months that defines movement from action into maintenance.

Not only have stage-matched interventions been found to be more effective per se, but also more effective in recruiting participants to the change programmes in the first instance. Compared to the typical recruitment rates of 1-5% of smokers in free action-orientated programmes (Prochaska et al., 1999), Fava et al. (1995) recruited more than 81% of smokers from a population of over 5,000 smokers. Moreover, in terms of programme retention, Prochaska et al. (1992) claimed that the stages and processes of change combined with a decisional balance measure were able to predict with 93% accuracy which patients would drop out prematurely from psychotherapy.

3.5.5 Studies that challenge the TTM

A number of recent reviews have challenged the effectiveness of the TTM in promoting behaviour change in relation to a range of health issues. Riemsma et al. (2002) reviewed 37 randomised controlled trials evaluating staged interventions, and found that studies varied both in terms of methodological rigour and outcome effectiveness (although methodological rigour did not appear to be related to effectiveness outcomes). Of 13 smoking cessation trials reviewed by Riesma et al., 4 showed significant differences favouring the tailored groups, 1 produced mixed outcomes, and 7 found no significant differences in behaviour change (1 did not include a non-stage based comparison intervention). Of 7 interventions to promote physical exercise, 3 found no significant differences in behaviour change outcomes, 2 found mixed evidence, and 1 provided support for improved effectiveness of tailored interventions (1 did not provide any behaviour change data). In terms of dietary change, 2 of 5 studies demonstrated significant differences favouring tailored interventions, 2 showed mixed evidence,
and 1 found no significant differences. Of 6 studies aimed at multiple lifestyle changes, 3 showed no significant differences between groups, 2 showed mixed effects, and 1 showed positive effects in terms of all of the behaviours studied (smoking cessation, fat intake, and physical activity). Of the 2 studies aimed at increasing mammography screening, 1 showed no significant effects, and 1 supported the improved effectiveness of staged interventions. The one trial involving treatment adherence found support for tailored interventions. Two of the 3 trials aimed at prevention showed no significant differences between groups for any measure of behaviour change, and the third generated mixed outcomes. It should be noted, however, that none of the studies reviewed found standard interventions to be more effective than those that are stage matched.

Adams and White (2003, 2005) conducted a review of 26 studies evaluating the effectiveness of the TTM in promoting physical exercise, involving interventions adopting tailored written information, tailored counselling, or a combination of the two. In the short term (six months or less), 11 of 15 (73%) programmes reported some significant benefit of TTM based interventions over control conditions—in terms of stage progression, activity levels, or both (one study was excluded on the basis of recruitment methods). Of those studies involving more longer-term follow up (over six months), two of seven (29%) interventions reported some benefit of tailored interventions. Adams and White argued that their review questions the long-term value of tailored interventions, due to the finding that longer term studies are much less likely to be performed: the follow up had been carried out beyond six months in less than half of the studies reviewed. The authors argue that future studies must give priority to performing long-term follow up studies and achieving activity adherence as well as adoption. However, it seems important to distinguish between lack of evidence and evidence of lack of effectiveness, as the scarcity of long-term follow-up studies does not enable firm conclusions to be drawn about the effectiveness of such interventions. Indeed, as argued by Brug and Kremers in their commentary in Brug et al. (2005),
‘One cannot expect long-term effects from such short-term interventions, whether stage-matched or not.’ (p. 56)

Others have argued that it is unreasonable to assume that the TTM, or any individually based ‘psychological’ intervention can possibly be expected to counteract the influences within our built and social environments indefinitely (Harre, 2005). Harre suggested that such short-comings should not be held as a problem for the model itself, but rather that the TTM be considered as part of a comprehensive intervention plan. Essentially, Harre argued that we must be reasonable in what we can expect from health-related interventions in general, and in line with this, highlighted that the majority of interventions reviewed by Adams and White were effective in the short-term.

Slightly different conclusions were drawn by van Sluijs et al. (2004) following their review of stage-based interventions on smoking, physical activity, and dietary behaviour. They found mixed evidence both in terms of stage progression and specific behaviour change. Following its development for use with smoking cessation, van Sluijs et al. question the applicability of the stage of change model to other health-related behaviours such as dieting and physical activity. Van Sluijs et al. argue that whilst smoking is a dichotomous behaviour, other behaviours to which the model has been applied are less clear, a large grey area surrounding what constitutes sufficient exercise, for instance. Although this is true, it could also be argued that sufficient evidence exists regarding the amount of exercise recommended per week for example, to enable distinctions to be made. However, application of the TTM is more advanced in relation to certain behaviours (e.g. smoking, diet) than others (i.e. mammography screening), and so further research may be needed in order to develop more rigorous approaches for intervening with each behaviour. Moreover, despite the mixed evidence, van Sluijs et al. conclude that the stages of change model:

‘...can still be viewed as a valuable model for changing behaviour, especially in primary care. It enables the primary care physician to obtain
important information for behaviour change in a short period of time, and it seems to be a logical basis for a behaviour change intervention.' (p. 342)

Furthermore, it is also important to note that, as highlighted by Sutton (2005), a critic of the TTM, the systematic reviews of stage-based interventions published to date (e.g. van Sluijs et al., 2004; Riemsma et al., 2003) have included studies that were not actually proper applications of the TTM.

It has also been argued that relatively few experimental studies have compared matched and mismatched interventions (Sutton, 2005, 2001; Weinstein et al., 1998). Prior to 2006, only five such studies could be identified. Three of these studies could not confirm that the hypothesised matched conditions were significantly more effective than the mismatched conditions (Blissmer & McAuley, 2002; Quinlan & McCaul, 2000; Project MATCH Research Group, 1998). However, two studies using stage models did find evidence of matching effects (Dijkstra et al., 1998; Weinstein et al. 1998). More recently, Dijkstra et al. (2006) provided further evidence that stage-matched interventions were significantly more effective than the mismatched interventions.

As with the HBM and TPB, the TTM has also received criticism on the basis of measurement. Sutton (2000) cites a number of variations in the wording of questions to assess stage, for instance, that are used in different studies on smoking cessation adopting the TTM. Namely, 'intending to quit', 'seriously considering quitting', 'seriously thinking of quitting', and 'planning to quit'. Sutton argued that these seemingly small differences have strong effects on measures, citing work by Weinstein et al. (1996, unpublished manuscript) regarding radon testing, in which 24% of participants said that they 'planned' to test, but only 14% said that they had 'decided' to test. This work (which has since been published; Weinstein et al., 1998) however, is actually an application of the precaution adoption process model - PAPM (Weinstein, 1988). As stated by Sutton (2005), 'the PAPM differs from the TTM in a number of ways' (p. 248), including the PAPM
having seven instead of five stages, and different criteria for determining stage. As there are a number of key distinctions between the TTM and the precaution adoption process model, it seems inappropriate to cite these findings as an application of the TTM. In addition, contrary to claims that TTM assessment methods have not been validated (e.g. Adams & White, 2003; Sutton, 2000), a number of validation studies exist. Jordan et al. (2003), for example, demonstrated both the discriminant and concurrent validity of stage of change assessment with regards to recovery from anorexia. Kerns et al. (1997) developed a measure to assess stage of change in terms of managing chronic pain, and also found substantial support for each factor’s discriminant and criterion-related validity.

Perhaps one of the most fundamental criticisms levelled at the TTM is the notion that the TTM is a ‘pseudo-stage’ model (Sutton, 2000), that the stages are not characterised by qualitatively different processes, but rather that they are simply points on the same linear continuum. In the words of Davidson (2001), for instance,

‘the segments of the cycle are probably not distinct stages but artificial markers on a motivational continuum.’ (p.24)

One of the fundamental arguments concerns the arbitrary time periods used to define some stage divisions (i.e. contemplation – intending to take action in the next 6 months, and preparation – intending to take action in the next 30 days). Although the preparation stage is also defined by the presence of a specific plan for action, either of these criteria is sufficient for classifying an individual as in the preparation stage. As argued by Sutton (2001, 2000, 1996), the use of arbitrary time periods such as this casts doubt on the assumption that the stages are qualitatively distinct. Armitage and Arden (2002) argue that behavioural intentions, for example, can be relatively negative in the precontemplation stage and progressively more positive in the contemplation, action, and maintenance stages, thereby increasing in a linear fashion across the stages. Armitage and
Arden attempted to test the existence of any non-linear trends, or 'discontinuity patterns' as termed by Sutton (2000) between the stages, by assessing the variance of the components of the TPB (behavioural intention, attitude, subjective norm, self-efficacy, perceived behavioural control, and self-identity) across the stages of change. Although the authors concluded that the results were:

'In general...[results are] suggestive of the fact that the TTM is a pseudo-stage model – with increasing higher scores as the data move from precontemplation through to maintenance.' (p.95),

In addition to linear relationships, quadratic components of the relationships between the factors were also identified. Furthermore, Armitage and Arden did not assess the factors that are predicted to vary with movement across the stages according to the TTM, namely, the decisional balance construct, habit strength, and the processes of change. As outlined previously, evidence has shown distinct patterns of these factors over the stages of change, but instead Armitage and Arden assessed variations in the components of the TPB.

In contrast to criticisms such as those outlined above, Smedslund (1997) argued that the sequence of the stages of change does not need to be empirically tested, as the conceptual definitions of the stages make the sequence of progression a priori and 'necessarily true'. What is meant by this, is that due to the fact that the stages of change are defined by relatively objective constraints (i.e. intending to take action or not, having taken action or not), they cannot logically occur in any other sequence. For instance, relapse must follow action, commitment to change (preparation) must precede the change, and given reasonable interpretations of the terms, commitment to act presupposes intention (contemplation), and intention must be preceded by awareness of the problem. As a result, Smedslund argues that the temporal sequence of the stages is not empirical, but due to the meaning of the concepts, is given a priori. Consequently, he suggests that this makes any experiment aiming to establish this sequence a 'pseudo-empirical enterprise'. This also suggests that any apparent deviations from the sequence are likely to be...
the result of inadequate measurement instruments. What Smedslund does accept as useful empirical research, is exploration of the percentages of persons in the given stages in a given population, which can also help plan interventions.

The rationale outlined by Smedslund also counters, to some extent, the argument put forward by Bandura (2000) that the TTM is not a genuine stage theory, as individuals can skip through one or more stages, and can also revert back to previous stages. Consistent with the argument of Smedslund, where reference has been made to individuals ‘skipping’ stages, it may simply be due to a failure to capture the individual while in those stages. After all, the model does not specify that individuals will necessarily remain in each stage for equal periods. Bandura also claims that ‘people do not fit neatly into prefixed categories’ (p.310), and considers the notion that some individuals have no interest in changing their health habits ‘common knowledge’, and consequently, not requiring ‘the encumbrance of stage theorising.’ (p.311). On the contrary however, I would argue that the stage of change ‘categories’ are sufficiently clear-cut (based on simple distinctions such as whether or not an individual is concerned about a particular health risk, and whether or not they have taken action, for instance), so that assigning stages does not require ‘fitting’ individuals to stages, as they necessarily fall into one of these categories, and can logically only be in one of these categories at a given time. Second, whilst I agree with Bandura’s point that some individuals have no interest in changing their health habits may be ‘common knowledge’, I would argue that this knowledge is not, however, always translated into practice, and this is the reason that it is a crucial aspect of the stages of change model. Finally, Bandura’s argument that ‘human functioning is simply too multifaceted and multidetermined to be categorised into a few discrete stages’ (1997, p.9) seems to conflict with his criticism of the stage of change model not representing a ‘genuine’ theory of change because ‘genuine’ change theories must be defined by an invariant sequence of change, and non-reversibility. If behaviour is complex and multifaceted, why must the sequence of change be invariant? Indeed, even Sutton (2001), himself a critic of the TTM, argued against
Bandura’s criticisms on the basis of invariance and irreversibility. Sutton (2001) argued:

‘while invariance and irreversibility may be appropriate for developmental stages, it seems unrealistic to insist on such strict assumptions for stages of change of addictive behaviours’ (p.182).

3.5.6 Application to the workplace

In light of the importance attributed to attitudes and beliefs in achieving behaviour change, calls have been made for application of the TTM to workplace interventions. The model has also been cited as a potential means of improving the engagement of small and medium sized enterprises (SMEs), by acquiring a greater understanding of their current needs, perceptions and attitudes towards health at work (Griffin et al., 2005). The TTM has been cited as offering a potential means of integrating the attitudinal and behavioural components of change into workplace interventions to tackle health (e.g. Prochaska et al., 2001; Haslam & Haslam; 2000; Maxfield et al., 1999; Dejoy, 1996). Maxfield et al. (1999) considered the appropriateness of stage of change framework for increasing the uptake of administrative controls or policies to reduce the risks of latex allergy among hospital workers. They provided some preliminary evidence to suggest that a preventive ‘alert’ message regarding the risks could result in significantly more individuals moving from the precontemplative stage (what Maxfield et al. refer to as ‘inactive’) into the contemplative stage (what Maxfield et al. refer to as ‘advocacy’). Urlings et al. (1990) provided some support for the benefits that such an approach might offer for ergonomics interventions, exploring the feasibility of adopting a staged approach to promote the introduction of standing aids into the Dutch furniture industry. This study did not, however, test the implementation of such an approach. Furthermore, consisting of a single case study, these findings have limited use in terms of broader application.
The specific relationships predicted by the TTM have been replicated within the organisational domain. The relationship between stages and the pros and cons of change, for example, has been identified in relation to participation in a collaborative service delivery (Levesque et al., 1999), change of service delivery in counselling agencies (Prochaska, 2000), readiness for a merger, participation in high-performance teams, and for continuous quality improvement (Prochaska et al., 2001a). Prochaska (2000) for instance, conducted an extensive evaluation of the applicability of the TTM to organisational change within family service agencies. Evidence was found for the systematic relationships predicted by the TTM in terms of the stages of change, the decisional balance construct (including the characteristic pattern of changes in pros and cons over the stages), and the ten processes of change. Regarding the ten processes, agencies in the precontemplation stage were significantly lower in their use of all processes, those in the action stage were the highest of among the highest users of consciousness raising, reinforcement management, counter conditioning, and commitment. Agencies in the more advanced stages of change were among the highest users of the helping relationships, stimulus control, counter conditioning, and commitment processes. Whilst this study provided support for application of the TTM to organisational change, by replicating the relationships between the constructs of the model and stages of change in this setting, it did not evaluate the effectiveness of change interventions that are tailored according the stage of change, compared to those that do not. Moreover, rather than a health-related intervention, the focus of this study was a change in the type of service provision in response to business demands (a movement to time-limited therapy). Being developed as a model of health-related behaviour change, it seems likely that the TTM is particularly applicable to organisational changes aimed at reducing ill-health. Other evidence has shown that although the stage of change model traditionally centres on individual behaviour change, Prochaska et al. (2001) demonstrated that stage-matched principles can be generalised to the group level in organisational change implementation.
3.6 Chapter summary

Behaviour has been identified as crucial to the effective reduction of MSDs, as for the risks to be reduced, action first needs to be taken by managers to implement risk-reducing measures (e.g. changes to the workplace layout, tools, equipment, or training). These changes then need to be adopted by employees, and integrated into their routine ways of working. Indeed, both HSE (2002) and NIOSH (1997) provided seven staged recommendations for tackling work-related MSDs, which recommend covering attitudinal and behavioural factors, in addition to factors relating to the physical work environment. However, current theory and practical guidance is unclear as to how recommendations for reducing the risks of MSDs in the workplace might actually be put into practice, particularly the attitudinal and behavioural change elements. Indeed, the neglect of psychological or behavioural elements in current approaches to tackling MSDs has been suggested as being, at least in part, due to the lack of techniques in ergonomics methodology for assessing psychological and systems environments (Haslam, 2002). Consequently, this chapter evaluated the most commonly adopted models of health behaviour change, in order to identify their potential applicability to the occupational domain.

The TTM (or stage of change model) was highlighted as having intuitive appeal for application to occupational health problems, due to the model’s recognition of the cyclic nature of change, and the consequential need for ongoing efforts to maintain healthy behaviour and prevent risks. This is consistent with previous calls for application of the stage of change model to workplace interventions aimed at tackling ill-health (Prochaska et al., 2001; Haslam & Haslam, 2000; Dejoy, 1996). Unlike the HBM or TPB, the stage of change model provides a practical framework that can be used to help guide the change process. This framework integrates all aspects of the intervention process from intervention development, to implementation, and monitoring. The scope for improving the effectiveness of ergonomics interventions as a result, is broad, particularly as
effective management of the change process has been held as a key reason for the success of (or lack of) organisational interventions (Schein, 1980).

Stage-matched interventions have not only been found to increase the effectiveness of interventions, but also the initial recruitment of individuals to change interventions. The fundamental reason for this is that traditional interventions often assume that individuals are ready for behaviour change, and therefore typically only relate to a very small proportion of the population. In contrast, the TTM recognises that different individuals will be in different stages and that as a result, interventions must be tailored according to their specific needs. In addition to recruitment rates (as discussed), the TTM has also been found to increase retention rates. This is a significant problem for behaviour change programmes, with almost 50% of participants tending to drop out prematurely (Wierzbicki & Pekarik, 1993). Due to its emphasis on the dynamic nature of behaviour change, the TTM is also valuable as it enables monitoring of change over time, and provides a sensitive measurement of progress.
Overview of thesis

Chapter 1: Introduction

Chapter 2: Literature review: MSDs

Chapter 3: Literature review: Behaviour change

Chapter 4: Exploration of current practices
- 14 Semi-structured interviews with ergonomics consultants

Chapter 5: Evaluation of materials
- Content analysis of HSE materials
- Evaluation of coverage of stages of change

Chapter 6: Tool development
- Worker questionnaire (n = 168)
- Managerial questionnaire (n = 100)

Chapter 7: Implementation
- 24 interventions monitored
- Half tailored according to stage
- Worker & managerial assessments pre & post intervention

Chapter 8: Exploration of the change process
- Post-intervention interviews with managers following tailored & non-tailored interventions (n = 17)

Chapter 9: Discussion, implications and recommendations
4. EXPLORATION OF CURRENT PRACTICES

4.1 Introduction

MSDs remain the most common form of work-related ill health in Great Britain (HSE, 2005). In the UK, MSDs (upper and lower limb conditions and back pain) are estimated to lead to the loss of approximately 11.6 million working days each year (HSC, 2005), despite developments in both understanding and regulation regarding the management of these conditions. A similar picture exists in other industrially developed countries. Consequently, there remains a pressing need to examine why the prevalence of work-related MSDs remains so high and, furthermore, how attempts to alleviate risks can be made more effective.

As outlined in Chapter 2, MSDs are highly complex, both in terms of the nature of these types of disorder, and the range of interacting factors that have been identified as associated with their onset. Undoubtedly, the complex causation of MSDs poses a significant obstacle to their control. Karsh et al. (2001) for example, presented a conceptual framework for understanding MSDs describing the work environment, work organisation, technologies and task as factors which interact with individual personal capacity (biomechanical, physiological, and psychological) to lead to MSDs. As a result, approaches to tackling MSDs often need to be directed at various different levels, as also highlighted by Snook (1988) in relation to the management of back pain in industry. Although research has identified risk factors as including both physical factors (e.g. force, repetition and posture), and psychosocial factors (e.g. role clarity, social/authoritative support and control), the extent to which these elements have been tackled in practice is unknown.

In addition to tackling potential risk factors, the review presented in Chapter 2 also identified that intervention effectiveness is influenced by the way in which
changes are implemented. As a general framework for the management of upper limb disorders (ULDs) in the workplace, HSE (2002) proposed a seven staged management cycle:

- Understand the issues and commit to action
- Create the right organisational environment
- Assess the risk of ULDs in the workplace
- Reduce the risks of ULDs
- Educate and inform the workforce
- Manage any episodes of ULDs
- Carry out regular checks on programme effectiveness

Outlining the procedure for undertaking an ergonomics intervention in industry, Haines and McAtamney (1995) suggested a similar framework, including:

- Clarify the aims of the investigation
- Secure commitment
- Identify and prioritise the problems for assessment
- Structure the assessment procedure
- Collect data
- Analyse and interpret the data
- Make recommendations
- Implement changes
- Review changes

Despite this however, intervention studies typically focus on quantitative outcomes (e.g. posture angles, or the number of employees reporting MSD symptoms) rather than on the intervention process itself. As a result, the extent to which ergonomics consultants incorporate the aspects of such frameworks into their work, for example how often they ensure that the issues are understood and that commitment to action is obtained, is unknown. Furthermore, there have been few attempts to evaluate the effectiveness of such interventions (Griffiths, 1999), and as highlighted by Volinn (1999) the small number of studies that have
evaluated interventions are limited by methodological problems. This is a matter of concern, not only due to the importance of improving employee health, but also in light of the ever increasing number of consultants engaged in this type of work.

Consequently, exploration of the process followed by practitioners when implementing interventions aimed at tackling MSDs, may provide some information regarding possible reasons for the ongoing prevalence of MSDs. If, for example, research knowledge and recommendations are not being translated into practice, it is important that the barriers inhibiting this are identified, and that methods are developed to facilitate the implementation of evidence-based practice. Such an investigation may therefore, offer some insight as to why MSDs remain so prevalent, in spite of the growing body of knowledge regarding these problems, and the risk factors associated with them.

4.1.1 Aims of the study
The study reported in this chapter (also published, Whysall et al., 2004) sought to investigate the current approaches adopted in practice in attempting to tackle MSDs. Arguably, the most appropriate group of ‘experts’ for tackling MSDs (although not the only group of specialists that offer help and advice on tackling such problems), are ergonomists. HSE, for instance, identify ergonomics as the approach of best practice when dealing with MSDs. As cited on their WebPages:

"The best way to achieve this is by using an ergonomic approach, which looks at achieving the best "fit" between the work, the working environment and the needs and capabilities of the workers." (HSE, 2005)

Furthermore, the adoption of an ‘ergonomics approach’ is also identified as the recommended approach for reducing the risks of MSDs in HSE’s guidance on Upper Limb Disorders (HSE, 2002).
Of particular interest, were the types of factors assessed by ergonomics consultants in tackling MSDs, consultants' judgments of the effectiveness of their recommendations for change, the barriers considered to inhibit the achievement of successful implementation of advice, and the extent to which the outcomes of their interventions are evaluated.

4.2 Method

4.2.1 Research Design
In-depth semi-structured interviews were conducted with 14 ergonomics consultants, to explore the consultancy process undertaken for tackling the risks of MSDs. A framework of 5 guiding questions was developed, on the basis of the aims of the study. These questions related to:

1. The process adopted when conducting an assignment, from the first point of contact with the client to completion.
2. The factors evaluated/assessed in the course of their investigations.
3. The extent to which consultants seek feedback or conduct any type of evaluation.
4. Perceived effectiveness of interventions, and thoughts of how methods may be improved.
5. Perceived barriers to the implementation of recommendations, and/or the effective reduction of MSDs.

Interviews were conversational and open-ended, typically between 45-60 minutes in duration. The discussions were tape recorded and fully transcribed.

4.2.2 Sample
Interviewees were 14 ergonomics consultants from 12 different consultancy organisations in the UK, each with varying degrees of experience. Consultants were selected on a convenience basis from the Ergonomics Society's (UK) professional register of ergonomics consultants, and were invited to participate in
the study via letter or email. The register had 58 consultancies listed at July 2003. Being the issue of primary concern in this thesis, a criterion for participation was that consultants dealt with MSDs.

4.2.3 Analysis
Transcribed data from the interviews were analysed using the structured method outlined by Miles and Huberman (1994), involving a three-staged approach beginning with data reduction (involving initial coding and search for themes), followed by the generation of data displays, and conclusion drawing and verification. The first phase involved physically organising and sub-dividing data into meaningful segments by cutting and pasting material into categorical collections. The second phase involved determining criteria for organising data into themes (coding the data) and a subsequent search for patterns within themes to draw meaningful conclusions. The initial set of codes (or themes) corresponded to each question in the interview schedule. Other topics arose spontaneously in the discussion (emergent themes), which were assigned separate codes. The data under each theme was summarised and verbatim quotes used to illustrate the theme being described. The analysis was led by the original guiding questions (see section 4.2.1).

4.3 Results

4.3.1 Descriptive statistics
The average length of experience as a consultant for the interviewees was 10 years, ranging from 3 to 30 years. Four were independent consultants, 9 were employed within consultancy firms, and 1 operated as an associate to a consultancy firm. Excluding the sole practitioners, the consultancy firms represented ranged in size, employing between 2-28 consultants (mean = 13). Geographically, consultants were distributed across the UK. All but 2 of the interviewees practised in a context of professional ergonomics accreditation.
either through registration held by themselves or through the registration of their employer. Interviewee details are summarised in Table 7.

4.3.2 Initial contact
The consultants reported that initial requests for help or advice usually originated from the health and safety manager within client organisations. On occasions contact was also made by front line managers, occupational health specialists, human resources managers, in-house company ergonomists and, in small companies, a director. Compliance with Health & Safety Executive (HSE) inspections, or having already identified a specific problem themselves was highlighted as the most common motivators for clients to request help:

'Very often we are contacted because people already have a problem that is preventing an employee or a group of employees from working...'

Only three interviewees reported receiving requests from organisations that had not yet experienced problems, but that desired to take a more precautionary approach – in the words of one senior consultant representing a larger consultancy firm, companies that are 'wanting to look after people'.

A crucial part of the initial contact phase, identified by all interviewees (also consistent with Block, 1999), is the negotiation of a contract (formal or informal), the key aim of which was to establish likely cost and duration of the project. Two consultants highlighted the importance of clarifying expectations at this early
stage, especially to break down preconceived ideas of what an ergonomics consultant does:

'Sometimes people have very fixed ideas about what an ergonomics consultant will do, so it's very important to ensure that expectations are clarified prior to the visit.'

4.3.3 The consultancy process

A consistent message regarding general consultancy procedures was that there is no set process followed when undertaking an assignment aimed at reducing risks such as those for MSDs. As described by one experienced consultant, there is 'no fixed linear response'. One possibility is that in some instances, the

Table 7. Interviewee details

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<th>Consultant</th>
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<th>Professional ergonomics accreditation</th>
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consultant's employer has a standardised approach to consultancy practice, but that consultants were choosing to ignore it. However, from the responses, this is judged to be unlikely. Consultants suggested several reasons for a lack of standardisation to their approach. The diversity of the work was one such reason:

'What is required depends very much on the type of project...not all require workplace assessments as such, some are more like problem solving exercises.'

Experience also emerged as a likely reason for the absence of standardisation, consultants indicating that they tend instead to rely on an 'informal checklist', often developed as a result of experience. The importance attributed to building up a rapport with the client was highlighted by four interviewees, and might also contribute to the lack of standard approaches (this being perceived as obstructing the development of a good rapport). The importance of developing affinity with the client was illustrated by one male consultant with 12 years experience, '...if the client doesn't like you, you won't get the work.'

4.3.4 Meeting clients' needs and expectations
The importance of meeting a client's expectations was highlighted by several interviewees as imposing a strong influence on the consultancy process and outcomes. In the words of one:

'...at the end of the day it's all very well being right, but if you're not getting the work...' 

A second consultant, with over 30 years experience, explained the importance of achieving a careful balance between making sure the client feels they are getting what they want, whilst also effectively solving the problem:
‘If you don’t get the balance of these two factors, the project won’t be a success – if you don’t answer their needs, they won’t want you to go any further. If you just answer their needs but don’t actually solve the problem, it won’t work either.’

Another consultant suggested that this could be achieved by:

‘...attempting to influence what they think they [the client] want by framing the solution or problem.’

Despite this however, this consultant added that ‘...to some extent, you must do what they expect’, perhaps as a result of the notion that clients tend to accept recommendations, ‘so long as you’re getting at what they want.’ In terms of tailoring solutions, only one interviewee specifically stated that recommendations will be ‘tailored to the level of existing knowledge in an organisation’, on the basis that it is ‘no good telling them something they already know’. However, generally consultants did not appear to make any systematic attempt to explore stakeholders’ underlying understanding, other than asking what had already been tried. One interviewee, an associate consultant for 3 years, believed that:

‘...their occupational health dept should have covered this [the knowledge aspect] in the initial stages.’

Another with 12 years experience argued that ‘I don’t think you need to make people understand the issues’. He instead felt that highlighting the potential costs of claims is sufficient to motivate companies to take action. Accordingly, consultants identified that they generally examine only the physical or environmental aspects of the workplace. As one co-director of a consultancy firm explained, ‘We’re not psychologists, so it’s very much to do with physical aspects.’
4.3.5 Work assessment

The factors assessed, and the information gathered, that was common to all consultants included:

- obtaining an overview of the work and problems experienced by talking to their contact within the company (typically health & safety manager)
- a tour of the workplace in question
- detailed analyses of specific tasks, using tools such as RULA or REBA (Hignett & McAtamney, 2000; McAtamney & Corlett, 1993).
- photographic and video evidence of operators performing tasks
- talks/interviews with individual operators

Both photographs and other specific tools that enable the quantification of information (such as RULA or REBA) were highlighted as being 'good for explaining problems to management', and enabling the prioritisation of action. Several interviewees also emphasised the importance of talking to operators to clarify factors that may not be directly obvious, such as why they perform a task in a specific way. Despite this, it emerged that access to employees is at the discretion of the client, and not always granted. When able to interview operators, the factors that are typically discussed included the degree of repetition in the job, the frequency of breaks, the level of discomfort, 'aches and pains', sometimes using body mapping techniques, and how the employee feels their job could be improved.

As described by one female consultant:

'We would not assess attitudes as such, but do give them [operators] the opportunity to say what they think should be changed, and what they think would work...they often have the right ideas, but there are also certain things that they do not think of...because they don't feel they have authority to change their workstation.'
Regardless of the amount of information drawn from a workplace assessment, and the fact that workplace evaluations were identified as typically taking half to one day to complete, four interviewees indicated that it is often immediately apparent what the problem is, and what a particular workplace is like:

'...you get to a point where you walk into a place and within an hour, you know what that place is like.'

The process was referred to as relatively implicit, 'a feel thing' in the words of one interviewee, relied upon as a result of experience.

4.3.6 Variation within consultancy firms
Perhaps not surprisingly, due to the absence of standard procedures, one consultant with 12 years experience highlighted that the approaches adopted by different consultants (even those within the same consultancy firm) are likely to differ greatly:

'My own way of working is not necessarily the same as someone else who works for [name of consultancy], and the extent to which consultants conform to the company ethos differs.'

On the other hand, it emerged that due to fluctuating amounts of work, more and more consultancies are employing associates during times of peak demand. The implications of this were highlighted by the associate consultant, who explained that associates have less autonomy in deciding what to do and how to lead a project, as much of this tends to have been agreed beforehand. Consequently, it was suggested that associates are likely to follow the procedure that is dictated to them by the consultancy firm more closely.

Further differences emerged in terms of the size of projects taken on, as although some of the larger consultancies expressed a preference for large scale, long-
term projects, one independent consultant identified that he tends to avoid big
tenders, as he 'can't afford to spend the time on those'.

4.3.7 Recommendations
In terms of recommendations, the tendency to offer a range of potential solutions
was common. This appeared to be due to a combination of two main factors:
first, reflecting the complexity of ergonomics problems and, second, consultants'
recognition that clients are unlikely to implement all of the recommendations that
are made, due to limitations in factors such as time, cost, expertise, and
motivation. The importance of taking such a pragmatic approach was illustrated
by one interviewee:

'At the end of the day, recommendations are only worthwhile so long
as they are carried out.'

Categorisation of measures in terms of cost and short or long term timescale
were both approaches used to grade recommended changes. An assumption
behind this was that if clients are not disposed towards the most optimal
intervention, they will 'hopefully do something rather than nothing'. Explaining
the pros and cons of each recommendation and prioritising action were also
highlighted as common methods adopted to increase the likelihood of clients
taking action. The importance of prioritisation was linked to the complexity of
ergonomic problems, as illustrated by the following remark from a consultant with
around 20 years experience:

'Although most ergonomics problems are very complex, I've learnt that
essentially, companies want definitive answers – they want to know
what they can do that is achievable.'

Perception of cost may also be a key factor in the reluctance of organisations to
adopt pro-active, preventative measures, in that they fail to appreciate the benefit
of investing resources in order to reduce potential risks before they have materialised. An associate consultant with 3 years experience indicated how problems need to be obvious and serious before organisations are willing to act:

"In my experience, the severity of the problem tends to promote acceptance to do something about it."

Despite this, one consultant did highlight they were increasingly being contacted by clients who had not yet experienced problems, but who were keen to eliminate potential risks. As mentioned previously, however, this was the exception, the remainder of interviewees stating that clients almost always have an existing problem.

4.3.8 Overcoming barriers
A further barrier to promoting changes aimed at reducing risks, highlighted by several interviewees, was that the consultant’s contact in an organisation was rarely the person responsible for the ‘purse strings’. As a result, two interviewees described that they had begun to suggest that clients conduct ‘pilot’ projects, to enable them to get a realistic feel for the cost-benefits and likely barriers to implementing change, starting by targeting the key areas needing attention in their organisation. This enables clients to develop a business case that can be used to convince management of the benefits of allocating the necessary resources. Only one of the fourteen consultants identified contact with senior management as a common occurrence. In this case, the consultant, a co-director of the firm with 10 years experience, indicated that they would specify as part of their contract that recommendations be put forward by way of a presentation to senior management. Alternatively, it was indicated that their recommendations would be sent in advance to be discussed with senior management during a subsequent meeting.
Clients' motivations to request help were also highlighted as a key factor in determining action:

‘...at the end of the day it depends on the organisation, whether they intend to carry out the changes, which they often have the intention (or not) right from the beginning.’

For example, if a client was motivated by an adverse HSE inspection, they may be more likely to want to do as little as necessary to be seen to have done something. Regardless of all of these factors, however, it was described that often whether a client actually carries out recommendations or not will depend on the individual company, and ‘how much they value the health and safety of their employees.’ One interviewee explained that:

‘If a company is open-minded, they will consider whatever you propose, just take a deep breath and accept what needs to be done. If the company has a more negative culture, they might just say “we can’t do that here”.’

4.3.9 Initiating action and reducing risks
The extent to which consultants felt that their intervention would result in successful change varied greatly between interviewees. In the words of a female consultant working as a sole-practitioner:

‘You only go in for one day, so it’s difficult to get a good understanding of all of the problems and likely barriers. You have to accept that your recommendations will always be of limited value as a result.’

Another consultant with 20 years experience identified that:
‘...they are usually very receptive to the recommendations, even the organisational ones, as by then you have built up a rapport, and they trust you know what's best.’

This interviewee also believed that most of the time clients know what needs to be done, but 'just needed someone to confirm it.' As a result, it would perhaps be useful to investigate the extent to which clients' acceptance of recommendations depends upon the extent to which consultants tailor their recommendations to what they think clients want to hear.

Interestingly, despite consultants making little assessment of employees' or managers' knowledge regarding MSDs, lack of understanding was proposed as a reason why recommendations are rarely fully implemented. As remarked by one sole-practitioner:

‘Generally people have no idea what an ergonomics assessment is... This lack of understanding can make it less likely that recommendations are implemented properly. I know full well that the detail in the consultancy report goes straight over most people's heads...[I] feel very sure that companies focus on simple changes like job rotation and are very reluctant to take on board anything that requires radical changes.’

Alternatively, another interviewee felt that clients will usually do something to tackle the problem 'especially if the solutions are easy and inexpensive.'

4.3.10 Evaluation
Consultants were asked whether they evaluated their interventions, and if not, how they know whether they have been successful or not. The common response was that 'we don't often get the chance to follow up'. General agreement existed regarding the lack of evidence for the benefit of consultancy
interventions, many consultants being doubtful that their recommendations were often carried out in the manner intended. One interviewee suggested that this:

'is either because they [consultants] are not clearly putting the message across, or highlighting cost benefit enough.'

One reason for the lack of evaluation given by a number of consultants was uncertainty of its practical benefits. As articulated by a senior consultant with over 30 years experience:

'We rarely evaluate, but then again there are pros and cons for doing this. On the one hand clients may see it as a thorough approach if in the proposal you say that you will come back and assess changes, others may just decide to go with someone who knows what they do will work.'

For the most part though, lack of evaluation was largely attributed to factors outside of the consultants' control:

'We would love to do more to evaluate benefits of approaches, but in my experience, companies seem very disinterested in evaluation. Once they have made their changes, they're on to the next thing.'

Several interviewees highlighted a preference for long-term contracts of work, similarly to maintaining long-term relationships with clients with ongoing requests for work. In these cases consultants explained that they do get the chance to see the outcomes of their recommendations, although the clear message was that 'fewer of those [long term projects] exist.' In other circumstances where evaluation is conducted, it appeared that this may not necessarily be undertaken to assess the implementation of recommendations, but more for sales purposes, to initiate further work. In light of the lack of opportunity to revisit companies after
presenting their recommendations for changes, two consultants described the importance of ensuring that clients have the best chance of implementing changes effectively:

'Because of this, we try to promote a participatory approach, as there is more of a chance that they will get it right on their own after this type of intervention.'

As a result, when asked "how do you know that your proposed solutions are effective?", the consensus was that 'we don't really!' This response was frequently accompanied by one of two qualifying statements, either the notion that it is 'better to get them [clients] to change some aspects than nothing', or 'the fact that we get asked back into certain companies is a good indicator'.

4.4 Discussion

4.4.1 Key findings
The key findings from the interviews, and the challenges that are presented by these findings in terms of future practice, are summarised in Table 8. Perhaps one of the most important findings of this study was that the nature of ergonomics practice for tackling MSDs focused heavily on the physical aspects of work (e.g. force, posture, cycle time, and workstation layout). This seems surprising, firstly given the notion that ergonomics is an 'holistic approach to understanding complex and interacting systems' (Wilson, 2000), and second, in light of the widely recognised role played by psychosocial factors in relation to MSDs (as discussed in Section 2.9). Therefore, in emphasising physical issues, current interventions to tackle MSDs may be ignoring critical facets of the work system. At least part of the reason for this may be the lack of techniques in the repertoire of ergonomics methodology available to consultants for assessing psychological and systems environments (Haslam, 2002).
4.4.2 Implications for intervention effectiveness

The apparent lack of explicit attention given by the consultants to managers' and workers' attitudes and beliefs has a number of implications for the change process. As outlined in Chapter 3, it is important that the recipients of advice and recommendations (i.e. employers and employees) hold appropriate attitudes and knowledge, if efforts to achieve change are to be effective. This is supported by HSE (2002) guidance on managing upper limb disorders in the workplace, which not only recommends to 'assess the risk of ULDs in the workplace', but also highlights the importance of 'educating and informing your workforce', as part of the recommended seven staged management cycle. However, it could also be argued that the HSE guidance is circumspect as to how this might actually be achieved.

Furthermore, it is likely that knowledge, attitudes and beliefs will vary between different groups within an organisation, across employees, supervisors, managers, and directors (Haslam, 2002). Equally, the knowledge, attitudes and beliefs conducive to achieving change in terms of MSDs will also vary between such individuals. At a managerial level, attitudes, beliefs, and understanding are particularly relevant to the effectiveness of ergonomics consultancy interventions, given that individuals in these roles exert a strong influence on whether recommendations will actually be implemented or not. A failure to appreciate the complexity of ergonomics, and the potential benefits that can be gained from effective implementation of ergonomics solutions, might underpin the tendency for organisations to only partially implement recommendations and to select the least expensive or most easily made changes. Assessing and tackling these underlying motivations is not only likely to increase the probability that changes are implemented, but also that they are implemented effectively.

Another important finding from this study was the lack of evaluation undertaken. As a result, consultants (and organisations) cannot be sure of the extent to which interventions are effective. The absence of feedback on the success of their
work will also impede consultants’ ability to refine and improve their practice. Indeed, the importance of evaluation and feedback for learning has been emphasised in both the organisational learning (e.g. Greve, 2003) and systems thinking literature (e.g. Senge, 1990). In today’s culture of clinical governance and evidence based practice, there is a growing need for practitioners to prove the efficacy of their methods (e.g. Farmer & Chesson, 2001). Ergonomists should not be exempt from this process (nor, indeed, should any practitioner providing services to tackle MSDs), and evaluation should be integrated into approaches for tackling MSDs, either as part of the consultancy process or through independent audit, as proposed by NIOSH/NORA (2003).

4.4.3 Methodological limitations
Interviewer subjectivity is an important consideration in a qualitative study such as that described in this chapter. However, a number of measures were taken to minimise this, namely, the generation of a semi-structured interview framework to guide each interview, and the standardised approach to analysis developed by Miles and Huberman (1994).

This study examined ergonomics consultancy practice with respect to MSDs in the UK. Consequently, an interesting question is the extent to which the findings can be generalised to practices outside the UK. Although it was outside the scope and resources of this thesis to examine this systematically, the findings were presented to ergonomists working in consultancy practice in Canada, USA and New Zealand. All felt that the findings were highly applicable in their own countries. Thus, anecdotally, at least, it appears that the circumstances summarised in Table 8 are recognisable in connection with ergonomics consultancy operating in other countries. Furthermore, although at the time of this work, no other investigations of its kind had been conducted, Koningsveld et al. (2005) subsequently published an analysis of twelve research and consultancy projects in the Netherlands. On the basis of this, Koningsveld et al. highlighted a number of gaps in the design of projects, a number of which reflect
those identified by this study: a good inventory, direct workers' participation, strong management support, a step-by-step approach, focus not only on health issues (but also issues relating to the organisation system), establishment of a

**Table 8. Key findings and the challenges presented**

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<th>Consultancy Challenges</th>
<th>Contributing Factors</th>
<th>Suggested Improvements</th>
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| 1 Adopting a systems approach, which takes into account factors relating to the organisational context, worker, work tasks, and work environment | - Some ergonomists' perception of psychological and psychosocial factors as outside their remit  
- Lack of techniques in the repertoire of ergonomics methodology available to consultants for assessing psychological and systemic factors  
- Clients unreceptive to broad investigation | - Raising client awareness of the importance of psychological and systemic factors regarding the efficacy of ergonomics advice  
- Development of tools/techniques to enable holistic assessment, integrating factors relating to the organisation, worker, work tasks, work environment, and interactions between these factors |
| 2 Securing commitment from senior management | - Lack of involvement of senior management in requesting and receiving consultancy advice  
- Senior management stakeholders having little (if any) involvement in the consultancy process | - Consideration given to the knowledge, attitudes, and beliefs held by key individuals at different levels within the organisation  
- Consultants to seek involvement of appropriate senior management in projects  
- Assemble senior management in projects |
| 3 Uptake of recommendations by client organisations | - Clients' understanding of ergonomics, and the rationale behind recommendations  
- Clients' perceptions of cost-benefit of taking action, particularly with regard to preventative action and large scale changes | - Accompany ergonomics recommendations with information and advice aimed at improving clients' receptivity to change. Important factors include the cost-benefit of implementing change, and the benefits to be gained from taking a systems approach |
| 4 Evaluating the outcomes of advice/recommendations | - Clients' unwillingness to fund evaluation, restricting opportunity for consultants to evaluate  
- Clients' perception that a need for evaluation indicates ineffectiveness | - Emphasise importance of evaluation and organisational learning to clients  
- Encourage problem-solving approach, and a consultant/client relationship as an on-going partnership |
steering group, checks on the effects of interventions, and cost-benefit assessments.

4.5 Chapter summary

The study described in this chapter sought to investigate current practices in tackling MSDs, in order to identify the extent to which these practices reflect recommendations of best practice. Specific aims were to explore the process adopted when conducting an assignment, to identify the factors assessed by consultants in attempting to tackle MSDs, the extent to which consultants seek feedback or conduct any type of evaluation, their perceived effectiveness of interventions, and barriers to implementation of recommendations, and/or the effective reduction of MSDs. The importance these aims is emphasised by the fact that despite the prevalence of MSDs, relatively few studies evaluating interventions to tackle these problems appear to have been published (Institute of Medicine, 2001; Griffiths, 1999), and the limited number of studies that have evaluated interventions tend to focus on quantitative outcomes (e.g. posture angles, or the number of employees reporting MSD symptoms) rather than on the intervention process itself (as identified by the review of intervention evaluation studies, section 2.13). Interviews were conducted with fourteen ergonomics consultants representing a range of practices from large consultancy firms to self-employed individuals. It was evident from the data produced, that ergonomics practice with respect to MSDs represented in the sample interviewed focused heavily on the physical aspects of work. In emphasising physical issues, current ergonomics interventions may overlook critical facets of the work system. Consequently, neglect of the ‘psychological’, or ‘softer’ side of the change process may partly account for the mixed evidence for intervention effectiveness research (outlined in section 2.13). A second important point to emerge from the interviews was that evaluation was rarely carried out in practice. This combination of factors may go some way towards explaining the prevalence of MSDs in spite of increasing knowledge regarding the risk factors with which they
are associated. Further research is needed, therefore, to evaluate the
effectiveness of alternative approaches, specifically, those that integrate physical,
psychosocial, and behavioural elements, incorporating elements such as gaining
management commitment, and educating change recipients regarding the risks
(as recommended by HSE, 2002; NIOSH, 1997).

In conclusion, this study highlighted an apparent gap between recommendations
of best practice for the reduction of MSDs, and the approaches that are
implemented in practice. The study revealed important challenges that should be
addressed in the attempt to make interventions to reduce the risks of MSDs more
effective. Two fundamental needs have been identified: i) the development of
tools to facilitate the assessment of behavioural and psychological factors of
relevance to the process of reducing occupational health risks; ii) the generation
of a practical framework for guiding the intervention process. As MSDs have
remained the most common form of work-related ill health for over a decade, in
spite of growing evidence for the risk factors associated with their onset, it is
important that new approaches are developed that are not only be effective, but
also pragmatic.
5. EVALUATION OF GUIDANCE MATERIALS

5.1 Introduction

Another medium through which organisations receive advice on how to reduce the risks of MSOs, is through guidance materials such as leaflets. In the context of this thesis and its focus on the stage of change approach, it is appropriate to consider how guidance materials reflect the principles outlined by the stage of change paradigm. This is achieved by identifying relevant guidance materials published by the primary UK guidance authority for occupational health and safety, and systematically evaluating their content.

The Health and Safety Commission (HSC) and the Health and Safety Executive (HSE) are the two government bodies tasked with protecting the health and safety of the workforce. HSC is responsible for health and safety regulation in Great Britain. HSE, in partnership with local authorities, are the enforcing bodies who work in support of the Commission. It is the aim of HSC and HSE to reduce both the prevalence and incidence of occupational accidents and ill-health. In terms of MSOs, in 2000, HSE set out aims for a 20% reduction in the incidence rate by 2010.

Chapter 4 presented the results of a study aimed at exploring the process adopted by ergonomics practitioners when attempting to tackle MSOs. External consultants are an important source of expertise for many organisations attempting to tackle health and safety problems such as MSOs. However, research suggests that external consultants are only enlisted by approximately half of medium and large sized organisations (48% and 55%, respectively), and just 28% of small organisations (Clarke et al., 2005). It might be speculated that this difference is, at least in part, due to the more limited resources of small
organisations. Some larger organisations, on the other hand, may employ their own in-house specialists.

In order to support employers in tackling health problems such as MSDs, HSC and HSE provide a large amount of information in the form of guidance materials, frequently in the form of leaflets. HSC/E communications are produced to inform employers and employees about relevant health issues, so as to have the knowledge needed to adopt or implement safe working practices. A further important function of HSC/E communications is to encourage and motivate employers and employees to make improvements.

HSC/E guidance is likely to be particularly important for smaller organisations, which may be less likely to employ occupational health specialists, due to limited resources. Small organisations are important targets for reducing the incidence of MSDs, as they employ the majority of the workforce (DTI, 2004). Indeed, research suggests that HSE publications are not only the most common sources of advice or information utilised by small organisations, but also the most common source of advice or information consulted by medium and large sized organisations (Clarke et al., 2005). Consequently, it is important that such materials are actually effective in helping employees and employers achieve improvements in risk control and reduction.

The use of leaflets is a widespread approach in health promotion and understanding the effectiveness of this is relevant to use of guidance materials in the workplace setting. Ferguson et al. (2003) suggested that the widespread use of leaflets might be due to three main reasons. First, such publications are relatively inexpensive to produce and easy to distribute, thereby making them a potentially cost effective intervention. Second, leaflets are versatile, portable and, it is suggested, contain more information than posters. Third, leaflets may be used alone or in conjunction with additional health promotion interventions (Harvey et al., 2000).
The main aims of health promotion leaflets are to increase awareness or knowledge of a risk and to motivate behaviour change. Although there appears to be only a relatively limited number of studies that have evaluated the effectiveness of these types of materials, those that do exist, suggest that the use of health promotion leaflets has been effective in improving knowledge in relation to various public health behaviours. Watkins et al. (1987), for example, evaluated the effectiveness of a leaflet for hypertensive patients distributed by post. This leaflet contained information both on the condition, and how to control it. In comparison to a control group that did not receive any information, the patients that received the leaflet displayed a significant increase in knowledge one year after distribution of the leaflet. A Cochrane review of the effects of mass media interventions on the utilisation of health services (Grilli et al., 2002) found that 19 of the 20 studies reviewed concluded that mass media was effective. The major limitation of these advertising campaigns was identified as their short-term effect, as since behavioural change is not reinforced on an ongoing basis, the changes are not sustained.

Other evidence suggests that information provided in leaflets is not always acted upon appropriately (Ferguson, 2001). Indeed, a review of media based physical activity interventions, including a variety of print, graphic, audiovisual, and broadcast media programmes intended to influence behaviour change, revealed that the recall of such messages was generally high. However, these campaigns were found to have very little impact on physical activity behaviour (Marcus et al., 1998). Similar results were found by Reid (1985), in the evaluation of a mass media campaign on smoking in the UK. The 2 week campaign, centred on a national No Smoking day, included wide newspaper coverage, and radio and television slots promoting the stop-smoking campaign. Despite high public awareness, of 4,000 smokers studied 3 months after the campaign, only 11% had tried to stop smoking, and only 3% of these 4,000 had actually been successful.
The failure to change behaviour associated with a health risk is clearly a fundamental weakness, as safety communications have no value unless they actually inform or change behaviour so as to ensure safety (e.g. Cox & Tait, 1998). As a result, it has been suggested that mass media health promotion campaigns should be designed to support initiatives from other health organisations, and specifically, to prepare a large population for a health promotion intervention (Maes & Boersma, 2004). Consistent with this, are the findings of the evaluation of the Florida 'Truth' anti-tobacco intervention, which combined health promotion materials and physical interventions. The campaign incorporated the use of print and broadcast advertisements, action groups with teenagers, related items on the school curricula, tobacco sales restrictions and a website. The campaign resulted in increased knowledge of tobacco possession laws for adolescents, and a significant decline in teenage smoking during the first two years of implementation. These findings suggest that awareness raising media campaigns may be more effective if used in combination with other methods (Perry, 2000). In addition, Marcus et al. (1998) found evidence to suggest that approaches that were tailored to the target audience were more effective in achieving behaviour change. Indeed, as health promotion campaigns must reach the masses, heterogeneity of the target population is an important concern. Symonds et al. (1995), for example, found that pamphlets designed to tackle back problems in the workplace, containing messages aimed at changing beliefs (e.g. "Back pain is not usually a serious problem. Continued back pain is not inevitable."), produced large changes in beliefs among workers with no previous history of lower back pain. This study suggested that those workers that had already experienced back problems might require a different approach. Consequently, tailoring messages to the needs of different segments of the population (and different types of health problem) may prove to be a more adequate strategy for intervention (Maes & Boersma, 2004).

A possible reason for the failure of mass media health promotion campaigns to have the desired effects is that the extent to which they are based on theory
relating to communication and behaviour change, is unknown (Abraham et al., 2002). A recent evaluation of poster campaigns regarding hand hygiene revealed that health promotion posters seldom draw on knowledge about effective ways to frame messages (Jenner et al., 2005). Jenner et al. argued that the posters were not designed to motivate, some even containing mixed messages. There is general agreement theory should be part of the design and evaluation of health promotion initiatives (Green & Tones, 1999). Consequently, research has identified that the design of health promotion communications appears to be an important consideration when trying to influence safe working practices.

A large proportion of health promotion materials use fear as a motivator (Ferguson et al., 2003). Fear appeals are persuasive messages designed to scare people by describing the terrible things that will happen to them if they do not do what the message recommends (Witte, 1992). While some studies substantiate the effectiveness of fear appeals (e.g., Fiske, 1992; Beck, 1984; Stainback & Rogers, 1983), others demonstrate their ineffectiveness (e.g., Shadel et al., 2002; Taubman Ben-Ari, 2000; Worden and Flynn, 1999; Goldberg et al., 1991). Ferguson et al. (2003) found that leaflets in which the information was framed positively (highlighting the benefits of adopting safe working practices) were generally more influential on intentions to act than leaflets containing negatively framed information. In general, health communicators recommend that people should not be scared into healthy practices (Hill et al., 1998). Witte (1992, 1998), on the other hand, argued for the use of fear appeals, but highlighted the important interaction between fear and perceived efficacy. In other words, according to Witte, not only must individuals believe that they are at risk, but individuals must also believe that they are capable of performing the necessary action to reduce the risk. Such a notion of consistent with the Theory of Planned Behaviour (Ajzen, 1988; 1985), described in Chapter 4 (section 4 5), and the stage of change approach (a component of the Transtheoretical Model; Prochaska & DiClemente, 1983).
As discussed in depth in Chapter 3 (section 3.5), the stage of change model suggests that the most effective approach for generating behaviour change will vary over time. The model construes change as a process involving movement through a series of five stages, encompassing both attitudinal and behavioural changes:

i) precontemplation (resistance to recognising or modifying problem behaviour);

ii) contemplation (recognition of the problem, thinking about changing, but not ready to act);

iii) preparation (intending to change in the next 30 days, and/or having made specific plans to do so);

iv) action (having engaged in behaviour change, no longer than 6 months ago); and

v) maintenance (initiated changes over 6 months ago, working to consolidate gains made) or relapse.

The precontemplation stage, for instance, is typically characterised by denial of the problem in hand. The costs of resolving the issue tend to be overestimated, whilst the costs of not addressing the issue are underestimated (Carr, 2004). As a result, the presentation of strong messages is considered important in order to convince individuals within this stage of the risks, and prevent the target audience from dismissing the information as unnecessary or irrelevant. Fear appeals, for instance, are therefore likely to be effective for individuals at this early stage. However, once individuals are aware of the risks, and are convinced of the need for changes to be made, they are seen as having progressed into the preparation stage. Therefore, individuals in this stage require practical information regarding the types of changes that should be made. Alternatively, those that have already made changes need to be encouraged of the importance of maintaining such behaviours or practices in order to prevent relapse. Techniques such as counter conditioning (i.e. highlighting positive aspects of
behavioural change) are likely to be most effective for individuals in the maintenance stage, in addition to practical information regarding the need for ongoing efforts, and systems for maintaining low levels of risk (e.g. monitoring, evaluation, and feedback).

Research adopting the stage of change model has shown that by tailoring health promotion interventions according to the beliefs, attitudes, and intentions that underpin an individual’s current stage, the likelihood that individuals will take action can be significantly increased (e.g. Rakowski et al., 1998; Prochaska et al., 1993). Tailored interventions have also been provided using a computer-based ‘expert system’ programme, which matches messages to individuals’ information needs (Dijkstra et al., 1998). Inconsistent evidence for the effectiveness of approaches such as fear appeals is perhaps unsurprising, therefore, due to the failure of such approaches to take account of the temporal dimension, given that an individual’s receptiveness to such an approach is likely to vary over time.

As HSE publications appear to be the most commonly consulted source of advice or information by organisations regarding workplace health and safety (Clarke et al., 2005), it is important that these publications are as effective as possible in promoting the desired changes. As discussed, the importance of this is heightened by the fact that small organisations employ the majority of the workforce, and due to limited resources, smaller organisations may rely more heavily on guidance such as that provided by HSE. However, as with other health promotion materials, the extent to which HSE health promotion materials are based on behaviour change theory appears to be unknown. There has been relatively little previous research on the content of workplace health promotion leaflets (Abraham et al., 2002). Furthermore, no evidence could be found for application of behaviour change theory or readiness to change, to the design of such publications.
5.1.1 Aims of the study
Following on from the study outlined in the previous chapter exploring the practices of ergonomics advisors, this chapter deals with another common source of advice and guidance for employers, and seeks to evaluate this guidance within the stage of change framework. Specifically, the purpose of this study was to determine the extent to which HSE guidance (in the form of leaflets) on tackling MSDs reflect the stages of change outlined by Prochaska and DiClemente (1983). The study had three main aims:

1. To perform a content analysis to categorise the nature of the information contained within the leaflets.

2. To evaluate if, and to what extent, leaflets providing information about MSDs target the stages of change outlined by the Transtheoretical Model of behaviour change (Prochaska & DiClemente, 1983).

3. To measure (objectively) the proportion of each leaflet, in terms of area coverage, devoted to information pertaining to each of the stages.

5.2 Method

5.2.1 Selection of materials
All non-priced HSE leaflets providing guidance on tackling MSDs were collected, current as of March 2006. These materials were gathered from both the HSE website, and the HSE library at the Health and Safety Laboratory, Buxton. Three inclusion criteria were applied, in order to limit the number of potentially confounding factors. First, that leaflets promoted the reduction of risks for work-related MSDs. Second, that leaflets were published by HSC or HSE. Third, that leaflets were unpriced. General ergonomics publications, not specifically aimed at tackling MSDs, were not included. The end sample consisted of 16 leaflets.
5.2.2 Analysis

In order to gain an understanding of the types of messages conveyed by these publications, a content analysis was performed. Content analysis has been considered a reputable approach for analysing communication contents for many years (Bartkus et al., 2004). A relatively simple procedure was followed, as the aim of this part of the analysis was simply to identify the key messages conveyed. As suggested by Rubin and Rubin (1995), an initial list of tentative codes was created, based on each individual leaflet (relating to the key concepts mentioned). This list was then compared against subsequent leaflets to identify ‘repeatable regularities’, or to generate new codes. This process has also been referred to as discriminant sampling (Lincoln & Guba, 1985).

Qualitative analyses were undertaken to evaluate the extent to which each publication provided information pertaining to the precontemplation, preparation, and maintenance stages of change. Based on a review of the stage of change literature (see Chapter 3), the key messages relating to each of these stages are shown in Table 9. A coding framework was developed through initial piloting and consultation with other researchers familiar with the stage of change approach. The final coding framework evaluated leaflets according to the extent to which each publication provided information relating to each of the stages of change, on three levels. First, an initial dichotomous judgment was made to identify whether the piece of guidance provided any information at all relating to each stage (yes or no). Second, a rating of the quality of this information (in terms of the extent to which it conveys the key messages underpinning each stage) was made, using a scale of one to three (1 = good, 2 = moderate, 3 = poor). This relatively coarse scale was used in an attempt to reduce the degree of subjectivity. A standard framework was generated to help define these criteria, specifying the range of factors that should be considered in relation to each stage (see Appendix 1). Finally, an objective, quantitative measurement was made to evaluate the percentage (area) of the document that was devoted to information pertaining to each stage of change. This was achieved by calculating the number of pages,
half page or quarter page units providing relevant information, divided by the total number of pages. These figures were then rounded to the nearest 5%, in order to reflect the relative crudity of the calculation. Pages containing no information (e.g. back or inside cover) were excluded from this calculation. A second coder provided independent checks on the reliability of the ratings, and reliability was calculated using percentage of agreement between the coders.

Table 9. Key messages relating to each of the stages of change

<table>
<thead>
<tr>
<th>Key beliefs</th>
<th>Key messages to convey</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Precontemplation (not considering changing)</strong></td>
<td></td>
</tr>
<tr>
<td>No need to change — MSDs not considered a significant risk</td>
<td>Raising awareness of risks, risk severity, susceptibility, health effects, and other effects e.g. productivity, profit, morale</td>
</tr>
<tr>
<td><strong>Preparation (strong intention to change)</strong></td>
<td></td>
</tr>
<tr>
<td>Intention to make changes in near future and/or concrete plans for the specific steps to be taken</td>
<td>Types of changes that can be effective in reducing MSDs Most effective approaches to implementation (e.g. value of taking a systems approach, worker participation)</td>
</tr>
<tr>
<td><strong>Maintenance (having taken action, working to prevent relapse or consolidate gains made)</strong></td>
<td></td>
</tr>
<tr>
<td>Must work to consolidate and maintain the changes/improvements</td>
<td>Emphasise need for continual efforts to prevent relapse Continually changing risks Need for ongoing vigilance, evaluation and feedback</td>
</tr>
</tbody>
</table>

Due to the specific definition of the contemplation stage (e.g. planning to take action within the next six months), and the difficulty of presenting such information in leaflets, leaflets were assessed according to the following three stages only: precontemplation (raising awareness of the risks and the need to make changes), preparation (practical information regarding the types of changes that can be made to reduce the risks), and maintenance (how to maintain low levels of risk). The action stage was combined with the preparation stage for the purposes of this analysis, as this stage essentially reflects the implementation of
the practical information that should be highlighted to individuals in the preparation stage. In terms of maintenance, the recommendation to update risk assessments following specific changes to the work or workplace was not considered sufficient. In order to effectively maintain low levels of risk, it is thought that risk assessments should be systematically reviewed on ongoing basis - not just when changes have been made to the workplace. Ongoing reviews of the effectiveness of measures are important for a number of reasons. It could be argued, for instance, that organisations are continually evolving. In addition, employees' attitudes and behaviours are likely to affect the extent to which they might be considered as 'at risk' (particularly in relation to psychosocial risk factors), and these factors are also likely to vary over time.

5.3 Results

5.3.1 Nature of leaflets
Within the sample of 16 leaflets generated, 4 were aimed specifically at smaller organisations, although it was stated that many of the general principles were also likely to be relevant to organisations regardless of size (leaflets 1, 2, 3, and 12 - see Table 10 for leaflet numbers). Twelve of the 16 leaflets (75%) were aimed specifically at tackling manual handling tasks (leaflets 1, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16). The majority (10 of 16) were also industry specific (leaflets 5, 7, 8, 9, 10, 11, 13, 14, 15, 16).

5.3.2 Content analysis
Leaflet content fell into three main themes and further sub-themes, illustrated by the index tree (Figure 14). The first main theme to be identified, 'the problem', was sub-divided into a number of sub-themes: 'definition', 'risk factors/causes', 'prevalence', for 'regulatory requirements', and 'consequences'. In terms of regulatory requirements, some leaflets made reference to specific acts. In most cases, this was the Manual Handling Operations Regulations (1992), but less frequent mention was also made of the Management of Health and Safety at
Work Regulations (1999), the Health and Safety at Work Act (1974), the Provision and Use of Work Equipment Regulations (1998), and the Display Screen Equipment Regulations (1992). A further subset of the themes was identified in relation to 'consequences': employee absence, symptoms, compensation, productivity/quality, and retraining. The second main theme, 'solutions', was subdivided into the following themes: task, environment, equipment, work organisation, individual differences, training, participation, and further information. These sub-themes were fairly consistently cited across the range of leaflets. The third main theme, 'controlling the risks', was subdivided into four further themes: monitoring/early reporting of symptoms, rehabilitation, evaluation of measures, and the risk assessment updating.

5.3.3 Analysis of leaflets according to the stages of change

The percentage coverage of each leaflet, and ratings of the quality of information provided, according to the precontemplation, preparation, and maintenance stages, are presented in Table 10. A summary of results for all leaflets, including mean ratings of the quality of the information given in the leaflets according to stage of change, and the mean percentage (area) of the leaflets that was attributed to each stage, is presented in Table 11, according to the three identified stages of change. Intercoder reliability between the raters was high (89% agreement on coverage, and 83% agreement on quality ratings).
<table>
<thead>
<tr>
<th>Leaflet</th>
<th>No. of pages</th>
<th>Coverage (Y/N)</th>
<th>% coverage*</th>
<th>Quality rating (1=good, 2=moderate, 3=poor)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Getting to grips with manual handling (Rev1, 2000)</td>
<td>10</td>
<td>✓ ✓ x</td>
<td>5 85 0</td>
<td>2 1 3</td>
</tr>
<tr>
<td>2. Aching arms (or RSI) in small businesses (2003)</td>
<td>10</td>
<td>✓ ✓ ✓</td>
<td>15 60 10</td>
<td>1 1 3</td>
</tr>
<tr>
<td>4. Are you making the best use of lifting and handling aids? (2004)</td>
<td>11</td>
<td>✓ ✓ x</td>
<td>15 70 0</td>
<td>1 2 3</td>
</tr>
<tr>
<td>6. Working with VDUs (2003)</td>
<td>15</td>
<td>✓ ✓ x</td>
<td>5 70 0</td>
<td>2 2 3</td>
</tr>
<tr>
<td>7. Work-related upper limb disorders in the printing industry (1994)</td>
<td>20</td>
<td>✓ ✓ ✓</td>
<td>20 60 5</td>
<td>1 1 1</td>
</tr>
<tr>
<td>8. Handling the news: Advice for employers on manual handling of bundles (1999)</td>
<td>18</td>
<td>✓ ✓ ✓</td>
<td>10 80 5</td>
<td>2 1 2</td>
</tr>
<tr>
<td>9. Manual handling in the textiles industry (1998)</td>
<td>16</td>
<td>✓ ✓ x</td>
<td>5 90 0</td>
<td>1 1 3</td>
</tr>
<tr>
<td>11. Handling loads in agriculture (1996)</td>
<td>7</td>
<td>✓ ✓ x</td>
<td>10 90 0</td>
<td>2 1 3</td>
</tr>
<tr>
<td>14. Don't put your back into it: how to avoid manual handling in the plastics industry (1995)</td>
<td>6</td>
<td>✓ ✓ x</td>
<td>50 35 0</td>
<td>1 3 3</td>
</tr>
<tr>
<td>15. Manual handling in the railway industry (2000)</td>
<td>14</td>
<td>✓ ✓ ✓</td>
<td>5 70 25</td>
<td>1 1 1</td>
</tr>
<tr>
<td>16. Handling the news: advice for news agents and employees (2002)</td>
<td>6</td>
<td>✓ ✓ x</td>
<td>10 75 0</td>
<td>2 2 3</td>
</tr>
</tbody>
</table>

* Does not necessarily equal 100, as some information was not relevant to any of the stages
Table 11. Mean quality ratings and percentage coverage, according to stage of change

<table>
<thead>
<tr>
<th></th>
<th>% coverage</th>
<th>Quality rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Min</td>
</tr>
<tr>
<td>Precontemplation</td>
<td>12</td>
<td>5</td>
</tr>
<tr>
<td>Preparation</td>
<td>71</td>
<td>55</td>
</tr>
<tr>
<td>Maintenance</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

As shown in Table 10, all 16 leaflets provided some information of relevance to the precontemplation and preparation stages (i.e. information regarding the risks/why action needs to be taken and practical information regarding how to actually reduce the risks). Only 7 of the 16 leaflets (44%), however, provided any information regarding the maintenance of risk reducing efforts over time. Overall, the largest proportion (71%) of each leaflet tended to be devoted to practical information, in terms of the types of changes that should be made. In contrast, on average only 4% of each leaflet contained information regarding the maintenance of low levels of risk over time. Where it was provided, information regarding the maintenance of risk reducing measures over time tended to be of moderate quality. Information relating to the precontemplation stage was rated good to moderate quality, and practical information, of relevance to individuals in the preparation stage, tended to be of good quality. The leaflets tended to consistently describe the broad range of risk factors that are associated with MSDs (i.e. factors relating to the work tasks, work tools or equipment, the work environment, the organisation of work, and individual/psychosocial factors).

5.3.4 Suggested sources of further information

In the course of the analysis, it was observed that all leaflets provided a list of sources for further information. In fact, on average, 10% of each leaflet was attributed to providing further sources of information. Consequently, post-hoc analyses were conducted to identify the types of further sources that are suggested. These sources are listed in Table 12, according to their title and...
where applicable, reference number. In brackets following the title of each source, is the number of the leaflet (from the sample evaluated in this study) that cited the publication as a further source of information (following the numbering of the study materials given in Table 10). Due to the large number of additional HSE sources provided, only sources cited by more than one leaflet are presented. For instance, leaflet number 7 ("Work-related upper limb disorders in the printing industry") provides an additional list of 23 HSE publications of specific reference to the printing industry. As these sources are not suggested by any other of the leaflets evaluated, they are not included in this analysis.

Table 12. Suggested sources of further information

<table>
<thead>
<tr>
<th>HSE priced guidance</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual handling: Guidance on regulations L23 [1, 3, 7, 8, 9, 10, 12, 13, 14, 15, 16]</td>
<td></td>
</tr>
<tr>
<td>Manual handling: Solutions you can handle HSG115 [1, 3, 4, 5, 8, 12, 13, 14, 15]</td>
<td></td>
</tr>
<tr>
<td>A Pain in Your Workplace? Ergonomic problems and solutions HSG121 [1, 2, 5, 12, 15]</td>
<td></td>
</tr>
<tr>
<td>Upper Limb Disorders in the Workplace HSG60 [2, 5, 7, 15, 16]</td>
<td></td>
</tr>
<tr>
<td>The Law on VDUs: an Easy Guide HSG90 [2, 6]</td>
<td></td>
</tr>
<tr>
<td>Work Equipment: Guidance on Regulations L22 [7, 13]</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HSE free guidance</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting to Grips with Manual Handling: A short guide for employers INDG143(rev1) [3, 5, 7, 8, 9, 13, 14, 15, 16]</td>
<td></td>
</tr>
<tr>
<td>Five Steps to Risk Assessment INDG163(rev1) [3, 7, 15]</td>
<td></td>
</tr>
<tr>
<td>If the Task Fits – Ergonomics at Work INDG90(rev1)¹ [4, 7, 13]</td>
<td></td>
</tr>
<tr>
<td>Working with VDUs Leaflet INDG36 [2, 7]</td>
<td></td>
</tr>
</tbody>
</table>

¹Leaflet has subsequently been superseded by a revised publication
Only one leaflet (leaflet 3: “Back in work: Managing back pain in the workplace”) provided any non-HSE sources of further information. These were *Occupational Health Guidelines for the Management of Low Back Pain at Work: Evidence Review and Recommendations* (Faculty of Occupational Medicine; free), *Back Pain at Work: A guide for people at work and the employers* (Faculty of Occupational Medicine; free), *Working Backs Scotland Pack* (free in Scotland), *Beating Back Pain in Small Firms* (TUC; free), and *The Back Book* (The Stationery Office, 2000, priced). The remaining 15 leaflets suggested HSE sources only for further information. The most commonly recommended source of information was guidance on complying with manual handling regulations, suggested by 11 of the 16 leaflets. The next most commonly recommended sources provided guidance on reducing the risks associated with manual handling, ‘Manual handling: Solutions you can handle’, and ‘Getting to Grips with Manual Handling: A short guide for employers’ (the former priced HSE publication, and the latter one of the free leaflets evaluated within this study).

5.4 Discussion

5.4.1 Key findings

The study described in this chapter was concerned with evaluating the extent to which HSC/E leaflets aimed at helping employers and employees tackle work-related MSDs include information of relevance to the precontemplation, preparation, and maintenance stages of change. First, a content analysis was conducted to categorise the nature of the messages conveyed by the leaflets. Following this, the 16 leaflets were evaluated, according to the extent to which they provided information targeting these stages of change. In addition to an estimation of the proportion of each leaflet (in terms of area coverage) devoted to information pertaining to each of the stages, judgments were made of the quality of information provided.

Whilst all leaflets provided some information of relevance to the precontemplation and preparation stages, only 5 of the 16 leaflets (31%) included information regarding the maintenance of risk reducing measures. Furthermore, where it was provided, this information tended to be of moderate quality, and on average, only
4% of each leaflet was devoted to information regarding the ongoing management of problems. These findings are consistent with a Cochrane review of the effects of mass media interventions (Grilli et al., 2002) outlined in the introduction to this chapter. Grilli et al. argued that a major limitation of advertising campaigns was their short-term effect, as changes are not reinforced, and therefore not sustained. In addition, information relating to the precontemplation stage typically accounted for 12% of each leaflet, also tending to be of moderate quality. In contrast, overall, 71% of each leaflet was concerned with practical solutions for tackling MSDs, of relevance to individuals in the preparation or action stage. In addition, this information was, overall, judged as of good quality. One of the reasons for this was that leaflets tended to be consistently comprehensive in highlighting a broad range of practical solutions that could be considered, or factors that could be assessed, in order to reduce the risks of MSDs. In contrast, the types of messages presented in relation to the precontemplation and maintenance stages (i.e. information regarding the risks, and information regarding how to manage the risks on an ongoing basis) tended to be varied. For instance, in terms of information regarding the risks that is likely to promote action among precontemplative individuals, some leaflets just cited the high levels of sickness absence that are associated with MSDs. Other leaflets cited a more extensive range of detrimental outcomes that could potentially result from MSDs, including not only absence, but also reduced productivity and/or quality, retraining costs, compensation claims, and the effects on individual health. Similarly, in terms of maintaining low levels of risk on an ongoing basis, some leaflets simply mentioned the need to encourage early reporting of symptoms, but made no reference to the importance of evaluating control measures, the importance of systematically updating risk assessments, the need for ongoing health monitoring, and rehabilitation programmes for workers that have developed problems.

5.4.2 Implications
Clearly, it is important that employers are provided with information regarding the practical changes that should be made to help reduce the risks associated with MSDs. However, the value of such information is limited unless it is acted upon. The stage of change model implies that action is unlikely to be taken unless the
recipient perceives there to be a need for changes to be made. This study suggested that HSE leaflets aimed at tackling MSDs provide a relatively limited amount of information aimed at persuading readers of the importance of taking action to tackle the risks (e.g. information regarding the costs associated with these problems). As a result, for employers unconvinced of need to take action, consulting these materials might even reinforce the view that the issue does not warrant action (at least for the time being). This may explain why previous findings have identified that messages conveyed by a range of print, graphic, audiovisual and broadcast media programmes had a very limited impact in changing behaviour (Marcus et al., 1998). The lack of information aimed at persuading readers of the importance of taking action is particularly surprising, perhaps, given that these sources of information might often be considered a ‘first-port of call’ (reflected the extent to which each leaflet provided the user with other sources of guidance).

Changes are also unlikely to be effective unless efforts are made to maintain the benefits overtime. Given that only 5 of the 16 leaflets (31%) provided information regarding the maintenance of risk reducing measures over time, this may be an important omission in the context of these materials. After all, the actual implementation of changes, whether they are changes to the physical workplace, the introduction of new tools or techniques, or new working practices, may only take a matter of days, weeks or months. However, in order for these changes to be effective they need to be maintained overtime and their effectiveness systematically reviewed. The importance of establishing systems for achieving this was generally not conveyed by the materials evaluated. Consequently, although leaflets are cited as potentially cost-effective interventions (Ferguson et al., 2003), this may not be the case if their effects are only short lived.

In terms of the lack of information regarding the maintenance of risk reducing measures over time, an important consideration is whether this simply reflects a lack of developed approaches or frameworks for maintenance. It is possible that information regarding the practical changes provided by these leaflets is of better quality, and is more consistent, due to the existence of more guidance and evidence for the types of risk factors that should be tackled. However, this
explanation cannot really be applied to information relating to the precontemplation stage, as the undesirable outcomes and financial costs associated with MSDs are relatively well documented. It seems likely though, that the development of a standard framework of best practice in terms of maintaining low levels of MSD risks on an ongoing basis would be beneficial for achieving the HSE's aim of a 20% reduction in incidence of MSDs by 2010.

It is also important to consider what is expected of these leaflets, and how they are intended to be used. As stated in the introduction, it is assumed that the aim of such publications is to provide employers and employees with the relevant knowledge to adopt or implement safe working practices. Indeed, the finding that the leaflets involved in this evaluation tended to focus on the practical changes that should be considered when attempting to reduce the risks provides some support for this assumption. It may also be intended that these leaflets are to be used in conjunction with other forms of intervention, as suggested by Harvey et al. (2000). However, if this is the case (for instance, if it is intended that organisations enlist the support of a health and safety specialist to help implement changes), this is not made clear within the leaflets. The only further resources that readers are directed to are other leaflets or guidance materials, some of which are included in this evaluation.

In terms of the types of messages conveyed by these leaflets, an additional consideration is that the nature of these messages is not only likely to be influenced by current evidence, but also to some extent, by the political context. It could be speculated for instance, that the Government's current emphasis on reducing the numbers of people on incapacity benefit, has resulted in increased emphasis on rehabilitation. It is also interesting to note that although this study aimed to gather all leaflets relating to the topic of MSDs in general, 12 of the 16 leaflets identified were specifically concerned with tackling manual handling. This finding is worthy of note, for a number of reasons. First, the number of occupations for which manual handling constitutes a key component is decreasing within this country, due to the ongoing decline of our manufacturing industry, and the growing service sector. Second, by placing emphasis on manual handling, these leaflets downplay the role of individual and psychosocial
factors in the development of MSDs, instead implying that MSDs are primarily caused by the task of manual handling. In addition, although the information that is tailored according to specific industries is likely to be more effective than generic information, it appears that not all industries are represented. For instance, no materials meeting these criteria were found for the catering industry, the distribution industry (other than for newspapers), or the healthcare sector. There is no obvious reason for this pattern of provision.

5.4.3 Methodological limitations
This study was exploratory and its limitations should be recognised. As an attempt to reduce the subjectivity of ratings and to avoid enforcing fine distinctions where it was not felt appropriate, a limited scale was used for evaluating the quality of leaflets. It was felt that this was appropriate due to the restricted amount of information that can be conveyed in such leaflets. Moreover, a second coder rated the quality of information provided by leaflets independently, to assess the reliability of ratings. These findings suggested good levels of reliability.

Future research might usefully conduct experimental evaluations of the effectiveness of such leaflets, possibly by comparing the effectiveness of tailored and non-tailored leaflets when used in practice to encourage employers to take action to implement safe working practices. Depending on the outcomes of such research, bodies such as the HSC/E, which are concerned with promoting safe or ‘healthy’ practices/behaviours, might consider ensuring that their materials provide information of relevance to the stages of change, and possibly even the cost-effectiveness of producing and disseminating tailored materials.

5.4.4 Chapter summary
Leaflets are a widespread means of promoting health. Evidence for the effectiveness of such leaflets in promoting a range of health behaviours, however, is mixed. In addition, the extent to which such guidance is based on theory relating to communication and behaviour change, is unknown (Abraham et al., 2002). Research adopting the stage of change model (Prochaska & DiClemente, 1983) has shown that by tailoring health promotion interventions according to the
beliefs, attitudes, and intentions that underpin an individual's current stage of change, the likelihood that individuals will take action can be significantly increased (e.g. Rakowski et al., 1998; Prochaska et al., 1993). It is possible that leaflets presenting information to help employers and employees tackle occupational health or safety problems may also benefit from tailoring according to stage of change.

The study presented in this chapter attempted to evaluate the extent to which leaflets aimed at helping employers and/or employees tackle MSDs provided information of relevance to the different stages of change: the precontemplation, preparation/action and maintenance stages. One of the main findings was that whilst all leaflets provided some information of relevance to the precontemplation and preparation stages, only 5 of the 16 leaflets (31%) provided information regarding the maintenance of risk reducing measures. Due to the importance of maintaining effective risk reducing measures on an ongoing basis, this may be an important omission in the context of these materials.
Overview of thesis

Chapter 1: Introduction

Chapter 2: Literature review: MSDs

Chapter 3: Literature review: Behaviour change

Chapter 4: Exploration of current practices
- 14 Semi-structured interviews with ergonomics consultants

Chapter 5: Evaluation of materials
- Content analysis of HSE materials
- Evaluation of coverage of stages of change

Chapter 6: Tool development
- Worker questionnaire (n = 168)
- Managerial questionnaire (n = 100)

Chapter 7: Implementation
- 24 interventions monitored
- Half tailored according to stage
- Worker & managerial assessments pre & post intervention

Chapter 8: Exploration of the change process
- Post-intervention interviews with managers following tailored & non-tailored interventions (n = 17)

Chapter 9: Discussion, implications and recommendations
6. TOOL DEVELOPMENT

6.1 Introduction

The literature review presented in Chapter 2 identified the complexity of MSDs, and the range of risk factors that should be tackled in order to reduce the prevalence of these problems. The review also highlighted the importance of the implementation process, with key elements for success including ensuring that interventions to tackle these risk factors are embedded within a process of stakeholder engagement, that change recipients are educated about the risks, and that interventions are evaluated. The extent to which these factors are incorporated into interventions in practice, however, was unknown.

In light of the importance of behaviour change for the effectiveness of interventions, Chapter 3 presented a review of the most commonly adopted behaviour change models, the Health Belief Model, the Theory of Planned Behaviour, and the Transtheoretical Model (or Stage of Change approach). The review highlighted the potential applicability of the stage of change model as offering a potential means of integrating the attitudinal and behavioural components of change into workplace interventions to tackle health. This is consistent with previous calls for application of the stage of change approach to tackling occupational ill-health (e.g. Prochaska et al., 2001; Haslam & Haslam; 2000; Dejoy, 1996). It is suggested that the tendency for ergonomics practitioners to neglect behavioural factors in practice is not due to lack of appreciation of the effect of behaviour on risk, but an absence of techniques for measuring and integrating behavioural and physical workplace factors (Haslam, 2002). Benefits of the stage of change approach include recognition of the cyclic nature of change, the model's integration of attitudinal, behavioural, and physical/environmental factors, and its holistic approach to the intervention process, incorporating all elements of the intervention process from establishing a receptive environment, developing tailored interventions, to maintaining and evaluating changes.
As the extent to which psychological or behavioural factors are incorporated into interventions is unknown, Chapter 4 described a study that investigated the extent to which ergonomics practitioners tackle such factors in practice. This study revealed that the nature of ergonomics practice for tackling MSDs focused heavily on the physical aspects of work (e.g. force, posture, cycle time, and workstation layout). In emphasising physical issues, current interventions to tackle MSDs may be ignoring critical facets of the work system, namely, risk perception, attitudes, readiness to change, and stakeholder commitment. However, it has been suggested that part of the reason for this may be the lack of techniques in the repertoire of ergonomics methodology available to consultants for assessing psychological and systems environments (Haslam, 2002).

However, external consultants are only enlisted by approximately half of medium and large sized organisations (48% and 55%, respectively), and just 28% of small organisations (Clarke et al., 2005). As a result, Chapter 5 presented an analysis of guidance materials produced by HSC/E, aimed at helping employers tackle health problems such as MSDs. Such communications are produced to provide employers and employees with the relevant knowledge to adopt or implement safe working practices. HSC/E guidance is likely to be particularly useful for smaller organisations, which may be less likely to employ occupational health specialists, due to limited resources. The study evaluated the extent to which HSC/E leaflets aimed at helping employers and employees tackle work-related MSDs include information of relevance to the precontemplation, preparation, and maintenance stages of change. One of the main findings was that whilst all leaflets provided some information of relevance to the precontemplation and preparation stages, only 5 of the 16 leaflets (31%) provided information regarding the maintenance of risk reducing measures. Due to the importance of maintaining effective risk reducing measures on an ongoing basis, this may be an important omission in the context of these materials.

Consequently, despite the importance of psychological and behavioural elements in tackling health problems such as MSDs, and the intuitive appeal of the stage of change framework for guiding occupational health and safety interventions (as outlined in Section 3.5.6), the resources currently available (whether consultancy
services of external practitioners or guidance in the form of HSE leaflets) do not appear to reflect such factors.

6.1.1 Aims of the study

With a view to improving the efficacy of such interventions, this study aimed to develop the stage of change approach for use within the organisational setting. In order to achieve this, specific objectives were:

- to develop the stage of change approach for applicability to the occupational domain, specifically, for assessing stage of change with regards to reducing the risks of MSDs
- to design tools to assess both individual worker and managerial stage of change in relation to reducing the risks of MSDs in the workplace, based on the traditional set of questions developed in previous work
- to develop sets of likert style questions to assess individual worker and managerial stage of change in relation to reducing the risks of MSDs in the workplace, to enable comparison of alternative methods of assessing stage in this context
- to identify factors that may influence the implementation or effectiveness of interventions, and to generate a set of likert style questions to assess these factors
- to design a questionnaire incorporating the above items, and additional sections gathering important demographic or background information
- to test the reliability (and to some extent, validity) of these tools in a range of organisations where workers are considered at risk in terms of MSDs, and explore the factors relating to stage of change.

6.2 Method

It is intended that the measurement of both managerial and individual worker factors will enable exploration of the interplay between these factors in influencing safety-related behaviour in the workplace, of which little is known, despite both sets of factors having been identified as crucial to the successful reduction of occupational health problems such as MSDs (Dejoy, 1996). Due to the wealth of
research that already exists in support of the relationships between stage of change and the ten processes of change, decisional balance, and habit strength (outlined in section 3.5), these factors were not assessed. Furthermore, the majority of studies examining the stages of change model have focused on structure, and the least on outcome (Bouton, 2000). Aside from stage of change, additional information was also collected regarding the factors that influence the implementation of ergonomic improvements, of which little is known (de Jong et al., 2003; Haslam, 2002). Although MSDs are the focus of this thesis, it is believed that the approach will be applicable to a variety of health and safety issues.

### 6.2.1 Research instruments

Questionnaires were designed for both managers and workers. Both sets of questions comprised the following 3 sections:

- general information (e.g. company size, role of the respondent, tenure)
- stage of change assessment
- attitudes, behavioural intentions, and perceptions of the facilitators and barriers to the reduction of MSDs (descriptive statements rated for level of agreement on a 5-point Likert scale)

The worker questionnaire included an additional section, to assess musculoskeletal pain experienced in the previous 7 days, and the previous 12 months. The presence of pain or discomfort was assessed using the Nordic Musculoskeletal Questionnaire (Kourinka et al, 1987). This has been used in studies of Nordic workers and British occupational groups, and therefore allows comparison of pain prevalence with other working populations. The term 'musculoskeletal problems' (as opposed to musculoskeletal disorders) was used throughout the questionnaire, as some sufferers may be misled by the term 'disorder', and falsely discouraged from identifying their problems. Standardised instructions described what was meant by this term (see Appendix 2).
**Stage of change tool**

A relatively small set of standard questions was used to assess stage, based upon the traditional method of assessing of stage of change developed in previous work (e.g. DiClemente et al., 1991). These questions are based on the standard delimiting factors for classifying stage, with minor modifications made to improve applicability to the organisational domain, and the issue of MSDs (see Table 13). The precise timeframe ‘taking action within 30 days’ that is typically applied to define preparation was considered too narrow with regard to implementing the types of changes necessary to reduce work-related MSDs, as this process is often subject to external constraints. In order that the question related more closely to behavioural intentions rather than difficulties due to external constraints on the implementation of changes, the wording was relaxed to state ‘within the next month or two’. Slightly different wordings of question items were also required for managers than for workers, due to the nature of their roles in the organisation (see Appendix 3).

**Table 13. Delimiting factors for classifying stage**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precontemplation</td>
<td>Unconcerned about the risks and does not intend to take steps to reduce the risks in the next 6 months</td>
</tr>
<tr>
<td>Contemplation</td>
<td>Intends to take steps to reduce the risks in the next 6 months</td>
</tr>
<tr>
<td>Preparation</td>
<td>Intends to take steps to reduce the risks in the next month or two, and/or has specific plans for the types of changes that will be made</td>
</tr>
<tr>
<td>Action</td>
<td>Took steps aimed at reducing the risks in the last 6 months. These steps must reflect ‘higher order’ changes as described by HSE (2002)</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Took steps aimed at reducing the risks over 6 months ago, and is acting to consolidate the gains made (i.e. continual monitoring and feedback)</td>
</tr>
<tr>
<td>Relapse</td>
<td>Took action aimed at reducing the risks over 6 months ago, but is no longer paying any attention to the issue, and does not intend on doing so. Typically relapses into precontemplation</td>
</tr>
</tbody>
</table>

In addition to the modification outlined above, the successful reduction of MSDs risks in the workplace is a less easily quantifiable outcome than those of giving up
smoking or achieving weight loss. Consequently, a clear definition of what constitutes effective action to tackle MSD risks was needed to identify the action stage. This is consistent with Prochaska and colleagues at the Cancer Prevention Research Centre (2005), who argued that what constitutes 'action' will depend upon the criterion agreed by scientists as sufficient to reduce the risks of developing the health problem. HSE guidance on the effective management of ULDs (HSE, 2002) was used as the basis for these criteria. Organisations were classified as being in the action stage if they had recently, or were currently implementing what are referred to in the HSE guidance as 'higher order' solutions. Higher order solutions are attempts to eliminate the risk at source (e.g. through redesign of the work task, replacement of tools or components, or through automation of the task). Individual workers were classified as being in the action stage if they had made changes to their job in order to reduce the risk of MSDs, irrespective of whether their employer had made changes. It was found that in some circumstances, the employee has limited scope for making actual changes to their work or workplace. In these situations, employees' progression into the action stage may be dependent to some extent, upon the degree to which their employer had made changes. However, in cases where employees are unable to change the work or work environment themselves, it is possible for them to request that management make changes; itself a form of action.

Workers were also asked whether their employer had made any changes. However, this was to assess the level of agreement between the extent to which managers and workers reported action to have been taken, rather than for determining workers' stage of change. This would also enable assessment of the extent to which employees' action is related to that of their employers.

**Alternative stage of change assessment**

A set of Likert style questions was created as an alternative means of assessing stage of change, for purposes of assessing reliability (the questions are shown in Table 14, and a copy of the tool used is shown in Appendix 4). Questions were developed to assess the defining characteristics of stage (e.g. appreciation of the risk, perceived need to take action, intention to act, appreciation of the need to maintain efforts aimed at reducing the risks). Two items were developed for each
stage where possible, although this was considered inappropriate for certain stages, where the stage is defined by a single factor. For instance, the contemplation stage has only one primary defining characteristic, the consideration to take action in the next 6 months. Consequently, it would be difficult to construct two different questions regarding this without them being highly repetitive.

Table 14. Stage of change assessment using Likert scale

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precontemplation</td>
<td>Employees here are at risk from developing musculoskeletal problems</td>
</tr>
<tr>
<td></td>
<td>There is no need to change the way we work with regard to the risk of</td>
</tr>
<tr>
<td></td>
<td>musculoskeletal problems</td>
</tr>
<tr>
<td>Contemplation</td>
<td>It is a top priority that the risk of musculoskeletal problems is reduced in</td>
</tr>
<tr>
<td></td>
<td>the next 6 months</td>
</tr>
<tr>
<td>Preparation</td>
<td>It is a top priority that the risk of musculoskeletal problems is reduced in</td>
</tr>
<tr>
<td></td>
<td>the next month or two</td>
</tr>
<tr>
<td></td>
<td>I currently do not have any specific ideas about the changes that should be</td>
</tr>
<tr>
<td></td>
<td>made</td>
</tr>
<tr>
<td>Action</td>
<td>The risks of musculoskeletal problems have been reduced</td>
</tr>
<tr>
<td>Maintenance</td>
<td>There are further measures that need to be taken to reduce the risk of</td>
</tr>
<tr>
<td></td>
<td>musculoskeletal problems</td>
</tr>
<tr>
<td></td>
<td>Further time and resources need to be allocated to tackling</td>
</tr>
<tr>
<td></td>
<td>musculoskeletal problems</td>
</tr>
</tbody>
</table>

**Attitudes, barriers, facilitators**

A bespoke set of Likert style questions was generated to explore specific barriers and facilitators that may influence the effective reduction of ill health in the workplace (see Table 15). Items were decided upon through a selection process beginning with the generation of a large set of possible items, which were based upon a review of the stage of change literature, and in the case of barriers and facilitators, health behaviour change literature (with specific reference to occupational health and safety initiatives). This large item set was then systematically narrowed down according to the strength of the evidence base, and the relevance of each factor for the work environment in terms of tackling MSDs. This process was consultative, also drawing upon the expertise of my supervisors. The following factors were assessed in relation to MSDs: perceived
susceptibility to the risk, perceived cost-benefit of taking action, availability of necessary time and resources, internal/external attribution of cause, perceived efficacy of interventions, perceived effect of MSDs on absence, perceived effect of MSDs on productivity, resistance to change amongst the workforce, and perceived control over the risks.

Table 15. Question set to assess attitudes, barriers, and facilitators

<table>
<thead>
<tr>
<th>Perceived susceptibility</th>
<th>The risk of musculoskeletal problems is relatively low here</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived cost-benefit</td>
<td>The benefits of taking action to reduce the risks of musculoskeletal problems are likely to outweigh the costs</td>
</tr>
<tr>
<td>Time/resources</td>
<td>There is currently a lack of time/resources to tackle musculoskeletal problems</td>
</tr>
<tr>
<td>Internal/external</td>
<td>Problems in this organisation are more related to individual workers themselves than the work/workplace</td>
</tr>
<tr>
<td>attribution</td>
<td>Perceived efficacy of interventions</td>
</tr>
<tr>
<td>Perceived effect of MSDs on absence</td>
<td>Employees have taken absence due to musculoskeletal problems</td>
</tr>
<tr>
<td>Perceived effect of MSDs on productivity</td>
<td>Productivity is suffering due to musculoskeletal problems</td>
</tr>
<tr>
<td>Resistance to change amongst the workforce</td>
<td>Some people in the organisation have shown resistance towards making changes</td>
</tr>
<tr>
<td>Perceived control over the risks</td>
<td>Any remaining risk factors for musculoskeletal problems are factors that can’t really be controlled</td>
</tr>
</tbody>
</table>

Items were included to assess the delimiting factors underpinning each of the stages of change. In terms of barriers to, and facilitators of change, the following factors were considered relevant to MSDs: perceived risk, perceived cost-benefit of taking action, availability of necessary time and resources, internal/external attribution of cause, perceived efficacy of interventions, perceived effect of MSDs on absence, perceived effect of MSDs on productivity, resistance to change amongst the workforce, and perceived control over the risk.

6.2.2 Sample
The organisational questionnaire was administered to 100 health and safety managers, supervisors and directors selected from 2 commercially available
databases: ‘OneSource®’ and ‘Thomson Business Search Pro®’. OneSource® provides robust, integrated information on over 2 million public and private companies and more than 1.5 million executives in the UK. Similarly, Thomson Business Search Pro provides over 2 million UK business listings. Two databases were used to avoid any biases that may exist with one particular database, and to provide a comprehensive pool of businesses from which sampling could be made. Both databases are easily searchable, enabling sampling to be targeted across a range of sectors. Purposive sampling (Patton, 1990) was used in order to ensure that participants were from a range of high-risk industries in terms of MSDs (determined from 2000/01 occupational ill-health statistics, HSC, 2002). Industries represented included: construction, engineering, manufacturing, printing, delivery, and healthcare sectors, and the Fire and Rescue Service. The response rate for the managerial questionnaire was 38% (264 managers were contacted in total). Of the total sample contacted, 6% (16 managers) refused to participate, and 56% (148 managers) were unobtainable. A sample of 100 was determined necessary for the application of the multivariate analyses according to the number of target sectors. Where available, 2 different representatives from the same organisation (e.g. director and health & safety manager) were surveyed to explore differences between individuals of different managerial roles within the same organisation. As a result, the sample of 100 managerial representatives was derived from 85 different organisations.

In addition to managerial respondents, workers from 10 of the above organisations completed the questionnaire. Whilst selection of the organisations within which they were employed was purposive, in order to obtain workers from a range of high-risk sectors in terms of MSDs, selection was largely determined by employers' willingness to grant the research team access to their workplace and employees. The range of organisations that were selected suggests no clear bias apparent from this in the sample achieved. Selection of individual employees within each organisation was achieved using opportunistic sampling in order to cause as little disruption in the workplace as possible.
6.2.3 Analysis

Descriptive statistics were used to identify the distribution of organisations and workers across the stages of change, managers and employees' attitudes, and workers' reports of MSD symptoms. Cronbach's alpha was calculated to test the reliability of the stage of change tool, correlating stage of change assessed via the traditional method with stage derived from respondents' ratings of the descriptive statements relating to the delimitating factors of the stages of change. To conduct such analyses, stage was coded (i.e. precontemplation = 1, contemplation = 2, preparation = 3, and so on). Construct validity of the stage of change tool was assessed using what is known as the contrasted-groups approach (LoBiondo-Wood & Haber, 1998), involving the comparison of two known groups representing different characteristics, of which contrasting answers are expected. Kruskal-Wallis and Mann-Whitney tests were used to identify significant differences in stage of change according to independent factors.

6.3 Results

6.3.1 Descriptive statistics

In terms of role, of the 100 respondents in the organisational questionnaire, 47 were health and safety managers, 27 supervisors, 14 occupational health specialists, and 12 were company directors. These individuals came from a range of industries, as shown in Table 16. The organisations represented by these managers varied in size between those with 10 employees to 240,000 employees. The final sample comprised managers from 50 large organisations (250+ employees), 39 medium (50-249 employees), and 11 small organisations (0-49 employees).

One hundred and sixty-eight workers were surveyed in 10 of the above organisations. The industries represented by these organisations, and the numbers of workers surveyed from each of these industries are displayed in Table 17. The mean length of tenure for workers was 6 years (minimum 1 month, maximum 38 years, SD = 7.31 months). The sample of organisations from which the workers were drawn varied in size from those employing 30 personnel to
6,000 personnel, 2 of the organisations classified as small (0-49 employees), 3 as medium (50-249 employees), and 5 large (250+ employees).

Table 16. The distribution of managers according to sector

<table>
<thead>
<tr>
<th>Sector</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>12</td>
</tr>
<tr>
<td>Distribution</td>
<td>17</td>
</tr>
<tr>
<td>Education</td>
<td>20</td>
</tr>
<tr>
<td>Engineering</td>
<td>5</td>
</tr>
<tr>
<td>Fire and Rescue Service</td>
<td>1</td>
</tr>
<tr>
<td>Health Care</td>
<td>9</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>31</td>
</tr>
<tr>
<td>Printing</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Table 17. The distribution of workers according to sector

<table>
<thead>
<tr>
<th>Sector</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>22</td>
</tr>
<tr>
<td>Distribution</td>
<td>34</td>
</tr>
<tr>
<td>Education</td>
<td>25</td>
</tr>
<tr>
<td>Engineering</td>
<td>12</td>
</tr>
<tr>
<td>Fire &amp; Rescue Service</td>
<td>21</td>
</tr>
<tr>
<td>Healthcare</td>
<td>20</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>12</td>
</tr>
<tr>
<td>Printing</td>
<td>22</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>168</strong></td>
</tr>
</tbody>
</table>
6.3.2 Stage of change

Both managers and workers were distributed across the stages of change, although the profiles of the two groups were distinctly different, as shown in Figure 15. The largest proportion of managers \((n = 33, 33\%)\) identified their organisations as being in the maintenance stage (i.e. working to prevent relapse and consolidate gains made). The majority of workers, in contrast, were identified as being either in the precontemplative (i.e. not considering changing their behaviour) or preparatory stages (having specific ideas about the changes that need to be made but having not yet initiated change). The distinct difference between the stage of change profiles obtained for these two groups provides evidence of construct validity (the contrasted groups approach – Radovanovic & Alexandre, 2004; LoBiondo-Wood & Haber, 1998), confirming that the tool is able to detect differences in the attitudes, intentions, and behaviour characterising the two groups.

Figure 15. Stage of Change Profiles, Managers and Workers

In order to assess the reliability of the stage of change assessment, a Cronbach’s Alpha analysis was conducted, correlating stage of change (as assessed via the traditional method similar to that used in previous work by Prochaska and colleagues), with stage outcome as assessed by respondents’ ratings of statements relating to the delimitating factors of stages, measured on a Likert
scale. The analysis produced a Cronbach’s Alpha Coefficient Value of 0.90 in the case of the organisational questionnaire, and 0.92 in the worker questionnaire, suggesting the scales possess high levels of reliability.

Analysis of individual responses revealed that 89% of the total sample of managerial representatives, and 70% of workers, were concerned about the risk of MSDs (these are not equivalent to the numbers of managers and workers in the precontemplation stage as this also depends on their responses to subsequent questions). In the subset of organisations where steps had not already been taken, 72% of managers felt that steps should be taken in the next 6 months, compared to only 59% of workers. Of those managers not already taking steps to manage the risks, 51% were considering taking action in the next month or two, and also had a clear idea of the steps they were going to take. A similar proportion (53%) of workers felt that changes should be made in the next month or two, and 46% had ideas of the specific changes that should be made.

Almost half of the managerial sample (47%) indicated that they had already implemented steps to reduce the risks of MSDs within their organisations, the majority of which (91%) were steps included in the HSE (2002) recommendations for managing upper limb problems in the workplace. A similar proportion (44%) of workers had made changes to their work or workplace themselves, and of those that had made changes more than 6 months ago, only 25% felt that any further attention to the risks of MSDs in their work was necessary. In contrast, of the 41 managers that had taken action more than 6 months ago, 83% reported the intention to continue their efforts to tackle the risks of MSDs. Both the types of steps planned, and those already taken, by managers, are summarised in Table 18. Examples of the changes made by workers themselves, and their suggestions for changes that would help reduce the risks, are shown, verbatim, in Table 19. Only 43% of workers reported that their employer had made any changes to reduce the risk of MSDs in their work. This is a considerably different response to that of the managers within the same organisations, 80% claiming that changes had been made.
<table>
<thead>
<tr>
<th>von Reyn</th>
<th>6</th>
<th>9</th>
<th>11</th>
<th>9</th>
<th>11</th>
<th>14</th>
<th>14</th>
<th>9</th>
<th>16</th>
<th>14</th>
<th>30</th>
<th>29</th>
<th>39</th>
<th>43</th>
<th>46</th>
<th>48</th>
<th>55</th>
<th>59</th>
<th>79</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>11</td>
<td>33</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>22</td>
<td>11</td>
<td>44</td>
<td>11</td>
<td>44</td>
<td>44</td>
<td>44</td>
</tr>
<tr>
<td>Changes to incentives</td>
<td>Changes to vibration exposure</td>
<td>Reduction of work hours</td>
<td>Modifying pacing of tasks</td>
<td>Gradual increase of work for new employees/those returning from sick leave</td>
<td>Job rotation/rest breaks</td>
<td>Monitoring absence/sickness</td>
<td>Risk Assessment</td>
<td>Automation of task</td>
<td>Replacement of tools/equipment</td>
<td>Training</td>
<td>Redesign workstation/equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 18: Managers' plans for action and changes made.
<table>
<thead>
<tr>
<th>Sector</th>
<th>Ideas for changes</th>
<th>Changes already made/adopted by workers</th>
</tr>
</thead>
</table>
| Delivery    | “Make the conveyor automatic so that we don’t have to keep pushing the boxes along”  
“Make sure that the bins for picking items out of aren’t at such a low level causing continual bending.”  
“Widen the aisles to make more room for bending and lifting.”  
“Put heavier products on the middle shelves so that you don’t have to bend down or reach up to get them.”  
“Not being on a job too long”  
“Have the boxes delivered on palletes to remove the manual handling” | “Having all the pieces to job closer to hand so you don’t have to reach across table”  
“I found a seat so that I don’t have to keep bending down to the floor to pick objects up.” |
| Manufacturing | “Change heights of workstations to reduce stretching.” | “Organised workstations to remove twisting and reaching.”  
“Job rotation” |
| Engineering | “It would help if we had more trollys so that we don’t have to carry heavy loads.”  
“Could do with a hoist to turn the metal frames over. They are too large and heavy for one person.”  
“Design the welder so that it is lighter.” | “I put the spot welder on a stool so that I don’t have to put it down on the floor each time.”  
“Organised work area so that things I use most are easier to get at.” |
| Healthcare  | “Equipment for lifting and moving should be made compulsory on every ward.”  
“All beds to be made electric.”  
“Increase staff levels so that nurses do not have to lift alone.” | “Ensuring there is a supply of lifting equipment available.”  
“Use of hoists to lift patients.” |
| Construction | “Moveable platforms to reduce reaching”  
“More mechanical lifting equipment in and around construction sites.” | “Doing risk assessments on each job I do.” |
Table 19. (cont.) Workers' suggestions for changes

<table>
<thead>
<tr>
<th>Sector</th>
<th>Ideas for changes</th>
<th>Changes already made</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>“Better access to all rooms, ie more lifts and ramps.”</td>
<td>“Reorganised workstation, obtained wrist support and trackerball mouse.”</td>
</tr>
<tr>
<td></td>
<td>“Enough storage at various locations to stop having to carry equipment around.”</td>
<td>“I use a chair when going around the class talking to children rather than bending.”</td>
</tr>
<tr>
<td></td>
<td>“Risk Assessments.”</td>
<td></td>
</tr>
<tr>
<td>Printing</td>
<td>“Improve seating for working at tables to help neck and shoulder problems.”</td>
<td>“We have started changing jobs every hour.”</td>
</tr>
<tr>
<td></td>
<td>“Palettes that rise up and down so that don’t have to bend to pick up and put down.”</td>
<td>“I break bundles down into smaller sections to reduce grip stretch when feeding into machine.”</td>
</tr>
<tr>
<td></td>
<td>“Need hydraulic lifts for heavy boxes.”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>“Reduce size of bundles to reduce grip stretch.”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>“Avoid sitting or standing in one place for long periods.”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>“Job rotation within each shift.”</td>
<td></td>
</tr>
<tr>
<td>Fire &amp; Rescue</td>
<td>“Mechanical means for winding back in hose.”</td>
<td>“No longer manually move vehicles that have been involved in RTA/fire from the roadside.”</td>
</tr>
<tr>
<td>Service</td>
<td>“Allow for diversity of staff when purchasing equipment.”</td>
<td>“Risk assessments”</td>
</tr>
<tr>
<td></td>
<td>“Lighter portable hose and better storage of equipment so that heavier things are easily accessible.”</td>
<td>“Stickers on equipment informing the need for 2 people to lift”</td>
</tr>
</tbody>
</table>
6.3.3 Musculoskeletal pain and discomfort

Sixty-three percent of workers had experienced musculoskeletal pain in the previous 12 months that they felt was a result of their work. The lower back was the most common area within which pain was experienced, with 61% (n = 102) of those who had experienced pain having experienced problems in this area. Only 30% (n = 50) of those who had experienced pain in the last 12 months had taken time off work as a result. Twenty percent (n = 34) of the sample had experienced musculoskeletal pain in the last week that they believed to be a result of their work, although only one individual had had to take time off work as a result. The numbers of individuals experiencing pain in each of the areas, both in the previous 7 days and the previous 12 months, are shown in Table 20.

Table 20. Workers having reported musculoskeletal pain

<table>
<thead>
<tr>
<th>Area of Body</th>
<th>Experienced pain in last 12 months (n=97)</th>
<th>Experienced pain in last week (n=34)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Neck</td>
<td>31</td>
<td>32</td>
</tr>
<tr>
<td>Shoulders</td>
<td>48</td>
<td>49</td>
</tr>
<tr>
<td>Elbows</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Wrist/hands/fingers</td>
<td>45</td>
<td>46</td>
</tr>
<tr>
<td>Upper back</td>
<td>22</td>
<td>23</td>
</tr>
<tr>
<td>Lower back</td>
<td>60</td>
<td>62</td>
</tr>
</tbody>
</table>

<sup>a</sup> Percentage of those that experienced pain, not of the whole sample.

As workers may be reluctant to report their own symptoms, to alleviate the potential effects of such a bias respondents were asked whether their colleagues had experienced any musculoskeletal pain or discomfort, as a form of cross-validation. Forty-six percent reported that colleagues had experienced pain or discomfort in the last year, a slightly lower proportion to
those that reported experiencing symptoms themselves. This suggests that respondents did not underreport their own symptoms.

Comparison of annual prevalence rates for pain or discomfort with the Nordic reference set (Ydreborg & Kraftling, 1987), which comprised assistant cooks, cleaners, nursery/outpatient nurses and secretaries, shows a number of significant differences with the prevalence found by the study reported here. Reported prevalence was significantly higher among the current study sample compared to the Nordic sample in a number of body areas. Namely, shoulders (p<0.05), wrists/hands/fingers (p<0.05), upper back (p<0.05), and lower back (p<0.05), as shown in Table 21. Possible reasons for this are discussed in Section 5.4.2.

Table 21. Annual prevalence of musculoskeletal symptoms compared with Nordic reference sample

<table>
<thead>
<tr>
<th>Area of Body</th>
<th>Questionnaire sample Last 12 months (n=97)</th>
<th>Nordic sample Last 12 months (n=2929)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Neck</td>
<td>31</td>
<td>32</td>
</tr>
<tr>
<td>Shoulders</td>
<td>48*</td>
<td>49</td>
</tr>
<tr>
<td>Elbows</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Wrists/hands/fingers</td>
<td>45*</td>
<td>46</td>
</tr>
<tr>
<td>Upper back</td>
<td>22*</td>
<td>23</td>
</tr>
<tr>
<td>Lower back</td>
<td>60*</td>
<td>62</td>
</tr>
</tbody>
</table>

* Study population had significantly (p<0.05) greater prevalence of reported problems than Nordic reference group

6.3.4 Factors influencing managerial stage of change

Managerial stage of change was found to differ significantly according to organisation size [Kruskal-Wallis, $\chi^2 (2) = 12.0; p<.01$], with larger
organisations tending to be further advanced along the stage of change continuum than medium organisations with regard to tackling MSDs, and medium sized organisations in turn tended to be further forward than small organisations. In order to explore this, analyses were conducted to identify which other factors differed significantly according to organisation size. This revealed that managers within larger organisations tended to be more convinced than both medium and small organisations of the cost-benefit of taking action to reduce MSDs, with small organisations even less likely to perceive interventions as cost-beneficial than medium sized ones \( \chi^2 (2) = 12.0; p<.05 \). The same pattern of results was also found regarding perceived susceptibility of employees to MSD risks \( \chi^2 (2) = 8.0; p<.05 \), the perceived efficacy of changes \( \chi^2 (2) = 9.7; p<.05 \), the perceived effect of MSDs on absence \( \chi^2 (2) = 27.6; p<.001 \), and productivity \( \chi^2 (2) = 9.2; p<.05 \). The extent to which respondents reported the workforce to have shown resistance towards changes also differed significantly according to organisation size, with larger organisations having experienced more resistance than medium or small organisations \( \chi^2 (2) = 11.6; p<.05 \). However, it is possible that this is because larger organisations tend to be further advanced in terms of implementing changes, and have met and overcome the initial phase of greatest resistance.

Managerial stage of change also differed significantly with sector \( \chi^2 (7) = 17.1; p<.05 \), with the fire service and the healthcare sector being, on average, further advanced in terms of stage of change than all other industries, and the printing industry the least advanced in terms of acting upon the problem of MSDs. Managers' reports of whether the organisation had received any legal claims regarding work-related MSDs, and whether any employees had reported experiencing symptoms of MSDs, were also significantly related to stage \( \chi^2 (3) = 19.6; p<.0001 \). Those organisations that had received both legal claims and complaints from employees who believed they were suffering from MSDs were more likely to have taken steps to manage the risks of MSDs.
In terms of the relationship between stage of change and the attitudinal variables assessed, significant differences were found in managers’ perceived cost-benefit of taking action to tackle MSDs \( \chi^2 (3) = 27.9; p<.0001 \), and perceived efficacy of changes \( \chi^2 (3) = 9.6; p<.05 \). Both perceived cost-benefit and efficacy appeared to increase with stage progression, although it is not possible to determine whether this is either a cause or a consequence of taking action. Managers’ identification of employees as having taken absence due to MSDs \( \chi^2 (4) = 18.1; p<.01 \), and the belief that productivity is suffering due to MSDs \( \chi^2 (4) = 9.9; p<.05 \), also increased significantly with stage of change. The availability of time and/or resources to tackle MSDs, managers’ attribution (internal or external) of the cause of MSDs, perceived susceptibility of employees to MSDs, employees’ resistance to changes, and perceived control over risk factors were not significantly related to organisational stage of change.

Managerial stage differed significantly according to the role of the respondent \( \chi^2 (3) = 14.8; p<.05 \), unsurprisingly the organisation’s occupational health specialists and ergonomists tended to be to furthest advanced in terms of stage of change, followed by health and safety managers/advisors, followed by supervisors, with company directors tending to be in the earlier stages of change. In order to explore this further, differences between respondents of different managerial group in terms of attitudes (as measured by their responses to the Likert style questions assessing attitudes and perceived barriers/facilitators) were also assessed.

**Differences according to managerial role**

Significant differences were found in relation to a number of factors:

- Perceived cost benefit of taking action to reduce the risks of MSDs \( \chi^2 (3) = 19.2; p<.001 \). Occupational health specialists and ergonomists tended to be most convinced of the perceived cost-benefit, followed by health and safety managers/advisors, followed by supervisors and directors, the latter two groups being largely unconvinced of the cost-benefit.
- Perceived susceptibility of employees to MSDs \([\chi^2(3) = 14.4; p<.01]\), reflecting the same pattern of results as above
- Perceived efficacy of interventions to tackle MSDs \([\chi^2(3) = 10.1; p<.05]\), reflecting the same pattern of results as above
- Belief that employees have taken absence due to MSDs \([\chi^2(3) = 11.2; p<.05]\), reflecting the same pattern of results as above, but with health and safety managers and supervisors' responses very closely ranked
- Belief that productivity is suffering due to MSDs \([\chi^2(3) = 13.1; p<.01]\), following the patterns above, occupational health specialists and ergonomists were most likely to believe that productivity was suffering due to MSDs, followed by health and safety managers/advisors, followed by supervisors and directors, with only a small difference in responses of the latter two groups
- Employees' resistance to changes \([\chi^2(3) = 11.6; p<.01]\). Occupational health specialists and ergonomists were more likely to believe that employees had shown resistance towards making changes, followed by health and safety managers/advisors, followed by supervisors and directors
- Perceived control over risk factors \([\chi^2(3) = 9.4; p<.05]\). Directors were more likely to believe that the risk factors for MSDs (or any remaining risk factors) cannot be controlled, followed closely by supervisors, then by health and safety managers/advisors, and finally, occupational health specialists and ergonomists, who were more likely to believe that any remaining risk factors could still be controlled

There were no significant differences between managerial respondents from the different occupational categories according to beliefs about the availability of time/resources for tackling MSDs, or attribution (internal or external) of the cause of MSDs.

6.3.5 Factors influencing worker stage of change
Individual worker stage of change also differed significantly according to sector \([\chi^2(7) = 18.6; p<.01]\). Mean ranks indicate that construction workers
were on average in earlier stages of change than those from the other industries sampled, the majority of construction workers reporting no concern for the risks. Workers in the manufacturing industry, followed by those in the fire service, were the next lowest ranked groups of workers in terms of stage of change. In contrast, workers employed in the printing industry were on average the furthest advanced in terms of stage of change, followed by those in education and healthcare. Worker stage of change with regard to MSDs was, however, unrelated to tenure (in other words, it was not simply a matter of time in the job that led to them making taking steps to tackle the risks).

In terms of attitudes, as expected, worker stage of change was unrelated to the perceived cost benefit of interventions to reduce work-related MSDs, but did differ significantly according to perceived susceptibility to work-related MSDs [$\chi^2 (4) = 14.1; p<.01$]. Workers who believed that they were susceptible to the risks tended to be in the later stages of change. Workers in the later stages of change were also significantly more likely to believe that productivity was suffering as a result of MSDs [$\chi^2 (4) = 15.4; p<.01$], and perceive greater control over the risk factors [$\chi^2 (4) = 12.8; p<.05$]. Worker stage of change was unrelated to the perceived availability of time and/or resources to tackle MSDs, workers' attribution (internal or external) of the cause of MSDs, perceived efficacy of changes, perceived level of MSD-related absence, and perceived resistance to change amongst the workforce.

With regards to reported musculoskeletal pain or discomfort, worker stage of change differed significantly according to whether the worker reported having experienced musculoskeletal pain in the last 7 days [Mann-Whitney U, $Z = -2.9; p<.01$], although not according to reported pain over the last 12 months. Those workers that reported having experienced pain in the last 7 days tended to be further advanced in stage of change. Worker stage of change differed significantly, however, according to their reports of whether colleagues had experienced musculoskeletal pain both in the last 7 days [$Z = -2.5; p<.05$] and the last 12 months [$Z = -2.4; p<.05$]. Finally, worker stage of
change was unrelated to whether their employer had taken steps to tackle MSDs.

6.4 Discussion

6.4.1 Key findings
This study aimed to develop tools to assess stage of change in relation to tackling MSDs, to assess the applicability of the stage of change approach to occupational health issues such as MSDs, and explore the factors relating to managers and workers' stage of change in this context. High levels of reliability were confirmed by Cronbach's alpha, comparing the traditional method for assessing stage (consisting of a small set of dichotomous questions), with a parallel form of assessing stage developed for this study (comprising statements relating to the delimiting factors of stage measured for level of agreement on a Likert scale). This evidence provides support for the use of the traditional tool alone, which is beneficial for research tools administered in organisations due to the importance of brevity and ease of completion. Evidence of reliability provided in this study builds on the existing body of work supporting the reliability of the stage of change scale (outlined in Section 3.6.1), including use of the model in the workplace context (Section 3.5.6). A degree of evidence for construct validity was also provided, according to the contrasted groups approach (discussed in Section 6.3.2), and the significant differences identified between stage and specific attitudinal factors. In addition, on a qualitative level, the ease with which respondents completed the stage of change assessment tool suggests that the questions (reflecting the delimiting conditions for the stages) were reflective of the individual's perception of reality and actual experience. Alternatively, it could be argued that the sequence of the stages does not require validation, as the conceptual definitions of the stages make the sequence and categorisation of stages a priori, and 'necessarily true' (Smedslund, 1997, see Section 3.5.5).

The stage of change profiles of the managerial and worker samples were distinctly different, although both groups were distributed across the stages. Different groups of individuals within a single organisation (i.e. supervisor and
director) tended to be at different stages of change, providing support for the potential benefits of tailoring efforts to promote change according to the specific needs of these groups specifically. Health and safety managers, for example, who tended to be already convinced of the need to take action, may benefit most from practical advice on tackling the risk, whereas supervisors may require persuasive information to convince them of the existence of the risk, and the benefits of making changes. Similarly, the large proportion of workers within the precontemplation stage are unlikely to adopt advice given during training, or new equipment that is introduced to reduce the risk, as they do not perceive there to be any need for change. Tailoring approaches to the attitudes, beliefs and knowledge of the different stakeholder groups within an organisation, therefore, is likely to increase both the likelihood that changes will be implemented in the first instance, in addition to the subsequent success of such implementations. These findings are consistent with previous calls for the application of the stage of change approach to occupational settings (e.g. Prochaska et al., 2001; Haslam & Haslam, 2000; Dejoy, 1996).

6.4.2 Implications
The majority of managers and workers (89% and 70%, respectively) reported that they were concerned about the risks of MSDs, although only approximately half of each group felt that changes to tackle the risks should made in the near future. Consequently, the failure for action to be taken may not necessarily be due to lack of awareness, but instead perhaps, related to lack of motivation to take action, or barriers inhibiting action being taken. Furthermore, of the workers that had taken action, only 25% felt that it was necessary to do anything further (compared to 83% of managers). Consequently, an important factor in improving the effectiveness of interventions to reduce MSDs may be to encourage workers to remain vigilant to the risks, and to maintain risk reducing measures.

A discrepancy was also revealed between managers and workers' (i.e. those on the 'shop floor') reports of action having been taken. Managers tended to report that changes had been implemented much more frequently than their employees. Possible interpretations of this are that managers tended to over-
report the frequency with which changes had been made, or alternatively that interventions (i.e. training or new technologies) had not been adopted or recognised by employees. Alternatively, it may be that workers were simply unaware of changes that had been made, suggesting that they were not involved in the implementation of interventions. Not only is lack of employee participation in ergonomics interventions likely to reduce their effectiveness (e.g. Wilson & Haines, 1997), but this finding also reinforces the importance of hearing from different groups of stakeholders within an organisation.

Factors influencing stage of change
Both managerial and individual workers' stage of change varied significantly according to organisation size, with larger organisations tending to be further advanced. Exploration of differences according to organisation size revealed that managers in larger organisations tended to be more convinced about the cost-benefit of taking steps to tackle MSDs. This is consistent with a number of sources that suggest small businesses are often at a competitive disadvantage compared with larger organisations because of the time and cost involved in regulatory compliance. For instance, the cost per employee of taking action to manage manual handling risks has been identified as £341 per employee for small organisations and £37 per employee for large organisations (Lancaster et al, 2001). Large organisations with over 5000 employees also report consistently less expenditure per employee for all regulations compared with organisations with fewer than 5000 employees (Lancaster et al., 2003). As managers' reports of the availability of time and resources to tackle such problems did not differ significantly according to organisation size, this may be less a case of small businesses not having the resources to tackle health and safety problems, but perhaps the relative (whether actual or perceived) benefits of taking action. Due to the range of competing demands facing managers in smaller businesses, it may be that priority is given to initiatives offering more immediate gains, as opposed to the longer-term benefits that are offered by occupational health initiatives. Since 99% of businesses are small businesses, employing 47% of the private sector workforce (DTI, 2004), it seems important that steps are taken to improve this situation, either by promoting the benefits of tackling occupational health issues for smaller businesses, or through
government action to reduce the costs involved in small organisations tackling such issues.

Interestingly, both manager and worker stage of change also differed significantly according to industry sector, although in different respects for managers and workers. Most notably, workers employed in the printing industry were on average the furthest advanced in terms of stage of change, in contrast to managers from this industry, who were the least advanced of all managers. Not only does this highlight the importance of tailoring programmes aimed at tackling MSDs according to the different stakeholder groups within an organisation, but also illustrates that worker stage of change is not dependent upon managers having taken action. Due to the differences found according to sector, however, worker stage of change appears to be more influenced by other common factors such as organisational culture. The finding that construction workers tended to be in the early stages of change, unconcerned about the risks, may be indicative of the reluctance to report problems within the construction sector, for example. The fire service and healthcare industries tended to be generally further advanced than the other industries (including manufacturing, construction, and engineering), in the case of both managers and workers. It is possible that this reflects a private versus public sector difference, with public sector organisations tending to be held more accountable for their employees' wellbeing, perhaps also with increased demands for transparency of their activities. This is clearly an area that would benefit from further examination.

Musculoskeletal pain and discomfort
Comparisons were made between the prevalence of musculoskeletal symptoms reported by workers in this sample with Nordic reference set data (Ydreborg & Kraftling, 1987). Musculoskeletal problems were comparable to the Nordic reference group in relation to neck and elbow pain, but pain or discomfort in the shoulder, wrists/hands/fingers, upper and lower back was significantly higher among this study group than the Nordic population. It should be noted, however, that variation between the Nordic reference group and the present sample may be expected due to geographical, occupational or cultural/historical differences between the samples. A number of changes
over the last 20 years may have influenced the reporting of MSDs, including increased awareness and social acceptability of reporting such problems, for instance. In addition, the Nordic sample comprised assistant cooks, cleaners, nursery/outpatient nurses and secretaries. In some respects, these may be considered less strenuous occupations than some of those in the study sample (e.g. construction workers, workers in certain manufacturing industries, and fire and rescue workers). Furthermore, given that (for purposes of validity) an aim of the current study was to sample workers that were at high risk from MSDs specifically, the relatively high prevalence of pain and discomfort is not considered to be a limitation.

Worker stage of change was significantly related to musculoskeletal pain experienced in the previous 7 days, but not in the previous 12 months. A number of speculations can be made regarding the reason for this, one being that 7 days is a more accurate measure of musculoskeletal symptoms, due the introduction of a recall bias over longer reporting periods. Alternatively, it may be that the experience of musculoskeletal pain only influences stage of change in the short-term, as some workers reported having experienced pain in the past 12 months, yet still perceived there to be no need for changes to be made, and vice versa. This further highlights the importance of tackling attitudes in order to effectively reduce work-related MSDs, given that knowledge and symptoms from past experience do not necessarily lead to action.

6.4.3 Methodological limitations
The value of the stage of change assessment tool may be related to the amount of detail that is collected, introducing a trade-off between speed, and extent of information gathered. In the current study, a primary consideration in developing the tool was practicality, in order to increase the likelihood of its adoption in practice. Although this study provides evidence that the tool offers a reliable assessment of stage of change, application of the tool in practice will help to identify whether a tool that is practical in terms of brevity and simplicity, can also be effective.
It is acknowledged that sampling in the study was purposive in the selection of organisations, and opportunistic in the selection of individual employees and managerial representatives within these organisations. One weakness resulting from this is that the managerial sample did not consist of equal numbers of directors, supervisors, health and safety managers, and occupational health specialists. Instead, health and safety managers constituted 47% of the sample. As a result, the managerial stage of change profile may be favourably biased, reflecting more strongly the views of health and safety managers who have a clear interest in the issue. The difficulty of gaining participation of directors is a fundamental problem for research such as this, and may be reflective of senior managers' lack of appreciation for the importance of such issues. Substantial cultural and attitudinal shifts are likely to be required in order to ameliorate this situation. Alternatively, it may be that directors often delegate responsibility for health and safety matters to the health and safety manager within their organisation, including participation in research such as this. If reflective of their management of health and safety in general, this does not necessarily indicate lack of support or commitment for such issues.

A second bias in the sample emerged in relation to organisation size. Only 11% of participating organisations were small in size. The difficulty of gaining participation of small organisations may reflect differences according to (perceived or actual) relative cost-benefit, as previously discussed. The absence of a dedicated health and safety manager in many small organisations may also be an important factor in this respect. As a result of this, although it is often difficult to secure participation of small organisations for such research, when they do, it is typically the managing director who participates, providing an opportunity to assess the views of these individuals.

6.5 Chapter summary

As outlined in Chapter 2, MSDs have remained the most common form of occupational ill-health in Great Britain for over a decade, despite the growing body of knowledge regarding the risk factors associated with these problems.
Not only do risk factors include both physical and psychosocial elements, but a review of the effectiveness of interventions to tackle MSDs (Chapter 2, Section 2.13) also highlighted the importance of the implementation process. Important procedural elements include achieving stakeholder engagement, ensuring that change recipients are educated about the risks, and evaluating the effectiveness of interventions. Consequently, although MSDs may traditionally be perceived as physical problems, ‘softer’ attitudinal and behavioural factors are crucial to the effective reduction of such problems.

A review of behaviour change theories (Chapter 3) highlighted that a fundamental limitation of the Theory of Planned Behaviour (TPB, Ajzen & Madden, 1986; Ajzen, 1985) and Health Belief Model (HBM, Rosenstock, 1974; 1966) is the absence of recommendations for implementing the implications outlined by these models for achieving behaviour change. The stage of change approach (a component of the Transtheoretical Model, TTM, Prochaska & DiClemente, 1982), on the other hand, provides a guiding framework for achieving behaviour change, in addition to a practical tool for assessing behaviour change, enabling interventions to be tailored according to the specific needs of change recipients. Furthermore, in acknowledgement of the cyclic nature of behaviour change, the stage of change approach highlights the importance of maintaining changes, in order to avoid relapse. Despite the intuitive appeal of the model however, and previous calls for application of the model to workplace interventions, no previous attempts appear to have been made to apply the stage of change model in this way.

Furthermore, the study described in Chapter 4 revealed that while both physical and psychosocial factors have been associated with MSDs, in practice, interventions to reduce MSDs tend to focus on the physical work environment. It has been suggested that this may be due to the absence of tools and techniques to measure, or integrate psychosocial factors into ergonomics interventions (Haslam, 2002).

As a result, the principal aim of the study described in this chapter was to develop the stage of change approach for applicability to the occupational
domain, specifically, for assessing stage of change with regards to reducing the risks of MSDs. In order to achieve this, tools were designed to assess both individual worker and managerial stage of change in this context, based on the traditional set of questions developed in previous work. Questionnaires were completed by 100 managers and 168 workers from a range of organisations, from a variety of industrial sectors.

Tools designed to assess managerial and worker stage of change were both found to possess high levels of reliability. The stage of change profiles of the managerial and worker samples were distinctly different, although both groups were distributed across the stages. Stage of change also differed significantly according to managerial role or occupation, even for different types of managers within a single organisation (i.e. supervisor and director), providing support for the potential benefits of tailoring efforts to promote change according to the specific needs of these groups specifically. Given the importance of behavioural elements in reducing MSDs (in terms of the implementation, adoption, and maintenance of risk reducing measures or practices) therefore, implementation of this approach in practice has the potential to improve the efficacy of interventions to tackle MSDs substantially.
Overview of thesis

Chapter 1: Introduction

Chapter 2: Literature review: MSDs

Chapter 3: Literature review: Behaviour change

Chapter 4: Exploration of current practices
- 14 Semi-structured interviews with ergonomics consultants

Chapter 5: Evaluation of materials
- Content analysis of HSE materials
- Evaluation of coverage of stages of change

Chapter 6: Tool development
- Worker questionnaire (n = 168)
- Managerial questionnaire (n = 100)

Chapter 7: Implementation
- 24 interventions monitored
- Half tailored according to stage
- Worker & managerial assessments pre & post intervention

Chapter 8: Exploration of the change process
- Post-intervention interviews with managers following tailored & non-tailored interventions (n = 17)

Chapter 9: Discussion, implications and recommendations
7. IMPLEMENTATION

7.1 Introduction

As discussed in previous chapters, MSDs remain a substantial problem, despite the growing body of knowledge regarding these problems and the factors related to their onset. MSDs are associated with a diverse and interactive range of risk factors, both physical and psychosocial in nature. In addition, workers and managers' attitudes and behaviours have been identified as playing important roles in the reduction of MSDs, not only because of the association of these variables with psychosocial risk factors, but also because of the importance that is attributed to attitudinal and behavioural factors in the successful implementation of changes aimed at reducing the risk of MSDs. For instance, gaining managerial commitment and educating change recipients about the risks are cited as important components of an effective change programme for tackling these problems (HSE, 2002; NIOSH, 1997).

Due to the importance of these 'softer' factors in the effective reduction of MSDs, combined with an apparent absence of approaches for integrating such elements into ergonomics interventions, Chapter 3 presented a review of behaviour change theories, in order to assess their applicability for facilitating attitude and behaviour change in this context. This review highlighted a number of fundamental limitations of the Theory of Planned Behaviour (TPB, Ajzen & Madden, 1986; Ajzen, 1985) and Health Belief Model (HBM, Rosenstock, 1974; 1966), possibly two of the most widely researched theories in this area of work. Specific limitations included the absence of practical recommendations for implementing these models in order to achieve behaviour change. The stage of change approach (a component of the Transtheoretical Model, TTM, Prochaska & DiClemente, 1982), on the other hand, was identified as providing a guiding framework for achieving behaviour change, in addition to a practical tool for assessing behaviour change. This
tool enables interventions to be tailored according to the specific needs of change recipients based on the assumption that these needs change over time as readiness to change develops. Furthermore, in acknowledgement of the cyclic nature of behaviour change, the stage of change approach highlights the importance of maintaining changes in order to avoid relapse. Consistent with its intuitive appeal, calls have been made for application of the model to workplace interventions (e.g. Prochaska et al., 2001; Haslam & Haslam; 2000; Dejoy, 1996). Despite this however, no previous attempts appear to have been made to apply the stage of change model in this way.

As revealed by the study described in Chapter 4 however, while both physical and psychosocial factors have been associated with MSDs, in practice interventions to reduce MSDs tend to focus on the physical work environment. It has been suggested that this may be due to the absence of tools and techniques to measure, or integrate psychosocial factors into ergonomics interventions (Haslam, 2002). Chapter 5 described an evaluation of leaflets aimed at helping employers and/or employees tackle MSDs. Whilst all provided some information of relevance to the precontemplation and preparation stages, only 5 of the 16 leaflets (31%) provided information regarding the maintenance of risk reducing measures. Due to the importance of maintaining effective risk reducing measures on an ongoing basis, this may be a fundamental limitation to the effectiveness of these leaflets.

Having identified this gap between theory and practice, Chapter 6 described a study to develop the stage of change approach for use with workplace interventions aimed at tackling occupational ill-health. The tool traditionally used to assess stage of change (e.g. DiClemente et al., 1991) was modified for applicability to the issue of MSDs within the workplace, and for both managers and workers. Questionnaires containing the stage of change assessment tool were administered to 100 managers from a variety of organisations (in terms of size, and industrial sector), and a total of 168 workers from 10 of these organisations. This study provided evidence for the reliability (to some extent validity) of the tool in relation to reduction of the risks of MSDs. The findings also revealed distinctly different stage profiles for
managers and employees, suggesting that scope may exist for tailoring interventions according to the stage of change of these different groups of individuals within an organisation.

7.1.1 Aims of the study
The phase of the research described in this chapter aimed to assess whether interventions can be made more effective in practice, by using the tools developed in the study described in the previous study to tailor approaches according to the stage of change of both managers and workers. Ergonomics interventions aimed at tackling MSDs were monitored within a range of organisations. As in the initial study described in Chapter 4, ergonomics interventions were selected for the reason that ergonomics is the recommended approach for tackling MSDs (according to HSE, 2005; 2002). Specific aims of this study were:

- to visit a range of organisations intending to implement interventions aimed at tackling MSDs, and to obtain a range of pre-determined baseline measures (including stage of change) prior to implementation
- within half of these intervention cases, to feedback information and advice regarding stage of change, to help organisations tailor interventions accordingly
- to return 4-8 months following the implementation of interventions to evaluate their effectiveness, according to the range of measures taken prior to implementation (including stage of change progression).

It is hypothesised that working with organisations to tailor interventions according to managers and workers' stage of change will improve intervention effectiveness, by increasing the likelihood that changes are implemented, adopted and maintained.

7.2 Method

As noted by a number of authors, including Dejoy (2005), the consensus "gold standard" for assessing intervention effectiveness is the randomised control
group experiment. A number of problems with this approach can be identified, however. As argued by Griffiths (1999), 'in organisations we are dealing with social experiments', rendering random allocation of employees to groups 'virtually impossible' (p.590). Even with random allocation of workers to control groups, a number of effects may render control groups invalid (Cook & Campbell, 1979). For instance, individuals in control groups may resent the fact that other groups are receiving apparently more desirable treatment than they are, which may lead to increased dissatisfaction and diminished performance ('resentful demoralisation'). Alternatively, control groups may respond by trying harder ('compensatory rivalry'). Third, if employees or managers learn about and are impressed by the types of intervention being provided elsewhere, they may either deliberately or unintentionally implement them themselves ('treatment diffusion'). Finally, intervention providers may become unwilling to tolerate what they perceive to be inequalities between the intervention and control groups and try to overcome these inequalities ('compensatory equalisation').

Furthermore, aside from the above points, the aim of current study was to assess the effectiveness of tailored interventions in comparison to non-tailored (standard) interventions, not the effectiveness of interventions per se. In other words, the aim of this study was not to ascertain whether interventions are more effective than taking no action at all. As regulation requires that employers take action to tackle health and safety risks such as MSDs, it was felt that such a study would be of less practical use for employers. Instead, the study presented in this chapter was pragmatically orientated, concerned with exploring how employers should most effectively employ their resources when taking steps to tackle the risks of MSDs.

7.2.1 Sample
Recruitment was achieved through a press release from the Loughborough University Publicity Office, inviting organisations intending to tackle MSDs, to participate in the study. Following the release by the Loughborough Publicity Office, the article was featured in various other publications, including the Safety & Health Practitioner, RoSPA Occupational Safety & Health Bulletin,
and TUC Risks Magazine. If organisations met the basic criteria (i.e. organisations within high-risk industries for MSDs), respondents were selected on a first come first served basis. A number of interventions within different departments of the same organization were recruited, providing comparable cases, and 16 different organizations were involved. The sample originally consisted of 25 interventions, but it was not possible to conduct the follow-up visit in one of the cases (an office of a major delivery organisation). The reason given by the organisation was “industrial relations issues”, which they felt would result in unrepresentative results. Three other offices from the same organisation are included in the sample, however, so the withdrawal of this case was not considered to have introduced any particular bias to the sample.

The managerial questionnaire was administered to the managerial representative/s responsible for the implementation of each intervention. In the majority of cases, these individuals were not responsible for designing the interventions, but were responsible for their implementation on a day-to-day basis. Where possible, two managerial representatives were approached, for example, the immediate work supervisor and the health and safety manager. The worker questionnaire was administered to all workers involved in the interventions, where feasible. In large organisations where interventions were introduced organisation-wide, the questionnaire was administered to a sample of the workforce. The size of this sample was determined by the availability of workers, and the level of access given by the employer. Where workers within the same organisation/section were engaged in a range of different tasks, efforts were made to stratify the sample in order to sample workers across the range of work activities. These same workers were then requested to complete the questionnaire again post-intervention. No employees declined participation.

7.2.2 Research procedure
A total of 24 case study interventions aimed at reducing the risks of work-related MSDs were monitored within a variety of organisations. Interventions varied, consisting of multiple components, including redesign of the workplace
or work processes, the introduction of new tools (e.g. assistive lifting devices, ergonomic tools), job rotation, manual handling training, health monitoring, and the implementation of safety improvement teams (details of the interventions are shown in Table 22.

Visits were conducted to all organisations both prior to and following the implementation of interventions. During both visits questionnaires were distributed to the workers that were the target of interventions, and the managers directly involved in their implementation. Follow-up evaluations were conducted 4-8 months after the implementation of the interventions (mean follow-up time = 6 months). This variance depended largely on the ease of gaining access to the organisations, which was influenced by a number of factors, including availability of managers during this period, and closures (in the case of schools and some manufacturing plants). This variation also enabled evaluation of the effect of duration between pre- and post-intervention follow-up on the outcome variables.

7.2.3 Research instruments

Bespoke questionnaires were designed for managers and workers, both of which comprised the following 3 sections:

- demographic characteristics and background information
- stage of change assessment (developed in the study described in the previous chapter)
- health and safety climate assessment (Cox & Cheyne, 1999)

The worker questionnaire included an additional section; assessment of musculoskeletal pain experienced in the previous 7 days (more detail of this tool is given below). As in the study described in the previous chapter, the term ‘musculoskeletal problems’ was used throughout the questionnaire (for the reasons given in Section 6.2.1.). Standardised instructions were provided to clarify what was meant by this term. Demographic variables in the managerial questionnaire included factors such as company size, role of the
### Table 22. Intervention details

<table>
<thead>
<tr>
<th>Case</th>
<th>Tailored/Standard</th>
<th>Industrial sector</th>
<th>Intervention details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Standard</td>
<td>Manufacturing</td>
<td>Monthly safety ‘toolbox talks’, health screening for new staff, health and safety inductions, return to work interviews following absence, monthly safety improvement team meetings (employee representatives and management), reduction in shift length, introduction of near miss reporting system, improved staff facilities (canteen, showers, staff room), resurfacing of yard, stock rotation system (reducing the need for manual handling of damaged stock).</td>
</tr>
<tr>
<td>2</td>
<td>Tailored</td>
<td>Manufacturing</td>
<td>Job rotation, introduction of powered wire cutters, tool balancer, low impact hammers, advice regarding improved working postures, introduction of ergonomics issues board on shopfloor (providing information on MSDs symptoms, minutes from safety meetings, intended actions).</td>
</tr>
<tr>
<td>3</td>
<td>Standard</td>
<td>Manufacturing</td>
<td>Extensive physical changes to the workplace to remove the most physically arduous aspects of production, increased availability of equipment (e.g. FLTs), longer rest periods, management training in health and safety, improved risk-assessment procedure (emphasis on identifying risks for MSDs), management commitment to implementing actions required by risk assessments.</td>
</tr>
<tr>
<td>4</td>
<td>Tailored</td>
<td>Manufacturing</td>
<td>Production process altered to enable tasks to be undertaken at operative’s own pace, raised stacking table, health screening, improved risk-assessment procedure (incorporating MSD risks), accident reporting system, workshop for senior managers on the risks of MSDs.</td>
</tr>
<tr>
<td>5</td>
<td>Standard</td>
<td>Utilities</td>
<td>Interactive, individual web-based training package available for employees’ ongoing use, educating employees about how to assess their work for risks, and the types of changes that should be implemented to help to reduce the risks.</td>
</tr>
<tr>
<td>6</td>
<td>Tailored</td>
<td>Utilities</td>
<td>As above.</td>
</tr>
<tr>
<td>7</td>
<td>Standard</td>
<td>Utilities</td>
<td>Risk assessments, manual handling training for all workers, foot and wrist rests provided where desired, workstation adjustments (e.g. table height, placement of equipment, chairs adjusted for each individual and labelled), trolley for transporting mail sacks, space under desks cleared, reorganisation of storage areas for improved accessibility, automatic staplers, job rotation, blinds replaced to reduce glare.</td>
</tr>
<tr>
<td>8</td>
<td>Tailored</td>
<td>Postal &amp; delivery</td>
<td>Health and safety focus groups with employees, introduction of ergonomically designed trolleys to remove weight of delivery from the person, redesign of sorting frames, redesign of sack frames to prevent overfilling, risk assessments of delivery routes.</td>
</tr>
<tr>
<td>9</td>
<td>Standard</td>
<td>Education</td>
<td>Risk assessments of all workstations, new curved, adjustable desks, monitor risers, new adjustable chairs, reorganisation of workstations, wrist and foot rests where desired.</td>
</tr>
<tr>
<td>10</td>
<td>Tailored</td>
<td>Postal &amp; delivery</td>
<td>Health and safety focus groups with employees, introduction of ergonomically designed trolleys to remove weight of delivery from the person, redesign of sorting frames, risk assessments, and consequent reorganisation of delivery routes.</td>
</tr>
<tr>
<td>No.</td>
<td>Category</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>----------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Standard</td>
<td>postal &amp; delivery</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Tailored</td>
<td>Education</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Introduction of self-service terminal and drop boxes to reduce handling of books by staff at issue desk, foot rests where desired, maintenance of trolleys to improve manoeuvrability, reorganisation of equipment storage to ease access, refresher training in manual handling and how to identify problems.</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Standard</td>
<td>Education</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moving and handling training, reorganisation of storage, assistive lifting devices, job rotation.</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Tailored</td>
<td>postal &amp; delivery</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Installation of automatic doors, replacement of delivery trolley with motorised vehicle, removal of obstacles in delivery area enabling vehicles to back up to loading bay, enforcement of mail bag weight limits around the organisation.</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Standard</td>
<td>Manufacturing</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>All work areas assessed for MSD risks using a package developed for the company to calculate scores for MSD risk for each task, based upon video footage of workers performing the tasks, rotation of tasks based on recommendations generated by the package, ergonomic redesign of production line, light weight tools.</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Tailored</td>
<td>Manufacturing &amp; delivery</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Training in manual handling, health screening, improved storage of products on vehicles, mobile ramps to facilitate delivery.</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Standard</td>
<td>transport</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduction of baggage weights permitted.</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Tailored</td>
<td>Manufacturing &amp; delivery</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Training in manual handling, health screening, improved storage of products on vehicles, mobile ramps to facilitate delivery.</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Standard</td>
<td>transport</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduction of baggage weights permitted, training in manual handling, return to work interviews following absence, health screening as part of recruitment process.</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Tailored</td>
<td>transport</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduction of baggage weights permitted.</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Standard</td>
<td>Education</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Training in moving and handling, reorganisation of storage areas, assistive lifting devices, and adjustable wheeled stool for teachers.</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Tailored</td>
<td>utilities</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Training regarding the potential effects of MSDs and work-related risks of MSDs.</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Standard</td>
<td>manufacturing &amp; delivery</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Training in manual handling, health screening, improved storage of products on vehicles, mobile ramps to facilitate delivery.</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Standard</td>
<td>Education</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Training in moving and handling, reorganisation of storage areas, assistive lifting devices, job rotation, and adjustable wheeled stool for teachers.</td>
<td></td>
</tr>
</tbody>
</table>
respondent, and tenure. In the case of workers, these were variables identified as potential risk factors for MSDs (as identified by the literature review in Chapter 2), such as age, tenure, and number of hours worked per week.

**Stage of change tool**
Managerial and individual worker stage of change was assessed using the tools developed in the study described in the Chapter 6. As the short form tool (based on the traditional method of assessing stage, using a small number of dichotomous questions) produced high levels of reliability, it was selected over the alternative method (consisting statements describing the delimiting factors defining the stages, to be rated for level of agreement on a Likert scale), due to the advantages it offers in terms of brevity and ease of completion.

Following insights from the previous study, in classifying stage, relapsers that were no longer concerned about the risks were classed as equivalent to precontemplators, as despite having already taken action, promoting change among these individuals in practice requires the same approach as for precontemplators (neither group are intending on taking action). The grouping of relapsers in this way is in fact consistent with work by Prochaska et al. (2002). In terms of classifying action, the definition of what constitutes effective action to tackle MSD risks as used in the tool development phase was applied. As described in Section 6.2.1, HSE guidance on the effective management of ULDs (HSE, 2002) was used as the basis for these criteria. Organisations were classified as being in the action stage if they had recently, or were currently implementing what are referred to in the HSE guidance as ‘higher order’ solutions. Higher order solutions are attempts to eliminate the risk at source (e.g. through redesign of the work task, replacement of tools or components, or through automation of the task). Individual workers were classified as being in the action stage if they had made changes to their job in order to reduce the risk of MSDs, irrespective of whether their employer had made changes.
Health and Safety Climate Assessment

The short-form questionnaire of the Safety Climate Assessment (Cox & Cheyne, 1999) was incorporated into the questionnaire. Safety climate (as opposed to safety culture) was investigated because it reflects the more 'tangible' outputs of an organisation's safety culture. Organisational culture is characteristically resistant to change, typically taking years to evolve, whereas safety climate operates at a more localised level, providing a more sensitive measure of changes. In terms of the particular tool adopted, key considerations were reliability and practicality. The employee attitude questionnaire of Cox and Cheyne's (1999) Safety Climate Assessment toolkit has been extensively tested, and evidence has shown the instrument to be reliable, and sensitive enough to detect differences between occupational groups (Cox & Cheyne, 2000). The questionnaire is also relatively succinct, and easy to administer; important considerations when conducting research within organisations. Minor modifications were made to improve applicability of the tool to the issue of MSDs within the workplace (see Appendix 5).

Specifically, where question items referred to 'safety', this was altered to refer to both 'health and safety', to ensure that items were applicable to the management of MSDs, which may be considered as both health and safety issues. For example:

'Management acts decisively when a safety concern has been raised', was changed to
'Management acts decisively when a health and safety concern has been raised'.

In addition, for industries where the term 'production' was inapplicable (i.e. education), this term was substituted by the term 'performance'. Consequently, in these instances:

'Management here considers safety to be equally as important as production' became
'Management here considers safety to be equally as important as performance'
The wording of items was also adapted for administration to managers (see Appendix 6).

**Musculoskeletal pain/discomfort**

Musculoskeletal discomfort was measured using a combination of a body map and discomfort intensity ratings (Corlett, 1995; Corlett & Bishop, 1976). Workers were asked whether they had experienced musculoskeletal pain or discomfort in the previous 7 days, and if so, to identify on a body map, the area/s in which the pain or discomfort was experienced. Following this, participants were asked to rate the discomfort severity for each body area identified on a scale of 1-7 (1 being minimal discomfort, 7 extreme discomfort). The tool is shown in Appendix 7. Ideally, pain in both the last 7 and 12 months would be assessed, but due to the importance of brevity (in terms of time required for workers to complete the questionnaire), the period of 7 days was selected for this study. As discussed in Chapter 6, one of the benefits of a short recall period is that it is thought to produce the most accurate data — longer reporting periods have been found to introduce recall bias (Marshall et al., 1995). Body maps have also been used in many studies as an instrument to measure self-reported pain, and have been reported to be both reliable (e.g. Margolis et al., 1988) and to possess construct validity (e.g. Pope et al., 1997).

### 7.2.4 Tailoring of interventions

Interventions were allocated to either the ‘tailored’ or ‘standard’ condition alternately, in the order that they were recruited, to avoid biasing selection. Where interventions were implemented in different departments of the same organization, comparable cases were allocated to the standard and stage-matched conditions. Of 24 interventions monitored, 11 were tailored according to managerial and worker stage of change and 13 were ‘standard’ interventions. A slightly larger proportion of standard interventions resulted, due to the inability to tailor one case owing to the narrow time window between being allowed into the organisation to collect pre-intervention data, and implementation of the intervention. Organisational details relating to each
case study are shown in Table 23. Details of the interventions in each case are presented in Table 22.

Table 23. Organisational details

<table>
<thead>
<tr>
<th>Case</th>
<th>Tailored/Standard</th>
<th>Sector</th>
<th>Org. size</th>
<th>Section/dept size</th>
<th>Nature of work</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Standard</td>
<td>Manufacturing</td>
<td>11000</td>
<td>35</td>
<td>Manufacture of paving materials</td>
</tr>
<tr>
<td>2</td>
<td>Tailored</td>
<td>Manufacturing</td>
<td>850</td>
<td>20</td>
<td>Manufacture of alternators</td>
</tr>
<tr>
<td>3</td>
<td>Standard</td>
<td>Manufacturing</td>
<td>110</td>
<td>53</td>
<td>Foundry</td>
</tr>
<tr>
<td>4</td>
<td>Tailored</td>
<td>Manufacturing</td>
<td>110</td>
<td>54</td>
<td>Foundry</td>
</tr>
<tr>
<td>5</td>
<td>Standard</td>
<td>Utilities</td>
<td>4500</td>
<td>120</td>
<td>Call centre</td>
</tr>
<tr>
<td>6</td>
<td>Tailored</td>
<td>Utilities</td>
<td>4500</td>
<td>160</td>
<td>Call centre</td>
</tr>
<tr>
<td>7</td>
<td>Standard</td>
<td>Utilities</td>
<td>4500</td>
<td>15</td>
<td>Administration</td>
</tr>
<tr>
<td>8</td>
<td>Tailored</td>
<td>Postal &amp; delivery</td>
<td>88700</td>
<td>142</td>
<td>Courier</td>
</tr>
<tr>
<td>9</td>
<td>Standard</td>
<td>Education</td>
<td>460</td>
<td>32</td>
<td>University/College</td>
</tr>
<tr>
<td>10</td>
<td>Tailored</td>
<td>Postal &amp; delivery</td>
<td>88700</td>
<td>75</td>
<td>Courier</td>
</tr>
<tr>
<td>11</td>
<td>Standard</td>
<td>Postal &amp; delivery</td>
<td>88700</td>
<td>140</td>
<td>Courier</td>
</tr>
<tr>
<td>12</td>
<td>Tailored</td>
<td>Education</td>
<td>3000</td>
<td>55</td>
<td>Library</td>
</tr>
<tr>
<td>13</td>
<td>Standard</td>
<td>Education</td>
<td>6000</td>
<td>40</td>
<td>Primary education</td>
</tr>
<tr>
<td>14</td>
<td>Tailored</td>
<td>Postal &amp; delivery</td>
<td>8</td>
<td>8</td>
<td>Courier</td>
</tr>
<tr>
<td>15</td>
<td>Standard</td>
<td>Manufacturing</td>
<td>1200</td>
<td>380</td>
<td>Car seats manufacturer</td>
</tr>
<tr>
<td>16</td>
<td>Tailored</td>
<td>Manufacturing &amp; delivery</td>
<td>6000</td>
<td>80</td>
<td>Delivery/despatch</td>
</tr>
<tr>
<td>17</td>
<td>Standard</td>
<td>Transport</td>
<td>157</td>
<td>157</td>
<td>Baggage handling</td>
</tr>
<tr>
<td>18</td>
<td>Tailored</td>
<td>Manufacturing &amp; delivery</td>
<td>6000</td>
<td>100</td>
<td>Delivery/despatch</td>
</tr>
<tr>
<td>19</td>
<td>Standard</td>
<td>Transport</td>
<td>22000</td>
<td>400</td>
<td>Baggage handling</td>
</tr>
<tr>
<td>20</td>
<td>Tailored</td>
<td>Transport</td>
<td>4300</td>
<td>580</td>
<td>Baggage handling</td>
</tr>
<tr>
<td>21</td>
<td>Standard</td>
<td>Education</td>
<td>6000</td>
<td>40</td>
<td>Primary education</td>
</tr>
<tr>
<td>22</td>
<td>Tailored</td>
<td>Utilities</td>
<td>91600</td>
<td>23</td>
<td>Call centre/engineering</td>
</tr>
<tr>
<td>23</td>
<td>Standard</td>
<td>Manufacturing &amp; delivery</td>
<td>6000</td>
<td>500</td>
<td>Delivery/despatch</td>
</tr>
<tr>
<td>24</td>
<td>Standard</td>
<td>Education</td>
<td>4000</td>
<td>32</td>
<td>Primary education</td>
</tr>
</tbody>
</table>

A stage of change profile was generated for each workforce, and in the tailored condition, interventions were targeted according to the stage within which the majority of employees resided. Support for this approach is provided by evidence that stage profile tends to be relatively homogeneous.
within the workers in a given an organisation, whilst differing significantly between organisations (as outlined in Chapter 6). Calls have also been made for more interventions to be carried out at the group level, as whilst an individual approach is valuable in some cases, it is not considered time, effort, or cost effective in all circumstances. Maes and Boersma (2004) called for health psychologists to 'go for the numbers' rather than for the most intensive.

A standard framework was used for targeting information to stage (Velicier et al., 1998; Ferguson & Chandler, 2005) and is summarised in Table 24. This framework was based on the well established relationships between key factors such as decisional balance and habit strength, and stage progression at each transition point in the change cycle (outlined in Chapter 3, Section 3.5). Where workers were in the precontemplative stage, emphasis was placed on the use of strong messages about the detrimental effects of MSDs while workers in preparation received practical advice and skills training. In standard interventions, organisations carried out their interventions as they planned. As pre- and post-intervention surveys were carried out in both conditions, workers in both conditions received the same amount of contact with researchers. With each of the interventions that were to be tailored, feedback was provided, in the form of a written report, regarding the specific advice and information relevant to the stage of change of the workers and managers within each of these organisations. Leaflets and PowerPoint presentations containing this information were provided to organisations, to facilitate the communication of these tailored messages (copies of the leaflets for both managers and workers are shown in Appendix 8).

7.2.5 Analysis
Descriptive statistics were used to identify the distribution of managers and workers across the stages of change, workers' reported pain/discomfort, and safety climate. Scores were calculated for each dimension of the Safety Climate Checklist, following the method outlined by Cox and Cheyne (1999) generating a score between 2 to 10 for each dimension. Chi-square tests were used to identify significant differences in stage of change, and the proportion of workers reporting pain/discomfort, before and after the
### Table 24. Tailoring framework

<table>
<thead>
<tr>
<th>Key beliefs</th>
<th>Key messages to convey</th>
<th>Materials/Approaches</th>
</tr>
</thead>
</table>
| **1. Precontemplation (not considering changing)** | No need to change – MSDs not considered a significant risk                                                    | Raising awareness of risks, risk severity, susceptibility, health effects, and other effects e.g. productivity, profit, morale | Graphic information
|                                          |                                                                                                             | Probability of illness/injury                                                        |
|                                          |                                                                                                             | Significance of injury/illness                                                        |
|                                          |                                                                                                             | Case studies outlining costs suffered by individuals & organisations e.g. claims, production, absence |
| **2. Contemplation (thinking about changing)** | Risks acknowledged - contemplating need to make changes                                                   | Highlight the efficacy of interventions, and the benefits that can be gained from taking action (e.g. costs for managers, reduced fatigue/effort for workers) | Information regarding the benefits of change (for both workers & managers)
|                                          |                                                                                                             | Case studies/statistics documenting successful interventions (e.g. reduced absence/increased production, improved morale) |
| **3. Preparation (strong intention to change)** | Intention to make changes in near future and/or concrete plans for the specific steps to be taken            | Types of changes that can be effective in reducing MSDs                                | Practical advice on range of approaches
|                                          |                                                                                                             | Most effective approaches to implementation (e.g. value of taking a systems approach, worker participation) | Skills training
|                                          |                                                                                                             | Reduction of barriers to implementation of changes                                    | Development of specific & realistic plans of action |
|                                          |                                                                                                             | Participation                                                                          | Participation |
|                                          |                                                                                                             | Feedback                                                                              | Feedback |
|                                          |                                                                                                             | Assistance with tools/equipment                                                        | Assistance with tools/equipment |
| **4. Action (actually engaged in changing behaviour)** | Engaged in change efforts                                                                                  | Ongoing advice & support                                                              | Reinforcement of need to assess and maintain low levels of risk
|                                          |                                                                                                             | Skills training                                                                        | Ongoing relationship with advisors |
|                                          |                                                                                                             | Performance feedback                                                                   | Establishment of systems for ongoing monitoring & evaluation |
|                                          |                                                                                                             | Possibility of an initial increase in cases                                           |                                                                 |
| **5. Maintenance (working to prevent relapse or consolidate gains made)** | Working to consolidate and maintain the changes or improvements                                           | Emphasise need for continual efforts to prevent relapse                                | Reinforcement of need to assess and maintain low levels of risk
|                                          |                                                                                                             | Continually changing risks                                                            | Ongoing relationship with advisors |
|                                          |                                                                                                             | Need for ongoing vigilance                                                             | Establishment of systems for ongoing monitoring & evaluation |
|                                          |                                                                                                             |                                                                                       |                                                                 |

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implementation of interventions. Wilcoxon signed-rank tests were employed to evaluate any significant differences between workers' ratings of pain severity, and workers and managers' responses to the safety climate items, pre- and post-intervention.

In addition, to identify the specific factors that were associated with stage of change post-intervention, analyses were carried out to identify the independent variables that were significantly related to stage of change following both standard and tailored interventions. The results of these analyses are presented in Section 7.5. These analyses were conducted using the coding procedures adopted in phase one. Stage was coded numerically (i.e. precontemplation = 1, contemplation = 2, preparation = 3, and so on). Kruskal-Wallis and Mann-Whitney tests were used to identify significant differences in stage of change according to independent factors. Factors such as age, tenure, and hours worked per week, were split into 3 groups based on the distributions of the samples.

7.2.6 Structure of results section
Due to the importance of stage progression in relation to where individuals were at 'baseline' (prior to implementation), it is important that outcomes are considered in relative rather than absolute terms. Consequently, the results are presented according to comparisons between the outcomes of interventions in relation to the profile of each intervention group prior to the implementation of interventions (i.e. pre- and post-intervention comparisons within each intervention condition separately). As a result, the following section (Section 7.3) presents the results for individuals involved in standard interventions (pre and post comparisons for both workers and managers), followed by Section 7.4, which presents the results for the individuals involved in tailored interventions (pre and post comparisons for both workers and managers). The structure of the results section for this chapter is illustrated in Figure 16.
7.3 Results: Standard interventions

7.3.1 Participant characteristics

*Workers’ Characteristics*

Pre- and post-intervention data of the workers involved in the 13 ‘standard’ (non-tailored) interventions are shown in Table 25. A total of 187 workers completed the questionnaire prior to the implementation of interventions, and 162 post-intervention. These results combine the data from workers within a variety of different organisations (as shown in Table 23). Examination of the baseline data for missing respondents revealed that they were not significantly
different from the rest of the sample (mean age 39 years, SD 11.9 years; mean number of hours worked per week 41, SD 10.4 hours). The proportion of these respondents that reported musculoskeletal pain at baseline (79%) was not significantly different from the rest of the sample.

Table 25. Workers' personal characteristics

<table>
<thead>
<tr>
<th></th>
<th>Pre-intervention (N = 187)</th>
<th>Post-intervention (N = 162)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std.Deviation</td>
</tr>
<tr>
<td>Age (yrs)</td>
<td>39</td>
<td>11.5</td>
</tr>
<tr>
<td>Tenure (yrs)</td>
<td>7</td>
<td>7.1</td>
</tr>
<tr>
<td>Hrs worked per wk</td>
<td>34</td>
<td>13.4</td>
</tr>
</tbody>
</table>

**Managers' Characteristics**

A total of 21 managers involved in standard interventions completed the pre-intervention questionnaire, 13 of which were general managers, 5 health and safety managers, and 3 were supervisors. Following implementation of interventions, 12 managers in the standard intervention condition were available to complete the questionnaire, 7 of which were general managers, and 5 were health and safety managers. The only identifiable difference between those that were and were not available at the time of the follow-up, was that a larger proportion of general managers were unavailable. This appeared to be because general managers were off-site more frequently than health and safety managers, meaning that they were unavailable to complete the questionnaire. Whilst managers' involvement was crucial to tailoring the implementation of interventions in each organisation, due to the relatively small numbers of managers, care must be taken in interpreting these results as generalisable to broader managerial populations.
7.3.2 Worker stage of change

Prior to the implementation of interventions, the majority of workers in the standard intervention condition were in the preparation and precontemplation stages, 35% and 31% respectively. Only 12% of workers were in the action stage, and 16% in the maintenance stage. Following the implementation, little movement had occurred, the only significant difference was a reduction in the number in the preparation stage $\chi^2 (1) = 4.02; p < 0.05$, as shown in Figure 17.

**Figure 17. Worker stage of change (standard interventions)**

A breakdown of responses to the question items assessing stage of change enables detailed examination of workers' responses to the questionnaire items that relate to stage (reflecting their attitudes, perceptions, intentions, and behaviour). It should be noted that the percentage responses do not necessarily equate to the proportion of workers in the stage to which the question relates, as classification of stage also depends on workers' responses to subsequent questions.

Concern for the risks of developing musculoskeletal aches and pains differed little before and after standard interventions (69% pre and 73% post-intervention), as did the proportion of workers that perceived a need for changes to be made in the next 6 months (64% and 65% respectively). A small (although not significant) reduction occurred in the proportion of workers...
expressing the need for action to be taken in the next month or two, from 55% before the implementation, to 46% post-intervention. The number of workers that reported having made changes aimed at reducing the risks themselves increased significantly before and after the implementation of standard interventions, from 37% to 57% ($\chi^2 (1) = 5.42; p < 0.05$). However, the number of workers that reported the intention to continue or maintain the changes aimed at reducing the risks of MSDs following any initial changes reduced from 75% to 67% following the interventions (although this difference was not significant).

Finally, the length of the time interval between the initial and follow-up visits within organisations receiving standard interventions, was not significantly related to stage of change. The mean time of follow-up was 6.13 months.

7.3.3 Managerial stage of change
Prior to implementation of interventions, the majority of managers in the standard intervention condition were identified as being in the action (33%, n = 7) and maintenance stages (33%, n = 7). Following the implementation of standard interventions, however, the majority of managers (67%, n = 8) indicated that they were in the maintenance stage (see Figure 18). The increase in the number of managers in the maintenance stage following the implementation of interventions, however, was not significant (possibly due to the relatively small sample size).

Examination of responses to the question items assessing stage of change enables detailed examination of managers’ attitudes, perceptions, intentions, and behaviours. The proportion of managers that indicated they were concerned about the risks of their employees developing MSDs reduced (although not significantly, again, possibly due to the relatively small sample size) from 81% (n = 17) pre-implementation, to 58% (n = 7) post-implementation.

\(^2\) n is included here due to the small sample size
In terms of intentions to take action, as would be expected, prior to the implementation of changes, the majority of managers expressed the intention for changes to be made (71%, \(n = 15\) in the next 6 months, and 62%, \(n = 13\) in the next month or two). Following the implementation of standard interventions, 67% (\(n = 8\)) of managers still expressed the intention to make changes aimed at reducing the risks in the next 6 months, and 50% (\(n = 6\)) in the next month of two. Prior to the implementation of changes, 62% (\(n = 13\)) of managers had specific plans for the types of changes that would help to reduce the risks, compared to 58% (\(n = 7\)) post-intervention. For these figures to remain high is consistent with the large number of managers identified as being in the maintenance stage.

Before the implementation of these interventions, 67% (\(n = 14\)) of managers indicated that some steps aimed at reducing the risks had already been taken. Unsurprisingly, in the post-intervention questionnaire, virtually all (92%, 11 of the 12 managers) reported that changes had been made. In addition, 80% (\(n = 10\)) of managers indicated that they intended to pay further attention to the issue of MSDs following the implementation of interventions (compared to
67%, n = 14 of managers prior to the implementation of interventions). Again, none of these differences were statistically significant.

7.3.4 Musculoskeletal discomfort (workers)
Workers were asked if they had experienced any form of musculoskeletal pain or discomfort in the last 7 days, both prior to and following the implementation of changes aimed at reducing the risks of MSDs. The proportion of workers that reported pain/discomfort declined slightly, although not significantly, between the initial and follow-up questionnaires (77% pre and 70% post-intervention). In terms of the specific body areas in which respondents reported having experienced this pain or discomfort, the actual frequency of workers having reported pain/discomfort in each area is given in Table 26, and shown in percentages in Figure 19. There were no significant differences in the proportions of respondents reporting pain or discomfort in any of the individual body areas before and after the implementation of interventions. The lower back remained the body area within which workers most commonly reported having experienced pain, on both occasions.

For each of the areas within which workers reported having experienced pain or discomfort, they were asked to rate the severity of this pain/discomfort. Both pre- and post-intervention, workers' ratings ranged across the scale from 1 (minimal discomfort) to 7 (extreme discomfort), although Wilcoxon signed ranks tests revealed no significant differences according to the mean ranks of ratings from the pre- and post-intervention data. Mean ratings of pain/discomfort severity are displayed in Figure 20.

Finally, as would be expected given that no significant differences were identified between proportion of workers that reported musculoskeletal pain pre- and post-intervention, the length of time between pre- and post-intervention follow-up was not significantly related to musculoskeletal discomfort among workers receiving standard interventions.
Table 26. Percentage of workers having reported pain/discomfort - standard interventions

<table>
<thead>
<tr>
<th>Number of workers having experienced pain in each body area (% in brackets)</th>
<th>Pre-intervention</th>
<th>Post-intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of participants</td>
<td>187</td>
<td>190</td>
</tr>
<tr>
<td>Neck</td>
<td>38</td>
<td>44</td>
</tr>
<tr>
<td>Shoulder</td>
<td>41</td>
<td>35</td>
</tr>
<tr>
<td>Upper arm</td>
<td>19</td>
<td>16</td>
</tr>
<tr>
<td>Elbow</td>
<td>19</td>
<td>21</td>
</tr>
<tr>
<td>Forearm</td>
<td>19</td>
<td>16</td>
</tr>
<tr>
<td>Wrist</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td>Hand</td>
<td>24</td>
<td>19</td>
</tr>
<tr>
<td>Upper back</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>Lower back</td>
<td>52</td>
<td>49</td>
</tr>
<tr>
<td>Legs</td>
<td>30</td>
<td>31</td>
</tr>
</tbody>
</table>

Figure 19. Percentage of workers experiencing pain/discomfort in the previous 7 days (standard interventions)
7.3.5 Workers' attitudes towards health & safety

The short form of the Safety Climate Checklist (Cox & Cheyne, 1999) was administered to workers to assess attitudes and perceptions regarding the following factors: management commitment, communication, company prioritisation of safety, perceived importance of safety rules & procedures, supportive environment, involvement in health & safety, personal priorities & need for safety, and work demands enabling safe working. A breakdown of workers' pre- and post-implementation responses is shown in Table 27 (percentages are to the nearest whole number). Scores were calculated for each dimension of the Safety Climate Checklist are shown in Figure 21.

Changes in workers' responses to the Safety Climate items (shown in Table 27) were moderate following the implementation of standard interventions, the most notable change being an increase in workers' perceived involvement in health and safety following the implementation of interventions. Small improvements also occurred in relation to workers' perceptions of company prioritisation of safety, the supportive environment, and workers' personal priorities and need for safety. However, Wilcoxon signed-rank tests identified
no significant differences between workers' ratings of the Safety Climate items pre- and post-intervention.

7.3.6 Managers' attitudes towards health & safety
The short form of the Safety Climate Checklist (Cox & Cheyne, 1999) was administered to managers to assess attitudes and perceptions regarding the following factors: senior management commitment, communication, company prioritisation of safety, perceived importance of safety rules & procedures, supportive environment, involvement in health & safety, personal priorities & need for safety, and work demands enabling safe working. A breakdown of managers' pre- and post-implementation responses is shown in Table 28 (percentages are to the nearest whole number). Scores calculated for each dimension of the Safety Climate Checklist are shown in Figure 22.

The most notable change in managers' attitudes towards safety climate was a reduction in managers' personal priorities and need for safety. Care must be taken in interpreting these findings as representative or generalisable, however, due to the relatively small samples sizes. Increases are evident in managers' personal appreciation of risks, and their perceived importance of safety rules and procedures following the implementation of interventions, although none of these differences were statistically significant.
Table 27. Percentage of workers in agreement/disagreement with Safety Climate items (standard interventions)
[Initial survey results = regular font, Follow-up survey results = bold]

<table>
<thead>
<tr>
<th>Management commitment</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Neither agree nor disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management acts decisively when a health and safety concern has been raised</td>
<td>14%</td>
<td>20%</td>
<td>49%</td>
<td>39%</td>
<td>21%</td>
</tr>
<tr>
<td>In my workplace management acts quickly to correct health and safety problems</td>
<td>11%</td>
<td>23%</td>
<td>44%</td>
<td>35%</td>
<td>25%</td>
</tr>
<tr>
<td>Communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health and safety information is always brought to my attention by my line manager/supervisor</td>
<td>13%</td>
<td>14%</td>
<td>46%</td>
<td>47%</td>
<td>23%</td>
</tr>
<tr>
<td>There is good communication here about health and safety issues which affect me</td>
<td>10%</td>
<td>16%</td>
<td>42%</td>
<td>42%</td>
<td>32%</td>
</tr>
<tr>
<td>Company prioritisation of safety</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management here considers health and safety to be equally as important as production</td>
<td>11%</td>
<td>20%</td>
<td>38%</td>
<td>36%</td>
<td>25%</td>
</tr>
<tr>
<td>I believe health and safety issues are assigned a high priority</td>
<td>16%</td>
<td>22%</td>
<td>41%</td>
<td>38%</td>
<td>26%</td>
</tr>
<tr>
<td>Perceived importance of safety rules &amp; procedures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Some health &amp; safety rules and procedures don’t need to be followed to get the job done safely</td>
<td>1%</td>
<td>2%</td>
<td>15%</td>
<td>18%</td>
<td>23%</td>
</tr>
<tr>
<td>Some health and safety rules are not really practical</td>
<td>3%</td>
<td>5%</td>
<td>26%</td>
<td>25%</td>
<td>26%</td>
</tr>
<tr>
<td>Supportive environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am strongly encouraged to report unsafe conditions</td>
<td>19%</td>
<td>26%</td>
<td>48%</td>
<td>42%</td>
<td>18%</td>
</tr>
<tr>
<td>I can influence health and safety performance here</td>
<td>12%</td>
<td>16%</td>
<td>42%</td>
<td>41%</td>
<td>29%</td>
</tr>
<tr>
<td>Involvement in health &amp; safety</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am involved in informing management of important health and safety issues</td>
<td>14%</td>
<td>15%</td>
<td>36%</td>
<td>41%</td>
<td>26%</td>
</tr>
<tr>
<td>I am involved in the ongoing review of health and safety</td>
<td>5%</td>
<td>9%</td>
<td>26%</td>
<td>27%</td>
<td>36%</td>
</tr>
<tr>
<td>Personal priorities &amp; need for safety</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health and safety is the number one priority in my mind when completing a job</td>
<td>19%</td>
<td>21%</td>
<td>30%</td>
<td>35%</td>
<td>26%</td>
</tr>
<tr>
<td>It is important to me that there is a continuing emphasis on health and safety</td>
<td>25%</td>
<td>29%</td>
<td>54%</td>
<td>52%</td>
<td>15%</td>
</tr>
<tr>
<td>Personal appreciation of risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I'm sure it's only a matter of time before I develop a work-related health problem</td>
<td>16%</td>
<td>15%</td>
<td>28%</td>
<td>24%</td>
<td>33%</td>
</tr>
<tr>
<td>In my workplace the chances of developing a work-related health problem are quite high</td>
<td>21%</td>
<td>23%</td>
<td>35%</td>
<td>27%</td>
<td>22%</td>
</tr>
<tr>
<td>Work demands enable safe working</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production targets rarely conflict with health and safety measures</td>
<td>6%</td>
<td>6%</td>
<td>29%</td>
<td>23%</td>
<td>38%</td>
</tr>
<tr>
<td>I am always given enough time to get the job done safely</td>
<td>7%</td>
<td>10%</td>
<td>32%</td>
<td>36%</td>
<td>21%</td>
</tr>
</tbody>
</table>
Figure 21. Safety climate (workers - standard interventions)

- Work demands enable safe working
- Personal appreciation of risk
- Personal priorities & need for safety
- Involvement in health & safety
- Supportive environment
- Communication
- Company prioritisation of safety
- Perceived importance of safety rules & procedures
- Management Commitment

Pre-intervention Post-intervention
Table 28. Percentage of managers in agreement/disagreement with Safety Climate items (standard interventions)
[Initial survey results = regular font, Follow-up survey results = bold]

<table>
<thead>
<tr>
<th>Management commitment</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Neither agree nor disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management acts decisively when a health and safety concern has been raised</td>
<td>43%</td>
<td>17%</td>
<td>0%</td>
<td>10%</td>
<td>8%</td>
</tr>
<tr>
<td>In my workplace management acts quickly to correct health and safety problems</td>
<td>38%</td>
<td>25%</td>
<td>10%</td>
<td>8%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health and safety information is always brought to my attention by my line manager/supervisor</td>
<td>33%</td>
<td>25%</td>
<td>14%</td>
<td>0%</td>
<td>17%</td>
</tr>
<tr>
<td>There is good communication here about health and safety issues which affect me</td>
<td>24%</td>
<td>25%</td>
<td>19%</td>
<td>0%</td>
<td>8%</td>
</tr>
<tr>
<td><strong>Company prioritisation of safety</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management here considers health and safety to be equally as important as production</td>
<td>33%</td>
<td>50%</td>
<td>14%</td>
<td>0%</td>
<td>25%</td>
</tr>
<tr>
<td>I believe health and safety issues are assigned a high priority</td>
<td>38%</td>
<td>33%</td>
<td>10%</td>
<td>5%</td>
<td>8%</td>
</tr>
<tr>
<td><strong>Perceived importance of safety rules &amp; procedures</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Some health &amp; safety rules and procedures don’t need to be followed to get the job done safely</td>
<td>0%</td>
<td>0%</td>
<td>10%</td>
<td>8%</td>
<td>29%</td>
</tr>
<tr>
<td>Some health and safety rules are not really practical</td>
<td>5%</td>
<td>0%</td>
<td>19%</td>
<td>17%</td>
<td>19%</td>
</tr>
<tr>
<td><strong>Supportive environment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am strongly encouraged to report unsafe conditions</td>
<td>62%</td>
<td>67%</td>
<td>38%</td>
<td>25%</td>
<td>0%</td>
</tr>
<tr>
<td>I can influence health and safety performance here</td>
<td>48%</td>
<td>42%</td>
<td>52%</td>
<td>50%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Involvement in health &amp; safety</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am involved in informing management of important health and safety issues</td>
<td>57%</td>
<td>58%</td>
<td>43%</td>
<td>33%</td>
<td>0%</td>
</tr>
<tr>
<td>I am involved in the ongoing review of health and safety</td>
<td>57%</td>
<td>75%</td>
<td>43%</td>
<td>17%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Personal priorities &amp; need for safety</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health and safety is the number one priority in my mind when completing a job</td>
<td>33%</td>
<td>58%</td>
<td>24%</td>
<td>17%</td>
<td>33%</td>
</tr>
<tr>
<td>It is important to me that there is a continuing emphasis on health and safety</td>
<td>62%</td>
<td>83%</td>
<td>38%</td>
<td>17%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Personal appreciation of risk</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I’m sure it’s only a matter of time before I develop a work-related health problem</td>
<td>29%</td>
<td>25%</td>
<td>19%</td>
<td>0%</td>
<td>24%</td>
</tr>
<tr>
<td>In my workplace the chances of developing a work-related health problem are quite high</td>
<td>24%</td>
<td>8%</td>
<td>33%</td>
<td>25%</td>
<td>29%</td>
</tr>
<tr>
<td><strong>Work demands enable safe working</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production targets rarely conflict with health and safety measures</td>
<td>19%</td>
<td>8%</td>
<td>19%</td>
<td>42%</td>
<td>29%</td>
</tr>
<tr>
<td>I am always given enough time to get the job done safely</td>
<td>24%</td>
<td>8%</td>
<td>29%</td>
<td>33%</td>
<td>10%</td>
</tr>
</tbody>
</table>

217
Figure 22. Safety climate (managers - standard interventions)

- Management Commitment
- Work demands enable safe working
- Personal appreciation of risk
- Personal priorities & need for safety
- Involvement in health & safety
- Company prioritisation of safety
- Perceived importance of safety rules & procedures
- Supportive environment

Pre-intervention
Post-intervention
7.4 Results: Tailored interventions

7.4.1 Participant characteristics
Details of the workers sampled from the 11 ‘tailored’ interventions, both pre- and post-intervention, are shown in Table 29. A total of 197 workers completed the questionnaire prior to the implementation of interventions, and 142 post-intervention. These interventions were in a variety of different organisations, from the delivery, education, manufacturing, and utilities industries (as shown in Table 23).

Table 29. Personal characteristics

<table>
<thead>
<tr>
<th></th>
<th>Pre-intervention (N = 197)</th>
<th>Post-intervention (N = 142)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std.Deviation</td>
</tr>
<tr>
<td>Age (yrs)</td>
<td>41</td>
<td>9.5</td>
</tr>
<tr>
<td>Tenure (yrs)</td>
<td>9</td>
<td>8.2</td>
</tr>
<tr>
<td>Hrs worked per wk</td>
<td>30</td>
<td>16.4</td>
</tr>
</tbody>
</table>

In the tailored intervention condition, 22 managers completed the pre-intervention questionnaire, 16 of whom were general managers, 3 were supervisors, 2 were directors, and 1 a health and safety manager. Following implementation of tailored interventions, 16 managers completed the questionnaire, 13 of which were general managers, and 3 were health and safety managers. As in the standard intervention condition, whilst managers’ responses were crucial to the tailoring of interventions, due to the relatively small numbers of managers, care must be taken in interpreting these results as generalisable to the broader managerial population.

7.4.2 Worker stage of change
Similarly to the workers in the standard intervention condition, prior to the implementation of interventions, the majority of workers in the tailored intervention condition were in the preparation and precontemplation stages, 53% and 26% respectively. Only 5% of workers were in the action stage, and 12% in the maintenance stage.
Follow-up data from workers in the tailored intervention condition showed that considerable movement occurred in terms of worker stage of change. As shown in Figure 23, significantly fewer workers were in the precontemplation and preparation stages following tailored interventions \( \chi^2 (1) = 4.27; p < 0.05, \) and \( \chi^2 (1) = 20.83; p < 0.002 \), and significantly more workers were in the action and maintenance stages \( \chi^2 (1) = 24.16; p = 0.001, \) and \( \chi^2 (1) = 21.29; p = 0.001 \).

**Figure 23. Worker stage of change (tailored interventions)**

A breakdown of responses to the question items assessing stage of change among tailored interventions enables detailed examination of workers' attitudes, perceptions, intentions, and behaviours. As in the standard condition, the proportion of workers that reported being concerned about the risks of developing musculoskeletal aches and pains remained largely unchanged before and after tailored interventions, 77% of workers expressing that they were concerned about the risks of developing MSDs before the implementation of interventions, and 78% post-intervention.

In terms of intentions to take action, the proportion of workers in the tailored intervention condition that perceived there to be a need for changes to be
made in the next 6 months changed very slightly, from 74% to 70%. A small (although not significant) reduction occurred in the proportion of workers expressing the need for action to be taken in the next month or two, from 66% before the implementation of interventions, to 58% post-intervention.

The proportion of workers that had specific ideas for the types of changes that would help to reduce the risks increased significantly after the implementation of interventions, 51% providing specific suggestions pre-intervention, and 62% post-intervention [$\chi^2 (1) = 3.62; p < 0.05$]. As would be expected, in terms of changes made, significantly more workers identified that their employer had made changes aimed at reducing the risk post-intervention, 55% compared to only 40% pre-intervention [$\chi^2 (1) = 7.46; p < 0.05$]. Similarly, the number of workers that reported having made changes aimed at reducing the risks themselves increased significantly after the implementation of interventions, from 33% to 58% [$\chi^2 (1) = 21.49; p < 0.001$].

Encouragingly, the number of workers that reported that they intended to continue attempts to avoid the risks of MSDs following tailored interventions increased significantly, from 66% pre-implementation, to 88% post-implementation [$\chi^2 (1) = 4.92; p < 0.05$].

The length of the time interval between the initial and follow-up visits within organisations receiving tailored interventions was also significantly related to workers stage of change [$\chi^2 (2) = 7.85; p < 0.05$]. This relationship is logical given that stage of change is partly dependent upon temporal markers (e.g. the 6 month milestone when individuals are either categorised as being in the maintenance stage, or to have relapsed). The mean time of follow-up was 5.43 months.

**7.4.3 Managerial stage of change**

Prior to the implementation of interventions, the majority of managers in the tailored intervention condition indicated that they were in the maintenance stage (50%, n = 11). Following the implementation of interventions, as might be expected, the majority of managers were identified as being in the action
stage (56%, n = 9), as shown in Figure 24. The increase in the number of managers in the action stage following the implementation of interventions was statistically significant [$\chi^2 (1) = 4.47; p < 0.05$].

A breakdown of responses to the question items assessing stage of change enables detailed examination of managers' attitudes, perceptions, intentions, and behaviours. The proportion of managers involved in tailored interventions that reported being concerned about the risks of employees developing MSDs reduced from 96% (n = 21), to 86% (n = 14) following the implementation of changes. As in the standard intervention condition, managers' intentions to take action did not differ significantly before and after the implementation of interventions. Those that intended to take action in the next 6 months (the delimiting condition for the contemplation stage) decreased very slightly, from 68% (n = 15) to 63% (n = 10), and those intending to take action in the next month or two (one of the delimiting factors of the preparation stage) increased from 50% (n = 11) to 63% (n = 10) following implementation of changes.

**Figure 24. Managerial stage of change (tailored interventions)**

Perhaps unsurprisingly, following interventions, fewer managers had specific plans for the changes that they intended to make following the implementation
of interventions (56%, n = 9 compared to 68%, n = 15), and more managers reported that changes had been made to tackle the risks (88%, n = 14 compared to 73%, n = 16 pre-intervention). As in the standard intervention condition, none of these differences were statistically significant with the managerial sample.

Encouragingly, in both the pre- and post-intervention questionnaires, all of those managers that had taken action more than 6 months ago indicated that they intended to continue their attempts to maintain low levels of risk.

7.4.4 Musculoskeletal discomfort (workers)

Workers were asked if they had experienced any form of musculoskeletal pain or discomfort in the last 7 days, both prior to and following the implementation of changes aimed at reducing the risks of MSDs. The proportion that reported having experienced pain or discomfort at these two intervals differed slightly, although not significantly (80% of the sample pre-implementation and 73% post-intervention, p = 0.097). In terms of the specific body areas in which respondents reported having experienced pain or discomfort, the percentage of workers having reported pain/discomfort in each area is given in Table 30, and Figure 25.

There were significant reductions in numbers of workers that reported having experienced pain or discomfort in the upper arm [$\chi^2 (1) = 8.79; p < 0.05$], elbow [$\chi^2 (1) = 6.42; p < 0.05$], forearm [$\chi^2 (1) = 5.97; p < 0.05$], wrist [$\chi^2 (1) = 15.65; p < 0.001$], hand [$\chi^2 (1) = 3.02; p < 0.05$], lower back [$\chi^2 (1) = 3.38; p < 0.05$], and legs [$\chi^2 (1) = 10.81; p < 0.001$] in the post-intervention questionnaire. As was the case with the standard intervention condition, the lower back was the body area within which workers most commonly reported having experienced pain, both prior to and following the implementation of interventions.
Table 30. Percentage of workers having reported pain/discomfort - tailored interventions

<table>
<thead>
<tr>
<th>Number of workers having experienced pain in each body area</th>
<th>Pre-intervention</th>
<th>Post-intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of participants</td>
<td>198</td>
<td>142</td>
</tr>
<tr>
<td>Neck</td>
<td>40</td>
<td>32</td>
</tr>
<tr>
<td>Shoulder</td>
<td>45</td>
<td>41</td>
</tr>
<tr>
<td>Upper arm</td>
<td>28</td>
<td>14</td>
</tr>
<tr>
<td>Elbow</td>
<td>33</td>
<td>20</td>
</tr>
<tr>
<td>Forearm</td>
<td>25</td>
<td>14</td>
</tr>
<tr>
<td>Wrist</td>
<td>36</td>
<td>16</td>
</tr>
<tr>
<td>Hand</td>
<td>31</td>
<td>23</td>
</tr>
<tr>
<td>Upper back</td>
<td>26</td>
<td>20</td>
</tr>
<tr>
<td>Lower back</td>
<td>59</td>
<td>49</td>
</tr>
<tr>
<td>Legs</td>
<td>30</td>
<td>16</td>
</tr>
</tbody>
</table>

Figure 25. Percentage of workers experiencing pain/discomfort in the previous 7 days (tailored interventions)
For each of the areas within which workers reported having experienced pain or discomfort, they were asked to rate the severity of this pain/discomfort. Both pre- and post-intervention, workers' ratings ranged across the scale from 1 (minimal discomfort) to 7 (extreme discomfort). Wilcoxon signed ranks tests revealed that workers' ratings of pain severity were significantly lower following stage-matched interventions in a number of body areas: upper arm \(Z = -3.01; \ p < 0.05\), forearm \(Z = -2.58; \ p < 0.05\), wrist \(Z = -3.24; \ p < 0.001\), and legs \(Z = -2.15; \ p < 0.05\). Mean ratings are displayed in Figure 26.

**Figure 26. Mean ratings of workers' discomfort severity (tailored interventions)**

Finally, the proportion of workers that reported having experienced musculoskeletal discomfort did not differ significantly according to the length of time between pre- and post-intervention follow-up, in terms of the total proportion reporting any form of musculoskeletal pain, or pain for any individual body area.

**7.4.5 Workers' attitudes towards health & safety**

A breakdown of workers' pre- and post-implementation responses to the Safety Climate checklist is shown in Table 31 (percentages are to the nearest whole number), and workers' safety climate scores are shown in Figure 27.
Notable improvements are evident in workers' perceptions of management commitment, communication, and company prioritisation of safety following the implementation of interventions. Safety climate scores also show a reduction in relation to workers' personal appreciation of the risk following the implementation of interventions. However, this is because increased appreciation of risks amongst workers (for example, increased agreement that the chances of developing MSDs are quite high) is considered a detrimental outcome in terms of Cox and Cheyne's (1999) Safety Climate Assessment. In some circumstances though, particularly in the precontemplation and contemplation stages, it could be argued that such change is not only a beneficial, but also an essential outcome.

Wilcoxon signed-rank tests identified that workers were significantly more likely to agree with the statement 'Management here considers health and safety to be equally important as production' following the implementation of tailored interventions \[Z = -2.2; p < 0.05\]. A strong trend was identified for an increase in workers' agreement with the statement 'I believe health and safety issues are assigned a high priority' following the implementation of tailored interventions, although did not quite reach the level of statistical significance \[Z = -1.9; p = 0.06\]. These two items constitute the 'Company prioritisation' dimension of the Safety Climate Assessment. A trend was also identified for an increase in workers' agreement with the statement 'I'm sure it's only a matter of time before I develop a work-related health problem' following the implementation of tailored interventions \[Z = -1.9; p = 0.06\]. This item constitutes half of the 'Personal appreciation of risk' dimension.
Table 31. Percentage of workers in agreement/disagreement with Safety Climate items (tailored interventions)
[Initial survey results = regular font, Follow-up survey results = bold]

<table>
<thead>
<tr>
<th>Management commitment</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Neither agree nor disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management acts decisively when a health and safety concern has been raised</td>
<td>11% 15%</td>
<td>44% 40%</td>
<td>22% 27%</td>
<td>18% 17%</td>
<td>5% 1%</td>
</tr>
<tr>
<td>In my workplace management acts quickly to correct health and safety problems</td>
<td>10% 15%</td>
<td>42% 39%</td>
<td>24% 27%</td>
<td>20% 18%</td>
<td>5% 2%</td>
</tr>
<tr>
<td>Communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health and safety information is always brought to my attention by my line manager/supervisor</td>
<td>17% 18%</td>
<td>49% 51%</td>
<td>19% 16%</td>
<td>12% 14%</td>
<td>4% 2%</td>
</tr>
<tr>
<td>There is good communication here about health and safety issues which affect me</td>
<td>14% 18%</td>
<td>44% 46%</td>
<td>26% 24%</td>
<td>13% 11%</td>
<td>4% 2%</td>
</tr>
<tr>
<td>Company prioritisation of safety</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management here considers health and safety to be equally as important as production</td>
<td>11% 17%</td>
<td>37% 43%</td>
<td>24% 18%</td>
<td>20% 17%</td>
<td>8% 5%</td>
</tr>
<tr>
<td>I believe health and safety issues are assigned a high priority</td>
<td>15% 23%</td>
<td>37% 38%</td>
<td>28% 24%</td>
<td>15% 12%</td>
<td>6% 4%</td>
</tr>
<tr>
<td>Perceived importance of safety rules &amp; procedures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Some health &amp; safety rules and procedures don’t need to be followed to get the job done safely</td>
<td>4% 4%</td>
<td>24% 19%</td>
<td>20% 18%</td>
<td>37% 44%</td>
<td>15% 14%</td>
</tr>
<tr>
<td>Some health and safety rules are not really practical</td>
<td>4% 6%</td>
<td>31% 31%</td>
<td>22% 25%</td>
<td>33% 31%</td>
<td>10% 7%</td>
</tr>
<tr>
<td>Supportive environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am strongly encouraged to report unsafe conditions</td>
<td>24% 23%</td>
<td>46% 47%</td>
<td>17% 21%</td>
<td>11% 8%</td>
<td>2% 2%</td>
</tr>
<tr>
<td>I can influence health and safety performance here</td>
<td>14% 15%</td>
<td>41% 36%</td>
<td>26% 37%</td>
<td>17% 10%</td>
<td>3% 2%</td>
</tr>
<tr>
<td>Involvement in health &amp; safety</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am involved in informing management of important health and safety issues</td>
<td>14% 14%</td>
<td>38% 40%</td>
<td>30% 33%</td>
<td>18% 13%</td>
<td>1% 0%</td>
</tr>
<tr>
<td>I am involved in the ongoing review of health and safety</td>
<td>10% 12%</td>
<td>19% 20%</td>
<td>39% 41%</td>
<td>29% 23%</td>
<td>3% 4%</td>
</tr>
<tr>
<td>Personal priorities &amp; need for safety</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health and safety is the number one priority in my mind when completing a job</td>
<td>17% 20%</td>
<td>42% 36%</td>
<td>24% 29%</td>
<td>16% 14%</td>
<td>2% 1%</td>
</tr>
<tr>
<td>It is important to me that there is a continuing emphasis on health and safety</td>
<td>30% 35%</td>
<td>55% 54%</td>
<td>12% 7%</td>
<td>3% 4%</td>
<td>0% 1%</td>
</tr>
<tr>
<td>Personal appreciation of risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I’m sure it’s only a matter of time before I develop a work-related health problem</td>
<td>27% 20%</td>
<td>30% 27%</td>
<td>29% 30%</td>
<td>12% 18%</td>
<td>1% 5%</td>
</tr>
<tr>
<td>In my workplace the chances of developing work-related health problem are quite high</td>
<td>37% 24%</td>
<td>29% 38%</td>
<td>20% 22%</td>
<td>14% 12%</td>
<td>0% 4%</td>
</tr>
<tr>
<td>Work demands enable safe working</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production targets rarely conflict with health and safety measures</td>
<td>7% 5%</td>
<td>28% 24%</td>
<td>30% 42%</td>
<td>22% 19%</td>
<td>14% 10%</td>
</tr>
<tr>
<td>I am always given enough time to get the job done safely</td>
<td>9% 8%</td>
<td>34% 38%</td>
<td>20% 22%</td>
<td>18% 17%</td>
<td>20% 15%</td>
</tr>
</tbody>
</table>
Figure 27. Safety climate (workers – tailored interventions)

Management Commitment

Work demands enable safe working

Personal appreciation of risk

Personal priorities & need for safety

Involvement in health & safety

Supportive environment

Communication

Company prioritisation of safety

Perceived importance of safety rules & procedures

Pre-intervention – Post-intervention
7.4.6 Managers' attitudes towards health & safety

A breakdown of managers' pre- and post-implementation responses to the Safety Climate Checklist (Cox & Cheyne, 1999) is shown in Table 32 (percentages are to the nearest whole number). Scores calculated for each dimension are shown in Figure 28, which indicate that managers' personal appreciation of risks appeared to increase, although their perceived importance of safety rules and procedures, perceptions of senior management commitment, involvement in health and safety, and the extent to which their working environment was seen as supportive appeared to decline following the implementation of interventions.

As with the results from managers involved in the standard interventions, however, care must be taken in interpreting these findings as representative or generalisable, due to the relatively small samples sizes.

7.4.7 Comparisons of tailored & standard groups at baseline

Due to the alternate assignment of case studies to standard and tailored conditions in order to avoid the possibility of selective allocation effects, the researchers had no control over the stage of change profiles of the workers in these conditions pre-implementation of interventions. Despite this however, it is important to identify any significant differences in pre-intervention stage of change.

Comparison of the pre-intervention stage of change profiles of workers in the standard and tailored conditions revealed that whilst there are no significant differences in the numbers of workers in the precontemplation, contemplation, or maintenance stages prior to implementation of interventions, there were significantly more workers from the tailored condition in the preparation stage pre-implementation of interventions \([\chi^2 (1) = 11.91; p < 0.001]\). On the other hand however, there were also significantly more workers from the standard condition in the action stage than those in the tailored condition, prior to the implementation of interventions \([\chi^2 (1) = 7.51; p < 0.05]\). To simplify this comparison, the stages can be combined to create two categories, 'inactive' (individuals in precontemplation, contemplation, and preparation), and 'active' (individuals in the action and maintenance stages). An analysis of the frequencies of workers from the standard and tailored conditions in these two categories showed that overall there were no significant differences between the groups (see Figure 29).
Table 32. Percentage of managers in agreement/disagreement with Safety Climate items (tailored interventions)

[Initial survey results = regular font, Follow-up survey results = bold]

<table>
<thead>
<tr>
<th>Management commitment</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Neither agree nor disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management acts decisively when a health and safety concern has been raised</td>
<td>55% 31%</td>
<td>41% 69%</td>
<td>5% 17%</td>
<td>0% 0%</td>
<td>0% 0%</td>
</tr>
<tr>
<td>In my workplace management acts quickly to correct health and safety problems</td>
<td>46% 25%</td>
<td>50% 69%</td>
<td>0% 0%</td>
<td>5% 6%</td>
<td>0% 0%</td>
</tr>
<tr>
<td>Communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health and safety information is always brought to my attention by my line manager/supervisor</td>
<td>27% 25%</td>
<td>64% 63%</td>
<td>9% 0%</td>
<td>0% 13%</td>
<td>0% 0%</td>
</tr>
<tr>
<td>There is good communication here about health and safety issues which affect me</td>
<td>23% 38%</td>
<td>64% 56%</td>
<td>14% 6%</td>
<td>0% 0%</td>
<td>0% 0%</td>
</tr>
<tr>
<td>Company prioritisation of safety</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management here considers health and safety to be equally as important as production</td>
<td>32% 40%</td>
<td>50% 47%</td>
<td>9% 7%</td>
<td>9% 7%</td>
<td>0% 0%</td>
</tr>
<tr>
<td>I believe health and safety issues are assigned a high priority</td>
<td>36% 31%</td>
<td>59% 69%</td>
<td>0% 0%</td>
<td>5% 0%</td>
<td>0% 0%</td>
</tr>
<tr>
<td>Perceived importance of safety rules &amp; procedures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Some health &amp; safety rules and procedures don't need to be followed to get the job done safely</td>
<td>0% 6%</td>
<td>0% 19%</td>
<td>9% 6%</td>
<td>59% 31%</td>
<td>32% 38%</td>
</tr>
<tr>
<td>Some health and safety rules are not really practical</td>
<td>0% 6%</td>
<td>14% 25%</td>
<td>18% 13%</td>
<td>50% 38%</td>
<td>18% 19%</td>
</tr>
<tr>
<td>Supportive environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am strongly encouraged to report unsafe conditions</td>
<td>68% 56%</td>
<td>32% 31%</td>
<td>0% 6%</td>
<td>0% 0%</td>
<td>0% 6%</td>
</tr>
<tr>
<td>I can influence health and safety performance here</td>
<td>64% 56%</td>
<td>32% 38%</td>
<td>5% 6%</td>
<td>0% 0%</td>
<td>0% 0%</td>
</tr>
<tr>
<td>Involvement in health &amp; safety</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am involved in informing management of important health and safety issues</td>
<td>68% 50%</td>
<td>32% 50%</td>
<td>0% 0%</td>
<td>0% 0%</td>
<td>0% 0%</td>
</tr>
<tr>
<td>I am involved in the ongoing review of health and safety</td>
<td>64% 56%</td>
<td>36% 38%</td>
<td>0% 6%</td>
<td>0% 0%</td>
<td>0% 0%</td>
</tr>
<tr>
<td>Personal priorities &amp; need for safety</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health and safety is the number one priority in my mind when completing a job</td>
<td>14% 13%</td>
<td>59% 63%</td>
<td>18% 13%</td>
<td>9% 13%</td>
<td>0% 0%</td>
</tr>
<tr>
<td>It is important to me that there is a continuing emphasis on health and safety</td>
<td>32% 44%</td>
<td>68% 56%</td>
<td>0% 0%</td>
<td>0% 0%</td>
<td>0% 0%</td>
</tr>
<tr>
<td>Personal appreciation of risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I'm sure it's only a matter of time before I develop a work-related health problem</td>
<td>14% 25%</td>
<td>36% 25%</td>
<td>23% 38%</td>
<td>18% 13%</td>
<td>9% 0%</td>
</tr>
<tr>
<td>In my workplace the chances of developing a work-related health problem are quite high</td>
<td>5% 19%</td>
<td>36% 19%</td>
<td>23% 19%</td>
<td>18% 44%</td>
<td>9% 0%</td>
</tr>
<tr>
<td>Work demands enable safe working</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production targets rarely conflict with health and safety measures</td>
<td>23% 25%</td>
<td>32% 31%</td>
<td>9% 19%</td>
<td>32% 25%</td>
<td>5% 0%</td>
</tr>
<tr>
<td>I am always given enough time to get the job done safety</td>
<td>23% 13%</td>
<td>50% 50%</td>
<td>5% 19%</td>
<td>23% 13%</td>
<td>0% 6%</td>
</tr>
</tbody>
</table>
Figure 28. Safety climate (managers – tailored interventions)

- Work demands enable safe working
- Personal appreciation of risk
- Personal priorities & need for safety
- Involvement in health & safety
- Supportive environment

Pre-intervention
Post-intervention
As with stage of change, in order to identify any pre-implementation difference that may have biased the results, post-hoc analyses were carried out to examine any significant differences in self-reported pain prior to the implementation of interventions between the groups of workers that were to receive standard and tailored interventions. These analyses identified that prior to the implementation of interventions, self-reported pain was significantly higher among workers in the tailored condition in relation to a number of body areas. Namely, the upper arm \( \chi^2 (1) = 4.41; p < 0.05 \), elbow \( \chi^2 (1) = 10.63; p < 0.001 \), wrist \( \chi^2 (1) = 6.98; p < 0.05 \), and legs \( \chi^2 (1) = 4.53; p < 0.05 \).

### 7.5 Examination of independent variables related to post-intervention stage

Whilst the relationships between stage of change, decisional balance and habit strength constructs are well documented, the stage of change approach has not been previously applied to occupational health and safety issues. As a result, further analyses were conducted to explore the specific work- or organisation-related factors (e.g. organisation size, employee tenure) that were related to stage of change following the implementation of interventions. Results are first presented for the factors that were significantly related to worker stage of change, followed by the factors significantly related to managerial stage of change. Analyses were conducted.
using numeric labels for each stage (1= precontemplation, 2= contemplation, 3= preparation, 4= action, 5= maintenance). The tests applied calculate a mean rank of stage of change for each of the groups between which differences are being examines (i.e. short tenure vs long tenure). Consequently, a higher mean rank for a particular group reflects further average stage progression. These analyses will provide deeper insight into the types of variables that are significantly related to stage of change following the implementation of standard and tailored interventions. As it is the effects of the interventions (standard and tailored) that are of interest, and the factors that may be associated with the outcomes of the interventions, the results presented in this section relates to the post-intervention data only. In order to improve the fluidity of this section, discursive comments will be incorporated into the following sections (Sections 7.5.1 and 7.5.2).

7.5.1 Factors related to worker stage of change

Sector: In the tailored intervention condition, workers’ stage of change was significantly related to industrial sector \[\chi^2 (3) = 17.36; p < 0.001\]. Mean ranks revealed that workers in the education sector tended to be the most advanced in stage of change, closely followed by those in the manufacturing sectors, followed by those in the utilities industry. Workers in the postal and delivery sector tended to be the least advanced. The differences in the stage of change profiles between the highest and lowest ranked sectors (education and the postal/delivery sector, respectively) can be seen in Figures 30 and 31. The association between stage of change and sector was not significant for those workers in the standard condition however, although this relationship can be considered a strong trend \[\chi^2 (3) = 7.17; p = 0.07\]. This pattern of results may suggest that tailoring was implemented more effectively in certain sectors than others. This is not simply the continuation of existing differences between the sectors, as analyses of the pre-intervention data reveal that whilst sector was significantly related to stage among the workers in the ‘to be tailored’ condition \[\chi^2 (3) = 26.17; p < 0.001\], the sectors were ranked in almost the reverse order to that post-intervention. Prior to the implementation of tailored interventions, the postal/delivery sector were on average the most advanced group of workers in terms of stage, followed by the manufacturing sector, followed by the utilities industry, with workers in the education sector tending to be the least advanced. The tendency for workers in the postal and delivery sector to be the least
advanced in stage of change, however, may relate to the limited of control over the external work environment. This is consistent with the majority of postal and delivery workers being in the preparation stage, denoting that they appreciate the risks, and perceive there to be a need for changes to be made, although changes have not yet been made.

Figure 30. Workers’ stage of change – Education sector (tailored interventions)

![Pre-intervention vs Post-intervention stage of change for Education sector](image1)

Figure 31. Workers’ stage of change – Postal/delivery sector (tailored interventions)

![Pre-intervention vs Post-intervention stage of change for Postal/delivery sector](image2)
Age, tenure, hours worked per week: Stage of change was not significantly related to workers’ age, tenure, or number of hours worked per week for those workers having received tailored interventions. This was also the case in the standard intervention condition, in terms of age and hours worked per week, although following standard interventions, workers’ stage of change was significantly related to tenure $[\chi^2 (2) = 7.30; p < 0.05]$. The longer an employee had been employed within the organisation, the further advanced they tended to be in terms of stage of change (as shown in Figure 32). It might be speculated that this is because the longer a worker has been employed within an organisation, the more likely they are to have experienced musculoskeletal pain, due to increased exposure to the risk factors (given that all of the participating organisations were from what are considered by the HSE as high risk sectors), and so may have been forced to make changes as a result. Although further analyses showed no significant association between self-reported pain and job tenure, this does not necessarily refute this explanation given that the results only relates to pain experienced in the last 7 days. Aside from having experienced pain personally, however, it is possible that those workers that achieve long tenure, but do not report pain themselves, have known colleagues that have experienced these problems, which may have an equally motivational effect. This relationship was supported by the findings of the tool development phase of research (Chapter 6), which identified worker stage of change as significantly related to their reports of colleagues having experienced pain (both in the past 7 days and 12 months). Furthermore, the healthy worker effect (e.g. Nordander et al., 1999) is also consistent with this interpretation, given that those workers that have experienced musculoskeletal pain are more likely to leave (whether by choice or compulsion) occupations characterised by high MSD risks. Consequently, those workers that remain, but do not experience pain themselves, are likely to have witnessed colleagues experiencing these problems, which may have an equally motivational effect. In fact, at least part of the reason that these workers have achieved long tenure (as opposed to having been forced to leave the job as a result of the development of a work-related MSD) could be because they have taken steps to avoid developing such problems. As tenure was not significantly related to stage following tailored interventions, it might be speculated that by explicitly raising workers’ awareness of their susceptibility to MSDs, the tailoring process overrides the effect that otherwise tends to be time-related.
Musculoskeletal pain
Stage of change was significantly related to reports of musculoskeletal pain for workers in the standard condition \([U = 2548; p < 0.001]\), but only reached the level of a trend for those in the tailored condition \([U = 1555; p = 0.06]\). Examination of the stage of change distributions according to reported musculoskeletal pain (see Figures 33 and 34) reveals that following standard interventions, the maintenance stage consisted largely of workers that had reported pain. Following tailored interventions, however, the maintenance stage consisted not only of workers that had reported pain, but also an equivalent amount of workers that had not reported pain.

Figure 33. Percentage of workers reporting pain according to stage of change (Standard interventions)
It was speculated above with regards to tenure, that the tailoring process may stimulate perceived susceptibility to MSDs among workers, which otherwise might only develop over time, as a result of personal experience. A similar process might underpin the above results regarding stage of change according to the proportion of workers that reported having experienced musculoskeletal pain. Taking the example of the workers in the maintenance stage, for instance, in the standard intervention condition the maintenance stage consists mostly of workers that had experienced pain. Following tailored interventions, in contrast, the maintenance stage consists of approximately half worker that had experienced pain and half that had not. It could be argued that in the absence of tailoring, the predominant factor motivating maintenance among workers, is that they are or have already experienced pain. Following tailored interventions, on the other hand, workers that both did and did not report having experienced musculoskeletal pain are attempting to maintain changes aimed at avoiding such problems.

Health & safety climate
Following tailored interventions, workers’ stage of change was not significantly related to any aspect of health and safety climate measured by the Cox and Cheyne’s (1999) Safety Climate Assessment. Following standard interventions, however, workers’ stage of change was significantly related to a number of aspects of health and safety climate. Consistent with the discussions outlined above, in
relation to tenure and self-reported pain, this pattern of results may also reflect that the tailoring process can override forces that otherwise may determine the outcomes of an intervention (in this case, safety climate). The specific dimensions of safety climate that were significantly related to stage following standard interventions are outlined below.

Following standard interventions, worker stage of change was significantly related to both components of the management commitment construct; ‘Management acts decisively when a health and safety concern has been raised’ \[\chi^2 (4) = 17.85; p < 0.05\] and ‘In my workplace management acts quickly to correct health and safety problems’ \[\chi^2 (4) = 18.28; p < 0.05\]. As shown in Figure 35, those in the more advanced stages of change tended to be less likely to agree that management was committed to change.

**Figure 35. Management commitment according to stage of change**

Following standard interventions, worker stage of change was also significantly related to both components of the communication construct; ‘Health and safety information is always brought to my attention by my line manager’ \[\chi^2 (4) = 10.85; p < 0.05\], and ‘There is good communication about health and safety issues which affect me’ \[\chi^2 (4) = 12.03; p < 0.05\]. As shown in Figure 36, those in the more advanced stages of change tended to be less likely to agree that communication regarding health and safety matters was good within their organisation.
Following standard interventions, worker stage of change was significantly related to one aspect of the company prioritisation of safety construct; ‘Management here considers health and safety to be equally as important as production’ \( \chi^2 (4) = 13.65; p < 0.05 \). As shown in Figure 37, those in the more advanced stages of change tended to be less likely to agree that management regarded health and safety as equally as important as production.

Following standard interventions, worker stage of change was not significantly related to either the ‘Perceived importance of safety rules and procedures’ or ‘Supportive environment’ constructs. Significant associations were, however,
identified with one aspect of the involvement in health and safety construct; ‘I am involved in the ongoing review of health and safety’ $[\chi^2 (4) = 16.22; p < 0.05]$. As shown in Figure 38, those in the more advanced stages of change tended to both strongly agree and strongly disagree that they were involved in reviewing health and safety. Those with milder responses (whether of mild agreement or disagreement) tended to be in the earlier stages of change.

**Figure 38. I am involved in the ongoing review of health and safety, according to stage of change**

![Bar chart](image)

One aspect of the personal priorities and need for safety construct; ‘It is important to me that there is a continuing emphasis on health and safety’ was also associated with stage of change following standard interventions $[\chi^2 (4) = 18.48; p < 0.05]$. As shown in Figure 39, the pattern of results is similar to those above, with those in the more advanced stages of change tending to either strongly agree or strongly disagree about the importance of a continuing emphasis on health and safety.
Figure 39. It is important that there is a continuing emphasis on health and safety, according to stage of change

Following standard interventions, worker stage of change was significantly related to both components of the personal appreciation of risk construct; ‘I’m sure it’s only a matter of time before I develop a work-related health problem $[\chi^2 (4) = 16.52; p < 0.05]$, and ‘In my workplace the chances of developing a work-related health problem are quite high’ $[\chi^2 (4) = 17.34; p < 0.05]$. As shown in Figure 40, those in the more advanced stages of change tended to be less likely to agree that communication regarding health and safety matters was good within their organisation.

Figure 40. Personal appreciation of risk according to stage of change
Finally, following standard interventions, worker stage of change was also significantly related to both components of the work demands enable safe working construct; ‘Production targets rarely conflict with health and safety measures’ [$\chi^2 (4) = 22.20; p < 0.001$]; and ‘I am always given enough time to get the job done safety’ [$\chi^2 (4) = 13.97; p < 0.05$]. As shown in Figure 41, those in the more advanced stages of change tended to be less likely to believe that work demands enable safe working within their organisation. It might be assumed that those workers who do feel that work demands conflict with safe working practices do not feel that there is a need for changes to be made.

**Figure 41. Work demands enable safe working according to stage of change**

![Bar chart showing mean stage rank for different responses to statements about work demands enabling safe working.](image)

### 7.5.2 Factors related to managerial stage of change

Only a small number of factors were significantly related to managerial stage of change, and only in the standard intervention condition. Managers’ stage of change progression following standard interventions was significantly related to one aspect of the supportive environment construct; ‘I am strongly encouraged to report unsafe conditions’ [$\chi^2 (4) = 10.71; p < 0.05$], one aspect of the involvement in health & safety construct; ‘I am involved in the ongoing review of health and safety’ [$\chi^2 (4) = 5.99; p < 0.05$], and one aspect of the personal priorities & need for safety construct; ‘It is important to me that there is a continuing emphasis on health and safety’ [$\chi^2 (4) = 4.22; p < 0.05$]. These trends are displayed in Figure 42. It is possible that the
relatively small managerial sample was at least partly the reason for only a small number of significant differences being identified.

Figure 42. Safety climate factors relating to managerial stage of change

7.6 Discussion

7.6.1 Key findings
The study described in this chapter applied tools developed to assess stage of change in the context of reducing the risks of developing MSDs. Development and testing of the tools was described in Chapter 6, which revealed good levels of reliability. The aim of the study described in this Chapter, therefore, was to examine whether applying these tools in practice, to tailor interventions according to workers and managers' stage of change, could improve the effectiveness of such interventions.

A total of 24 interventions aimed at tackling MSDs were monitored, and in half of these cases approaches were tailored according to worker and managerial stage of change. Comparisons between the pre- and post-intervention data revealed that in the standard (non-tailored) intervention condition, there were no significant differences between the number of workers in each stage of change prior to, and following, the implementation of standard interventions, or between the numbers of workers that reported having experienced musculoskeletal pain (either overall, or in
each individual body area). A different pattern of results was found among workers following the implementation of tailored interventions, however, with significant differences in worker stage of change profile (reflecting stage progression), and significant reductions in the number of workers reporting musculoskeletal pain in a number of body areas. Following the implementation of tailored interventions, significantly fewer workers in the precontemplation and preparation stages, and significantly more were in the action and maintenance stages. A crucial determinant of this positive outcome appears to have been the prevention of relapse, as following the implementation of interventions, significantly more workers in the tailored condition reported the intention to continue efforts to maintain low levels of risk, as opposed to those in the standard intervention condition, who tended to relapse into precontemplation, not intending to pay any further attention to the issue. Due to the difficulty of making workplaces completely free from risks that may lead to MSDs, this is an important outcome, as workers need to remain vigilant to any potential risks even after initial steps have been taken to address the problem.

The results of this study are particularly striking considering that the comparison groups (standard and tailored interventions) comprise a number of different and varied interventions, both in terms of the type of intervention and the nature of the organisation. This may be indicative of the importance of the overarching change process itself, as opposed to the content of the interventions, per se. Such a notion is consistent with the literature reviewed in Section 2.13.8.

Comparison of data from managers and workers revealed that whilst the majority of managers in both the standard and tailored intervention conditions were in the maintenance and action stages, only 60% of workers in the standard intervention condition and 55% of those in the tailored intervention condition, stated that their employer had made changes aimed at tackling the risks of MSDs. Possible interpretations of this finding are that managers tended to over-report the frequency with which changes had been made, or alternatively that interventions (i.e. training or new technologies) had not been adopted or recognised by employees. Alternatively, it may be that workers were unaware of changes that had been made, suggesting that they were not involved in the implementation of interventions. Not only is lack of employee participation in ergonomics interventions likely to reduce their effectiveness (e.g. Wilson
& Haines, 1997), but this finding also reinforces the importance of hearing from different groups of stakeholders within an organisation.

A number of factors were significantly related to workers' stage of change following the implementation of interventions. Whilst stage of change following tailored interventions was only significantly related to industrial sector, a number of factors were significantly related to stage following standard interventions (including tenure, musculoskeletal pain, and various elements of safety climate). It is speculated that by explicitly raising workers' awareness of factors such as their susceptibility to MSDs, the tailoring process generates motivation to change that may otherwise only be related to factors such as time, personal experience of musculoskeletal pain, or organisational safety climate.

7.6.2 Implications
It is important to note that the total number of workers that reported having experienced any form of musculoskeletal pain (regardless of the body area/s of that pain) did not differ significantly pre- and post-intervention for either the tailored or standard groups. However, there were significant reductions in the numbers of workers that experienced pain in a number of specific body areas following tailored interventions. Consequently, it seems that whilst overall, the number of workers experiencing any one form of discomfort remained largely unchanged in both the standard and tailored conditions, following tailored interventions workers experienced pain in fewer body areas. It could be speculated therefore, that tailored interventions resulted in workers reporting pain in fewer body areas, but perhaps the remaining problems reflect more chronic conditions (e.g. back problems, as discussed in Chapter 2), which by nature tend to be more persistent. It may be possible to assess this possibility with a longer-term follow up. Consistent with this point, in both the standard and tailored groups, lower back pain was the most commonly reported area in which workers experienced pain. Given that lower back pain tends to be chronic, this may account for the failure to find significant differences between the number of workers that reported having experienced any form of musculoskeletal pain prior to and following the implementation of interventions, despite significant reductions in other body areas (in the tailored condition).
It was intended that workers' levels of sickness absence would also be assessed. However, due to the levels of inconsistency, or complete absence, of measurement systems in the vast majority of cases, it was not possible to conduct any meaningful or reliable analyses. This is consistent with findings from previous investigations of absence data in the construction industry (Gyi et al., 1999). The existence of systems for measuring and monitoring sickness absence is a fundamental foundation for managing and improving health and safety that appears to be lacking in a number of cases.

In terms of managers, although it is difficult to draw conclusions due to the relatively small sample size, the majority of managers implemented changes aimed at reducing the risks of MSDs. To an extent, this is unsurprising, as the organisations participating in the study were involved because they had identified a need to tackle the risks of MSDs. However, this need had typically been identified at a senior level within the organisation, and not the manager directly supervising the implementation of changes in the section, office, or department being monitored. As a result, efforts were needed to convince these local managers of the need for the changes, and the importance of maintaining these changes. Indeed, achieving managerial 'buy-in' is likely to have been an important element in the success of tailored interventions (a more in-depth, qualitative exploration of the potential barriers and facilitators of the intervention process is given in Chapter 8).

7.6.3 Methodological limitations
Due to attrition between pre and post-intervention data, it is important to consider the possibility of a survivor bias, or healthy worker effect (e.g. Nordander et al., 1999). If workers with health problems leave their jobs, the remaining population may include a larger proportion of workers whose health has not been adversely affected by their jobs. However, analysis of pre-intervention data identified no significant differences between those present and those absent at follow-up.

Owing to ethical requirements, for the purposes of this research it was not possible to identify individual workers, so tailoring was implemented at the group level according to stage profiles. It is assumed that scope exists for achieving even more powerful
results by tailoring interventions according to each worker's individual stage profile. However, as this would be a more resource intensive task, further research should examine whether any further benefits gained outweigh the additional resources required for adopting an individualised approach.

Although the same workers were asked to complete the questionnaire prior to and following the implementation of interventions, the extent to which the same workers completed the questionnaire pre- and post-intervention could not be proven. In future work, respondents could be asked to generate a unique and memorable identity code (e.g. the name of their first school, or mother's maiden name), which could be entered onto both the pre- and post-intervention questionnaires. This would enable checks to be made of the proportion of participants that completed both the pre- and post-intervention questionnaires. However, this may also introduce additional problems. For instance, although the selected code should be information that only the employee knows, requesting identification information such as this may raise workers' concerns about confidentiality. Moreover, given that this study was designed to measure overall group statistics, rather than individuals (due to the ethical limitations designed above), this matter was not considered a substantial limitation.

As groups were allocated alternately to each group in order of recruitment in order to avoid the possibility of biased allocation, control could not be imposed over matching the groups according to musculoskeletal pain at baseline. As a result, the proportion of workers that reported having experienced musculoskeletal pain prior to the implementation of interventions was not equivalent in the two groups. Significantly more workers in the tailored intervention group reported having experienced musculoskeletal pain prior to the implementation of interventions. This may be perceived as advantaging the standard intervention group. Alternatively, it could be argued that a significant reduction in musculoskeletal pain is more probable with a larger proportion of workers having reported musculoskeletal pain in the first instance. However, given that the proportion of workers having experienced some form of musculoskeletal pain in the standard and tailored intervention groups prior to the implementation of interventions were both over 70%, it can perhaps be concluded that there was substantial scope for reduction in both groups.
With regards to managers, the failure to find many statistically significant differences between pre- and post-intervention data is likely to be due to the relatively small number of managers involved. A total of 43 managers completed the questionnaire prior to, and 28 following, the implementation of interventions. The reduction in sample size post-implementation was due to a combination of attrition and the unavailability of some managers at the time of the follow-up. Overall, there were no discernable differences between those managers that were and were not available at follow-up. However, despite the small sample size being a limitation in terms of identifying statistically significant differences in relation to managers, the main reason that managerial data was obtained was for the purposes of tailoring interventions. The primary concern of the work in this thesis is improving the effectiveness of interventions to reduce workers' occupational ill health, and as a result, it is the findings relating to workers that are of ultimate concern.

A common problem facing intervention research is that organisations cannot be forced to participate. Consequently, this makes it difficult to include organisations in which it is perceived that there is no need for changes to be made (those where the managers, or at least the key decision-makers, are precontemplative). Fortunately, in most cases, there is likely to be at least one manager (often the health and safety manager, as identified in the tool development phase, Chapter 6) who recognises the need for the risks to be managed, and the task is to ensure that the other stakeholders within the organisation are equally committed to taking action. Further research needs to investigate how, if at all, it may be possible to encourage participation of organisations in which the issue is not perceived to be a risk.

Finally, in terms of the stage of change construct, the results show very small numbers of workers and managers residing in the contemplation stage, both prior to and following the implementation of interventions, in both the standard and tailored intervention conditions. This is likely to be testament to the brief time that individuals reside in this stage, due to the time parameters that define this and the subsequent (preparation) stage. It is also possible that the contemplation stage is less relevant in the organisational context compared to the context of individual health-related behaviours such as smoking, for example. Therefore, future investigations could examine whether it is more appropriate and pragmatic in the workplace context, for
the contemplation and preparation stages to be combined, whilst retaining the same degree of power. This would not be an indication that the contemplation is necessarily an invalid stage, but that in the context of tackling MSDs, this stage may not add a great deal of practical value (in terms of tailoring interventions). The contemplation stage is undoubtedly important in tailoring interventions for other types of change intervention, such as those for giving up smoking for instance, possible because in such instances the benefits of smoking are stronger than the benefits of performing work activities in such a way as to put oneself at risk from MSDs. The factors holding an individual in the contemplation stage, and preventing them from progressing to the preparation stage are likely to be stronger for activities such as smoking or unhealthy eating (particularly addiction). As a result, in the context of work-related MSDs, the practical benefits of combining these stages (in terms of simplifying the assessment and tailoring processes) may outweigh the potential costs of reduced accuracy (particularly as few individuals appear to reside in the contemplation stage at any one time). Again, however, the effect of such a modification requires formal evaluation.

7.7 Chapter summary

Despite the importance of attitudes and behaviours in the effective reduction of MSDs, the study described in Chapter 4 suggested that such factors may not typically be assessed in practice. It is suggested that this may be, at least in part, due to the absence of approaches or techniques for integrating such elements into ergonomics interventions. The review of behaviour change theories, presented in Chapter 3, identified the stage of change approach (a component of the Transtheoretical Model, TTM, Prochaska & DiClemente, 1982) as offering a potential means of bridging this gap between theory and practice. Consequently, Chapter 6 described a study aimed at developing the stage of change approach for use with workplace interventions aimed at tackling occupational ill-health. After modifying the stage of change approach for applicability to the issue of MSDs within the workplace, questionnaires containing the stage of change assessment tool were administered to 100 managers from a variety of organisations (in terms of size, and industrial sector), and 168 workers from 10 of these organisations. This study provided evidence for the reliability (to some extent validity) of a tool developed to assess stage in relation
to reducing the risks of MSDs. The findings also revealed distinctly different stage profiles for managers and employees, emphasising that scope may exist for tailoring interventions according to the stage of change of these different groups of individuals within an organisation.

The phase of the research described in this chapter aimed to assess whether interventions can be made more effective in practice, by tailoring approaches according to the stage of change of both managers and workers, using the tools developed in the study described in Chapter 6. Twenty-four interventions were monitored within a range of organisations. In half of these cases, information and advice was provided to organisations to help them tailor the approaches according to stage of change. No significant differences were found in workers' stage of change, or self-reported musculoskeletal pain following the implementation of standard interventions. Following tailored interventions, however, significant differences were found according to worker stage of change profile (reflecting stage progression post-intervention), in addition to significant reductions in the number of workers reporting musculoskeletal pain for a number of body areas. Following the implementation of tailored interventions there were significantly fewer workers in the precontemplation and preparation stages, and significantly more were in the action and maintenance stages.

A crucial determinant of this outcome appears to have been the prevention of relapse, as following the implementation of interventions, significantly more workers in the tailored condition reported the intention to continue efforts to maintain low levels of risk. Those in the standard intervention condition, on the other hand, tended to have relapsed into precontemplation, not intending to pay any further attention to the issue. Due to the difficulty of making workplaces completely free from risks that may lead to MSDs, it is important that workers remain vigilant to any potential risks even after steps have been taken to address the problem. Consequently, the results of this study suggest that adoption of the stage of change approach could significantly improve the effectiveness of interventions to tackle MSDs, by increasing the likelihood that changes are adopted, implemented, and maintained. The promising results of this study suggest that this approach may have the potential to achieve dramatic reductions in the prevalence of MSDs.
Overview of thesis

Chapter 1: Introduction

Chapter 2: Literature review: MSDs

Chapter 3: Literature review: Behaviour change

Chapter 4: Exploration of current practices
- 14 Semi-structured interviews with ergonomics consultants

Chapter 5: Evaluation of materials
- Content analysis of HSE materials
- Evaluation of coverage of stages of change

Chapter 6: Tool development
- Worker survey (n = 168)
- Managerial survey (n = 100)

Chapter 7: Implementation
- 24 interventions monitored
- Half tailored according to stage
- Worker & managerial assessments pre & post intervention

Chapter 8: Qualitative exploration of the change process
- Post-intervention interviews with managers following tailored & non-tailored interventions (n = 17)

Chapter 9: Discussion, implications and recommendations
8. QUALITATIVE EXPLORATION OF THE CHANGE PROCESS

8.1 Introduction

A notion recognised by the World Health Organisation (1988), and highlighted throughout this thesis, is that in order to effectively reduce ill-health, interventions need to be designed to tackle behaviour, attitudes, beliefs, and intentions. As shown in Chapter 4, however, it appears that in practice, interventions to tackle MSDs tend to focus almost entirely on physical aspects of the work environment (such as force, repetition, and posture). Such an approach not only overlooks the importance of behaviour change in effectively reducing health and safety risks, but also the influence of psychosocial risk factors, which have been associated with MSDs (e.g. Eriksen et al., 2004; Harkness et al., 2003). It is of additional concern, therefore, that relatively few attempts have been made to evaluate the effectiveness of such interventions (e.g. Griffiths, 1999), and little research has been conducted to identify workplace barriers (Loisel et al., 2005).

Considering the importance attributed to attitudes and behaviours in the effective reduction of problems such as MSDs, it is likely that these factors represent important levers for bringing about much needed reduction in MSD prevalence. Indeed, previous calls had been made for application of behaviour change models such as the stage of change approach (Prochaska & DiClemente, 1982) to workplace interventions (e.g. Prochaska et al., 2001; Haslam & Haslam; 2000; Dejoy, 1996). Chapter 6 described the development of a tool to assess stage of change in the context of reducing the risks of MSDs in the workplace. This tool, found to possess high levels of reliability, was then implemented in practice to evaluate whether intervention effectiveness can be improved by tailoring approaches according to managers and workers' stage of change (Chapter 7). Following tailored interventions, workers were significantly more likely to implement, adopt and maintain changes aimed at reducing the risks. Moreover, following tailored interventions, significantly fewer workers reported musculoskeletal pain, in a number of body areas. No significant differences were found between workers' reports of musculoskeletal pain in the different body areas prior to and following non-tailored interventions.
Although the quantitative study presented in Chapter 7 provided evidence to suggest that tailoring interventions can significantly improve their effectiveness, quantitative studies such as this only provide information regarding the size and direction of an effect. Such an approach can be enriched by qualitative studies, which provide more detailed and contextual information regarding the specific nature of this effect. Indeed, in light of the complexity of the intervention process, it is unsurprising that calls have been made for more qualitative investigations into occupational health interventions (Hignett & Wilson, 2004; Kompier et al., 2000; Griffiths, 1999; Parker & Wall, 1998). Goldenhar and Schulte (1994) argued that due to the complexity of phenomena in occupational health intervention studies, focus should be placed more on the intervention process and context, rather than outcomes alone. Inadequate implementation has been identified as a fundamental reason for the ineffectiveness of interventions aimed at tackling occupational health and safety problems (e.g. Aborg et al., 1998; Westgaard & Winkel, 1997), and is likely to be one of the reasons for the effectiveness of interventions implemented following the stage of change approach. Moreover, due to the mixed evidence for the effectiveness of interventions to tackle MSDs, and the tendency for seemingly identical interventions for tackling MSDs to be effective in some instances but not in others, Karsh et al. (2001) argued that future efforts to explore the effectiveness of interventions may be more valuably focused on the intervention process itself:

'...study of the implementation process is crucial both for our understanding of future research results and for understanding the variance in outcomes...' (pp.89-90).

Despite this, existing evaluation studies aimed at tackling MSDs have typically focused on quantitative outcomes (e.g. posture angles, or the number of employees reporting MSD symptoms), rather than on the intervention process itself. In contrast, the importance of the intervention process appears to be well acknowledged in relation to occupational stress. Considering the importance of psychosocial risk factors for MSDs, it may be possible to speculate a degree of similarity between the intervention processes for tackling these two health problems. Kompier et al. (2000), for instance, suggested that interventions aimed at preventing stress should combine both “content” and “process”, integrating five key factors: 1) A stepwise and
systematic approach; 2) An adequate diagnosis or risk analysis, 3) A package of work-directed and person-directed measures that logically “fit in” with the problems identified in the risk analysis; 4) A participatory approach assuring involvement and commitment of both employees and middle management; and 5) The sustained commitment of top management. Similarly, developing earlier work by Nytro et al. (2000), Saksvik et al. (2002) identified five key ‘processes’ for stress and health interventions: 1) The ability to learn from failure and to motivate participants; 2) Multi-level participation and negotiation, and differences in organisational perception; 3) Insight into tacit and informal organisational behaviour; 4) Clarification of roles and responsibilities, especially the role of middle management; 5) Competing projects and reorganisation. Similar factors are reflected by Rubenowitz (1997), in terms of the key obstacles to gaining positive intervention results with ergonomics problems, namely, lack of commitment from line managers, neglecting to engage technicians and employees concerned, ignoring to take psychosocial conditions into consideration, and ignoring the impacts of the proposed changes on the wage system and the organisational system. However, these recommendations appear largely based on a combination of anecdotal evidence and personal experience.

In order to gain a more in-depth understanding of the process of implementing interventions and making changes in the context of tackling MSDs therefore, a qualitative investigation was undertaken. In particular, this study aimed to evaluate the intervention process in more depth, by conducting interviews with the managers responsible for implementing the interventions studied in Chapter 6. Of principal interest, was what interviewees considered to be the key barriers and facilitators in the process of implementing interventions to tackle work-related MSDs.

8.2 Method

8.2.1 Research design

Twenty-four interventions aimed at tackling MSDs were monitored within 16 different organisations from a variety of industry sectors (see Chapter 7). These multi-component interventions included a range of elements, from changes to the physical work environment (e.g. workstation height, repositioning of tools and/or materials), changes to the organisation of work (e.g. job rotation, rest breaks), and changes to
the tools and/or equipment used (e.g. introduction of lightweight tools, lifting devices).
Further details of the interventions are provided in Table 22 (Chapter 7). Between 4-8 months following the implementation of interventions, interviews were conducted with the manager, ergonomist, occupational health advisor, or health and safety manager/advisor responsible for the implementation of interventions. All interviewees had also been involved, to some extent, in the design and planning of the interventions. A semi-structured interview schedule was formulated in order to explore key aspects of the intervention process, with the key questions regarding what interviewees perceived to be the main barriers and facilitators in the process of implementing changes. The interview schedule was piloted with general and health and safety managers not participating in the main study, and subsequently refined. Each interview lasted between 60 to 90 minutes, and was conducted on the premises of each organisation, usually within the interviewee's office. Interviews were tape recorded, with the agreement of participants. In some situations the interview location was noisy, in which cases interviews were also recorded by hand. All recorded material was fully transcribed, verbatim.

8.2.2 Sample
As described in Chapter 7, recruitment of the organisations within which the interventions were carried out was achieved through a University press release, inviting organisations that were intending to implement changes to tackle health and safety, to participate. The purpose of the study was given as an investigation of the process of tackling occupational health and safety problems such as MSDs. The press release was subsequently featured in various other publications, including the Safety & Health Practitioner, RoSPA Occupational Safety & Health Bulletin, and TUC Risks Magazine. If organisations met the basic criteria (i.e. organisations within high-risk industries for MSDs, determined by 2000/01 occupational ill-health statistics, UK Health and Safety Commission, 2002), respondents were selected on a first come first served basis. Within these organisations, those individuals directly responsible for the implementation of change initiatives were interviewed.

8.2.3 Analysis
Transcribed data from the interviews were analysed using the structured method outlined by Miles and Huberman (1994), involving a three-staged approach
consisting of data reduction (involving initial coding and search for themes), data displays and exploration, and conclusion drawing and verification. The first phase involved physically organising and sub-dividing data into meaningful segments by cutting and pasting material into categorical collections, corresponding to the interview questions. The second phase involved search for emerging themes which arose spontaneously in the discussion, and for patterns within and between themes. As suggested by both Miles and Huberman (1994) and Rubin and Rubin (1995), an initial, tentative list of codes was created based on each individual transcript (relating to the issues, ideas, and concepts mentioned), which was then compared against subsequent sets of transcripts to identify 'repeatable regularities', or to generate new codes. This process has also been referred to as 'discriminant sampling' (Lincoln & Guba, 1985). Patterns codes were then identified by searching for recurring phrases or common threads between transcripts, and any similarities between groupings of interviewees. The data under each theme was summarised and verbatim quotes used to illustrate the theme being described. Finally, theory building and conclusion drawing was achieved by constructing explanations based on the combinations of concepts that emerged, and interpretations of the data. This iterative process involved continual verification of conclusions by checking back among the data, and by comparing the results with existing knowledge/literature in the field.

8.3 Results

Details of interviewees (n = 17), and the organisations within which they were employed, including the interviewee's role, the industry within which they were employed, the number of workers to be affected by each intervention, and the interviewee's tenure with the company, are shown in Table 33. In some large organisations, it was possible to monitor 2 or 3 different interventions within demographically disparate sites, offices, or departments, enabling comparisons between sites. As a result, some interviewees were involved in more than one of the interventions monitored (as denoted by case number in Table 34), explaining why there are fewer interview participants than interventions monitored. A total of 12 different organisations were involved in this phase of research.
Interestingly, there were no discernible patterns in the responses according to whether an intervention was tailored or non-tailored. Interviewees tended to identify common barriers and facilitators of change across the board.

### Table 33. Interviewee and intervention details

<table>
<thead>
<tr>
<th>Industry</th>
<th>No. of Workers</th>
<th>Role of Interviewee</th>
<th>Tenure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>35</td>
<td>Works Manager</td>
<td>5 yrs</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>20</td>
<td>Health &amp; Safety Manager</td>
<td>15 yrs</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>53</td>
<td>Health &amp; Safety Advisor</td>
<td>2 yrs</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>54</td>
<td>Health &amp; Safety Advisor</td>
<td>2 yrs</td>
</tr>
<tr>
<td>Utilities</td>
<td>120 / 160*</td>
<td>Health &amp; Safety Advisor</td>
<td>26 yrs</td>
</tr>
<tr>
<td>Utilities</td>
<td>15</td>
<td>Office Manager</td>
<td>15 yrs</td>
</tr>
<tr>
<td>Transport &amp; communications</td>
<td>142</td>
<td>Office Manager</td>
<td>23 yrs</td>
</tr>
<tr>
<td>Education</td>
<td>32</td>
<td>Occupational Health Advisor</td>
<td>12 yrs</td>
</tr>
<tr>
<td>Transport &amp; communications</td>
<td>75</td>
<td>Office Manager</td>
<td>4 yrs</td>
</tr>
<tr>
<td>Transport &amp; communications</td>
<td>140</td>
<td>Office Manager</td>
<td>1 yr</td>
</tr>
<tr>
<td>Transport &amp; communications</td>
<td>142 / 75 / 140*</td>
<td>Ergonomist</td>
<td>20 yrs</td>
</tr>
<tr>
<td>Education</td>
<td>55</td>
<td>Office Manager</td>
<td>24 yrs</td>
</tr>
<tr>
<td>Education</td>
<td>8</td>
<td>Office Manager</td>
<td>2 yrs</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>380</td>
<td>Engineer</td>
<td>3 yrs</td>
</tr>
<tr>
<td>Manufacturing &amp; delivery</td>
<td>80 / 100 / 500*</td>
<td>Occupational Health Advisor</td>
<td>5 yrs</td>
</tr>
<tr>
<td>Transport</td>
<td>157 / 400 / 580*</td>
<td>Head of Safety</td>
<td>11 yrs</td>
</tr>
<tr>
<td>Education</td>
<td>40 / 40 / 32*</td>
<td>Health &amp; Safety Manager</td>
<td>2 yrs</td>
</tr>
</tbody>
</table>

### 8.3.1 Barriers experienced when making changes

The strongest themes to emerge in terms of perceived barriers to implementing changes to reduce the risks of MSDs were: the resistance of employees to changing their behaviour, problems in gaining senior managerial authorisation for changes,
and managers’ attitudes towards health and safety in general. The main themes within these categories are summarised in Table 34. The systematic categorisation of responses identified a number of patterns according to the interviewee’s occupation. The main patterns are identified in Table 2, and discussed further in relation to the main themes and sub-themes within these categories, below. No patterns were identified according to intervention type.

Inability to generate behaviour change among workers
The resistance of workers to changing their behaviour (or managers’ failure to promote behaviour change among workers) was the most frequently cited barrier to the intervention process. The difficulties experienced in getting employees to adapt their behaviour were highlighted by the manager of a small administration office within a major utilities organisation, who exclaimed that:

“I can only provide the equipment or training, can’t actually force people to use it. All you can do is tell them what to do, can’t control what they actually do.”

It was for similar reasons that the works manager of a concrete paving manufacturer stated, “…if I could replace the people, it would all be done much quicker…” Furthermore, concerning the adoption of new working practices, with a hint of sarcasm, the occupational health advisor for a large food and drinks manufacturer claimed that “…some of the delightful staff we have wouldn’t do it no matter what.” A number of other interviewees made similar references, including the health and safety manager of a large manufacturing organisation: “…habits are hard to change, some are still working the same way”, and an office manager within a medium sized subsidiary of a large delivery organisation: “Getting the guys to stick to the weight limit is another problem.” Consequently, in a number of cases the interviewees seemed to perceive workers’ behaviour as outside the scope of their influence.
Table 34. Key barriers to change
Further exploration of the data suggested that this resistance may be more closely underpinned by workers' attitudes than external factors such as usability, or practicality. A manager involved in implementing new equipment aimed at reducing physical strain amongst workers in a large, nation-wide delivery organisation said:

"When they first trialled one, a lot of the guys said they wouldn’t be seen dead with one of those, but since the guys came back and said how good they are, they’ve got used to them, and all want them now."

As an attempt to combat the tendency for employees to revert back to habitual ways of working, two interviewees described further plans to conduct process audits, which one described as involving going “back to basics”. The interviewees from these organisations, one a second subsidiary of the delivery organisation described above, and one a car seats manufacturer, explained that this was to involve taking time out from routine daily management tasks to promote risk awareness, check that all procedures are being followed, and enforce rules. The interviewee from the manufacturing organisation explained that it was important to ensure that workers do not “start doing their own thing, as this can compromise the ergonomics principles set out...”

The occupational health advisor of a large manufacturing and transport organisation also acknowledged the problem of resistance to change among employees, but described attempts that had been made to overcome this. When asked about the main barriers to change, she replied:

"The usual resistance to change, and 'oh, this is going to cause problems'. It's selling it, and getting the guys that have already benefited from doing things, actually to be your sellers, because they can do it better than anybody else to be fair."

_Gaining managerial authorisation and/or commitment_

A number of interviewees made reference to the difficulties they had experienced in gaining authorisation for the interventions to be implemented, and the need to effectively justify such plans to senior management. The manager of the postal
department within a large education institution, for instance, referred to "...the people you have to go through..." as one of the major barriers in tackling problems, and highlighted the need to "just keep banging on about it" to senior management. Another manager described this as "... a constant battle." Similarly, the health and safety manager overseeing the operations of a major transport organisation identified the main obstacle to implementing changes and reducing risks as:

"The number of people that must be consulted and in agreement. It's a very slow process."

This theme recurred across interviews regardless of occupational role or the industry within which the interviewee was employed. The manager of a mechanical component manufacturer, for example, expressed similar frustrations. The main reason he gave for changes having not been implemented was: "It takes time for things to get the go-ahead by senior management." This situation was also evident in the education sector; the occupational health advisor of a tertiary educational institution highlighting that "It takes a lot of arguing for changes to be made."

Similarly, an occupational health advisor from a large drinks manufacturing and distribution company explained that the process of acquiring senior managerial approval had resulted in some plans being delayed:

"It's all in sort of infancy, because I have to have agreement. The company is a little archaic in some respects."

In addition, the works manager of a small plant belonging to a large concrete manufacturing organisation noted: "I have to justify proposed changes substantially to senior management.", and went on to explain that the process of gaining agreement rested on justifying costs the costs involved.

Managerial attitudes towards health & safety
Closely associated with the theme of gaining management commitment, unsurprisingly, was the general theme of managerial attitudes towards MSDs (and health and safety in general). A number of specific sub-themes were identified in this
regard, namely, the perceived importance of tackling MSDs, appreciation of the benefits of taking preventative (as opposed to reactive) measures, and concern that identification of such problems may reflect badly on an individual's managerial competence.

The perceived importance of tackling MSDs (according to other managers within the organisation) emerged as an important theme in 5 interviews. The occupational health advisor within a tertiary education institution, for example, cited "Getting managers to appreciate the importance of it [MSDs]" as the most prominent barrier to making changes. In a number of cases, lack of appreciation for the importance of health and safety initiatives was suggested as leading to these initiatives being seen as just extra initiatives on top of what are considered everyday management activities, rather than an integral part of the management process. The occupational health advisor of a college employing around 460 members of staff, for instance, felt that staff saw occupational health and safety initiatives as "...just one other thing on the workload that they don't have time to do, and see it as an add-on." Similarly, the health and safety advisor for a large utilities organisation said that "[T]hey [general managers] seem to see it as an add-on, something extra for them to do." One interviewee also suggested that appreciation of the issue was important not only among managers (both senior and local), but among staff at all levels of the organisation:

"If you don't have the buy in of...it's not just management, local management as well, and staff buy-in."

A pattern was identified in terms of this subtheme, according to occupational role. As indicated in Table 34, lack of appreciation for the importance of health and safety initiatives was cited as a barrier to change by health and safety-related personnel only (i.e. health and safety managers/advisors, occupational health advisors, and the ergonomist). This can be contrasted with the office manager within a large transport and communications organisation, whose comment was consistent with the comments made by interviewees with health and safety-related roles. Referring to health and safety initiatives, this manager said:
"It's difficult enough to get the everyday paperwork done, never mind extra initiatives!"

A second subtheme in relation to managerial attitudes was the failure to appreciate the benefits of taking preventative action. The tendency for health and safety initiatives to be reactive in nature was highlighted by the health and safety manager for education in one borough council, who explained that amongst senior management:

"There has been a long standing position, though not openly stated, that health and safety applies when things go wrong and has perpetuated the negative approach towards health and safety generally."

Similarly, the occupational health advisor of an educational institution suggested that senior management did not see the benefits of activities aimed at preventing problems:

"...they are only keen to put changes into place when they need to do it to get staff back to work. Things are gradually getting better, but we're still fire fighting."

Further support for this theme came from the health and safety advisor for one manufacturing organisation, who explained that the continuation of attempts to tackle MSDs would only depend upon whether MSDs remained the key cause of RIDDOR incidents:

"Other [further] changes will depend on whether manual handling remains a key problem in next year's stats."

By only tackling issues that remain high in accident and ill-health statistics, organisations are likely to be continually fire fighting, and failing to ever get 'ahead of the game'.
A further subtheme in terms of managerial attitudes was the suggestion that managers within their organisation perceived health and safety initiatives as reflecting negatively on their own managerial competence. This subtheme emerged from interviews with health and safety-related personnel alone. The health and safety manager of an educational institution, for example, identified the main barrier in tackling health and safety problems such as MSDs as:

"Cultural problems, specifically cynicism of staff being concerned as to why a sudden interest and focus is being placed upon them..."

Insufficient resources

In a number of interviews, the theme relating to lack of appreciation for the benefits of prevention was closely related to lack of resources (typically in terms of staff time). As suggested by the occupational health advisor of a higher educational institution:

"We would like to take a much more proactive approach to tackling problems. At the moment we tend to only get to see those that are already experiencing problems, because we don't have enough time...would like to go and actively promote issues, raise awareness..."

Although not isolated to the educational sector, or to interviewees with a health and safety-related role, this theme (and, indeed, the close association of this theme with managerial attitudes) was well illustrated by the health and safety manager for a number of primary education facilities:

"...staffing resources to manage health and safety have been a major concern. Schools having been given greater self regulation without having the necessary skills to address in house safety matters. This has impacted on staff safety and health where staff members and head teachers have not successfully apportioned sufficient time or resources...time factors involved in addressing these issues are an ongoing issue as too are the perceptions of senior managers, head teachers."
Prioritisation of production over safety

Production rate was also identified as obstructing the implementation of changes. The health and safety manager of a manufacturing organisation employing around 850 employees stated that:

“We've done a little, but progress is slow because production demand has gone through the roof.”

This manager explained that production was seen as more important than conducting the training needed to enable rotation to be implemented:

“I have a hard time trying to persuade production managers to allow staff to be taken out long enough to train.”

Similarly, the health and safety advisor of another smaller manufacturing organisation explained that refresher training had not been implemented, as “current shift systems won’t allow for it.” As shown in Table 34, this theme was clustered exclusively among health and safety-related personnel. A pattern of negative reinforcement may arise here, whereby [senior and production] managers’ prioritisation of productivity over prevention of ill-health is likely to lead to further increases in ill-health, and higher rates of ill-health are in turn likely to be detrimental to productivity, reinforcing managers' tendency to prioritise productivity. Further exacerbating the problem, interviewees explained that temporary workers tended to be employed for periods of increased productivity. However, the prevalence of temporary employees in the workforce was cited as a reason for not being able to implement rotation, as managers were disinclined to train temporary workers in all tasks.

An association was also identified between the production priority and managerial authorisation and/or commitment to changes. The manager of a small manufacturing plant, for instance, stated that in order to gain managerial authorisation and commitment for the changes, he would emphasise the benefits to be gained in terms of increased efficiency (rather than employee health), due to the perception that efficiency is the key concern of the company’s senior management.
Finding appropriate equipment and space
In addition to the attitudinal and behavioural themes identified above, a further theme emerged, relating to the external environment: the inability to find the appropriate equipment or sufficient physical space within the workplace to implement intended changes aimed at reducing MSDs. Table 34 shows that this theme was identified among the responses of non-health and safety managers only. In terms of equipment for example, one interviewee sought to obtain a raised reading stand on which workers could place reading documents, but also annotate documents. Despite having trialled a number of products, the manager had not yet found one that she considered fit for purpose.

Industrial relations issues
Finally, three interviewees cited industrial relations issues as an important barrier to implementing changes aimed at tackling MSDs. For instance, one occupational health advisor suggested that the implementation of changes had been prevented because “...there are some IR issues that they [the trade union] want resolving first, before they go forward.”

8.3.2 Factors facilitating the change process
Fewer interviewees were able to cite factors that they believed acted as facilitators to change. The results suggest that this may be because a proportion of the facilitating factors reflect a mirror image of the barriers presented above. In addition, as a result of this, the factors that have equivalently been described in relation to barriers to change will not be elaborated upon again here. The main themes identified in terms of facilitating factors to change were: the existence of supportive and committed managers, changes of management, good awareness and/or communication of health and safety issues, and localised control over budget spending for health and safety matters.

Supportive managers
The importance of having enthusiastic and supportive management was the most commonly identified facilitator in relation to the implementation of interventions to tackle MSDs. As described by the health and safety advisor of a large utilities organisation, most critical to the success of occupational health interventions was
“Having the supportive management in there, to help with implementation and organisation.” She attributed the smooth implementation of changes at one site largely to the benefits of having managers that are “enthusiastic and organised, who value health and safety”.

Visible support for health and safety initiatives from senior management emerged as a subtheme here. The health and safety advisor for a medium-sized manufacturing company, for instance, explained that the company’s new Managing Director, who demonstrated more visible support to health and safety in general, “certainly had a beneficial effect”. In contrast to problems experienced due to lack of managerial commitment, the occupational health advisor to a large drink manufacturer described the positive effect of managerial support:

“...it is at director level being enforced, and also the operations managers are going to be targeted in their performance...and from that view I’m hopeful. I was a little cynical initially, but I’m hopeful that some of the things might actually work now.”

Change of management
In keeping with the importance of visible support and commitment from senior management, management reorganisation was identified as a theme in terms of change facilitators. Several interviewees indicated that this had prompted action. For example, as described by one office manager:

“...person who was in charge of the... team retired, so I thought it would be good, because it has been several years since risk assessments, and you know, to, stock take, so we updated the risk assessments.”

Similarly, the occupational health advisor of a tertiary education institution indicated that reorganisation of the college some years ago “shook things up a little”, and speculated that further impetus could perhaps be achieved from the replacement of the current health and safety manager, “...the current one is nearing retirement, and perhaps doesn’t have the same motivation...”
**Good awareness and/or communication**

An additional theme relating to the facilitation of change was good awareness and/or communication within the organisation, specifically between management and workers. The health and safety manager of a manufacturing company, for instance, attributed the success of their intervention to having "...taken on board the need to improve communication about what's going on." Finally, illustrative of the influence of structural factors, localised control over budgetary spending for health and safety was identified as an important change facilitator by two office managers. In the words of one: "Money hasn't been a problem, as I have my own budget to spend as appropriate."

### 8.4 Discussion

Due to the qualitative nature of the study described in this chapter, for fluidity and cohesion, discussion of the key findings and their implications will be combined into one section. As in the previous chapters, this will be followed by a section discussing methodological limitations, and a final section summarising the chapter.

#### 8.4.1 Key findings and implications

This qualitative study revealed a number of important factors that were considered to affect the successful implementation of interventions aimed at tackling MSDs. One of the most prominent findings to emerge was that the key barriers and facilitators cited by those involved in the implementation of interventions related largely to the 'softer' aspects of the intervention process, namely, the resistance of workers to changing their behaviour, gaining managerial commitment, and managers' general attitudes towards health and safety. These findings are consistent with previous work in relation to stress interventions (e.g. Saksvik et al., 2002; Kompier et al., 2000; Nytro et al., 2000), and intuitive recommendations in terms of ergonomics interventions (Rubenowitz, 1997). No patterns were identified according to tailored and non-tailored interventions. However, whilst the same themes were identified by interviewees following both types of interventions, in a number of cases interviewees that had been involved in implementing tailored interventions also acknowledged steps that had been taken to combat barriers relating to attitudinal or behavioural factors. Individuals involved in standard interventions also appeared aware that such
factors were important to the effective implementation of interventions, and so it seems that the failure for such elements to be integrated into standard interventions is not due to lack of knowledge. As suggested by Haslam (2002), perhaps the tendency to overlook such factors when implementing interventions is more related to the absence of practical methods for achieving this.

The resistance of workers to changing their behaviour was the most commonly cited barrier to the implementation of changes. However, resistance on behalf of workers may be equally reflective of managers' inability to generate behaviour change among their staff. Both interpretations appear to suggest that the application of attitude and behaviour change theories, and development of practical tools and techniques for enabling managers to measure and tackle behaviour change, may facilitate the implementation of such interventions (and subsequently, their effectiveness). This is consistent with previous calls for the application of models of health behaviour to workplace interventions (e.g. Prochaska et al., 2001; Haslam & Haslam; 2000; Dejoy, 1996), in order to improve their effectiveness. Such techniques might also include the use of workers for conveying messages about the benefits of particular changes (identified as a facilitator of the change implementation process), acting as norm senders to challenge workers' perceived norms regarding working practices. However, it should also be noted that the results presented here largely reflected the absence of positive attitudes towards health and safety, rather than negative attitudes per se.

Structural factors, such as insufficient resources, were also identified as important in the successful implementation of interventions. Patterns within the data also suggested that close interrelations existed between structural factors and managers' general attitudes towards health and safety. The lack of importance that interviewees believed managers attributed to the issue of tackling MSDs, for example, appeared to be closely related to the theme regarding insufficient allocation of resources. Speculation can also be made that external circumstances might also influence managers' attitudes and behaviour. For instance, managers' seeming prioritisation of production over health and safety matters may be related to their job requirements (i.e. too many role obligations per unit of available time). This notion is consistent with the arguments of Beer et al. (1990), that individual attitudes, beliefs,
and behaviours are shaped by structural/organisational factors such as the organisational roles and responsibilities imposed on them. The findings from this study, however, suggest that this relationship is also likely to be reciprocal. Consequently, programmes aimed at promoting attitude and behaviour change, particularly with regards to the benefits of prevention, should be accompanied by modifications to potential structural barriers. This might include ensuring that managers are given sufficient time for tackling health and safety matters, flattening the hierarchy or decision-making system through which authorisation for health and safety initiatives must be sought, or giving local managers/health and safety managers more budgetary control for spending on such matters.

The findings of this research also support recommendations for the increased use of qualitative methods in occupational health research (Ballard et al., 2004; Mergler, 1999), and the importance of exploring the interactive and systemic properties of workplace interventions, to complement the reductionist, ‘snapshot’ image captured by quantitative approaches. The principal factors highlighted by managers as influencing the effective reduction of occupational health risks are likely to be interactive, due to the complexity of this process. Possible relationships between these factors are illustrated in Figure 43.

The failure for managers to take a preventative, systems perspective in tackling organisational issues (possibly influenced by lack of knowledge of the detrimental effects of MSDs, and the benefits of preventative action) can lead to negative reinforcement cycles. For instance, the recruitment of temporary staff as a short-term solution to increased production demands was cited as the reason why rotation had not been introduced in two separate organisations. Lack of rotation increases the risks of MSDs, which can lead to increased absence, reduced productivity, and reduced efficiency. As a result, increased prevalence of MSDs amongst the workforce is likely to exacerbate the production-demand deficit, and require the recruitment of more temporary workers. This cycle is represented in Figure 44.
Figure 43. Possible influences on the effective reduction of MSDs

- Slow managerial decision-making
- Managerial attitudes/scepticism
- Resources/lack of prevention
- Employees' behaviour

INCREASED RISK OF MSDs

Figure 44. Exacerbation of problems due to short-term solutions

- INCREASED PRODUCTION
- DEMAND
- MSDs
- ROTATION

Recruitment of temps
It has been suggested that the tendency for managers to be somewhat short-sighted in the management of health and safety can result in a 'triangle of constraint' (Haslam, 2002), whereby sickness absence leads to reduced productivity, draining the time and energy of both managers and operators, reducing the likelihood of these individuals dealing with the underlying problems. Although prevention has been recognised as a crucial requirement for future intervention efforts (Linton & van Tulder, 2001; Engels et al., 1996; Frank et al., 1995), there appeared to be an absence of such approaches in this study. Similarly, these findings also indicated that the management of health and safety tends to be seen as a burden, rather than an integral component of managing an organisation. Indeed, previous arguments have been made for the integration of ergonomics interventions into organisational strategy as a potential means of developing the total efficiency of organisations (Porter, 1998). Similarly, the findings of this study suggest that the management of health and safety needs to be promoted as a means of facilitating organisational efficiency, rather than an obstruction to everyday operations. In order to achieve the necessary changes in attitudes and perceptions of health and safety initiatives, employers may need to be better informed about the potential benefits of such activities, such as increased productivity, reduced absence and turnover.

8.4.2 Methodological limitations
The initial selection of the interventions on which this study is based relied on organisations responding to a press release (self-selection), which called for organisations that were intending to tackle MSDs. Consequently, it is reasonable to assume that the organisations that have an interest in health and safety are more likely to participate in such a study than those that do not. In addition, the majority of respondents were subject matter experts, so it may be considered that their responses are biased by types of factors that know are important influences on the change process.

Despite these limitations however, these findings support (and are supported by) the quantitative data presented in the previous chapter. Given that one of the fundamental principles of the stage of change model is the promotion of positive attitudes that are consistent with the desired behaviour change, the significant differences that were identified between interventions according to tailoring (Chapter
7) provides some support to suggest that the factors identified by interviewees in this study (at least in terms of the importance attributed to ensuring that managers and workers' attitudes and behaviours are supportive of the intended changes) to some extent reflect 'reality'.

8.5 Chapter summary

Interviewees identified issues relating to knowledge, attitudes, perceptions, and behaviour change, in addition to structural factors, as the main barriers and facilitators in the process of implementing interventions to tackle MSDs. Patterns were also identified which suggested that the attitudinal and structural factors were closely interrelated, and are likely to be mutually influential. These findings may have implications for practice, due to the lack of attention that is typically paid to the 'softer' side of the intervention process in practice, when tackling MSDs (outlined in Chapter 4). In addition, the complex, interacting and systemic properties of workplace interventions illustrated by this study further highlight the power of the stage of change approach, given that the approach was found to significantly improve the effectiveness of such interventions (Chapter 7), even in the face of this complexity.
Overview of thesis

Chapter 1: Introduction

Chapter 2: Literature review: MSDs

Chapter 3: Literature review: Behaviour change

Chapter 4: Exploration of current practices
- 14 Semi-structured interviews with ergonomics consultants

Chapter 5: Evaluation of materials
- Content analysis of HSE materials
- Evaluation of coverage of stages of change

Chapter 6: Tool development
- Worker questionnaire (n = 168)
- Managerial questionnaire (n = 100)

Chapter 7: Implementation
- 24 interventions monitored
- Half tailored according to stage
- Worker & managerial assessments pre & post intervention

Chapter 8: Exploration of the change process
- Post-intervention interviews with managers following tailored & non-tailored interventions (n = 17)

Chapter 9: Discussion, implications and recommendations
9. DISCUSSION, IMPLICATIONS AND RECOMMENDATIONS

9.1 Introduction

This thesis is concerned with improving the effectiveness of occupational health and safety interventions, focusing specifically on interventions aimed at addressing musculoskeletal disorders (MSDs). The thesis explores the notion that employers' and employees' readiness to change, or stage of change, is an important determinant of intervention effectiveness. By adopting an interdisciplinary approach, this research aimed to promote advances in both understanding and practice in the reduction of occupational health problems such as MSDs. A series of studies have been presented, starting with an examination of current practices adopted by practitioners in tackling MSDs, moving on to an evaluation of guidance materials available to employers and employees on taking action to reduce the risks of MSDs, followed by the development of tools for measuring managers' and workers' stage of change in terms of taking action to reduce the risks of MSDs, then the subsequent implementation of these tools in practice to evaluate the effectiveness of tailored compared to non-tailored interventions, and finally a qualitative, post-intervention exploration of the intervention process.

This work is particularly timely, as despite the growing body of knowledge regarding the factors associated with MSDs, these problems have remained the most common cause of ill-health in Great Britain for over a decade. As outlined in Chapter 2, MSD causality is considered to be complex, with a range of potential and interactive risk factors relating to the work environment, work tasks, work organisation, and the individual worker. The tendency for MSDs interventions to focus on components of the work system in isolation, therefore, is proposed as a potential reason for their ongoing prevalence. An important feature of the approach developed in this thesis is that it provides a framework for combining interventions aimed the physical environment, with interventions aimed at attitudinal and behavioural factors.
To explore the issues raised by the research presented, this chapter is divided into three main sections: overview of the main findings, methodological considerations, and implications for practice.

9.2 Overview of findings

A summary of findings from each of the studies presented was provided at the end of each chapter throughout the thesis. The main points are reproduced below in Sections 9.2.1 – 9.2.5.

9.2.1 Exploration of current practices

An initial, qualitative study sought to explore the current methods adopted, and the practices followed, by ergonomics consultants in reducing the risks of work-related MSDs. This appears to be the first documented attempt to systematically explore current practices in tackling MSDs. The absence of such knowledge is likely to have acted as an obstacle to the improvement of such practices in the past. The findings of this study revealed that the nature of ergonomics practice within the sample interviewed focused almost exclusively on the physical aspects of the work environment (i.e. posture, force, and workstation layout). Such an approach neglects the psychological dimension of the complex interaction that can lead to MSDs. As speculated by Haslam (2002), this could be, at least in part, due to a lack of appropriate techniques in the ergonomics repertoire for assessing the psychological environment, particularly client attitudes and beliefs. It may also be due to a lack of appreciation for the importance of tackling these types of issues. As behaviour is considered a key factor underpinning many of today's most widespread health problems (WHO, 1988), and recommendations specify that MSDs interventions should combine ergonomics improvements with attempts to modify behaviour (HSE, 2002; WHO, 1998), the findings of this study highlighted a possible gap between best practice recommendations and current practice. The findings suggested that scope may exist for improving the effectiveness of current practice, by embedding ergonomics interventions within an holistic framework that integrates elements of attitudinal and behavioural change.
9.2.2 Evaluation of guidance materials
Having found that ergonomics advisors tend to focus solely on physical workplace factors, this study aimed to establish the extent to which this might also be reflected in other sources of advice available to employers. Leaflets are a widespread means of promoting health. However, evidence for the effectiveness of leaflets in promoting a range of health behaviours, is mixed. Consequently, this study attempted to evaluate leaflets aimed at helping employers and/or employees tackle MSDs. In light of the importance of recognising change as a process involving both attitudinal and behavioural adjustments (discussed in Chapter 3), leaflets were assessed according to the extent to which they provided information relating to three stages of change: the precontemplation, preparation and maintenance stages. Whilst all leaflets provided some information of relevance to the precontemplation and preparation stages, only 5 of the 16 leaflets (31%) provided information regarding the maintenance of risk reducing measures. Due to the importance of maintaining effective risk reducing measures on an ongoing basis, this may be an important omission in the context of these leaflets.

9.2.3 Tool development
This phase of research was aimed at adapting the stage of change approach for use within the organisational context, in taking action to reduce the risks of work-related MSDs. Tools were developed to assess both managerial and worker stage of change, and were administered in a large number of organisations across a range of industrial sectors. These tools were based upon the traditional method of assessing stage (e.g. DiClemente et al., 1991), using a relatively small set of dichotomous questions. The tools were found to possess high levels of reliability, identified by Cronbach's alpha, and indirectly supported by significant differences found according to stage of change and a number of independent variables. Managerial and worker stage of change profiles showed individuals in both groups to be distributed across all five stages. Interestingly, however, different stakeholders within the same organisation (i.e. employees, supervisors, directors) tended to be at different stages of change. Worker stage of change differed significantly according to independent variables such as industrial sector and organisational culture. Worker stage of change was not, however, significantly related to managerial stage of change, suggesting that workers were not dependent upon their employers recognising the problem or implementing action.
Overall, the results of this study suggest that efforts to promote change might be made more effective by tailoring approaches and advice according to the stage of change of different stakeholders within each organisation.

9.2.4 Implementation
The aim of the implementation phase of the research was to determine whether use of the stage of change tools in practice, to tailor interventions according to workers and managers' readiness to change, could improve effectiveness. The results suggested that the effectiveness of organisational interventions can indeed be improved by tailoring approaches according to stage of change. Not only did workers receiving tailored interventions progress significantly further in terms of stage of change than those that received standard interventions, but in a number of body areas the number of workers reporting musculoskeletal discomfort was also significantly lower following tailored interventions, as were workers' ratings of pain severity for a number of body areas. No significant differences were found according to reported discomfort following the implementation of the comparable standard interventions. In fact, in the standard intervention condition, the proportion of workers in the precontemplation stage (that is, those that were unconcerned about the risks and did not intend on taking any steps towards reducing the risks) remained unchanged following the implementation of interventions. Analysis of responses to the individual stage of change assessment items suggested that an important determinant of this outcome may have been prevention of relapse, as the proportion of workers that were concerned about the risks, and that felt changes should be made, remained largely unchanged following both tailored and standard interventions. However, following the implementation of interventions, significantly more workers in the tailored condition reported the intention to continue efforts to maintain low levels of risk. In contrast, those in the standard intervention condition tended to relapse into precontemplation, reporting that they had no intention of paying any further attention to the issue. This is a valuable finding, as the difficulty of making workplaces entirely risk free means that it is important for workers to remain vigilant to potential risks.

It is important to note that overall, the total number of workers that reported having experienced any type of pain (regardless of body area) did not significantly differ
following either tailored and standard interventions. Consequently, whilst the number of completely pain free workers appeared to be largely unchanged, following tailored interventions significantly fewer workers reported having experienced pain in the upper arm, elbow, forearm, wrist, hand, lower back, and legs. In other words, each worker appeared to experience pain in fewer body areas. It could be speculated that this is because the remaining problems reflect more chronic conditions (e.g. back problems, as discussed in Chapter 2), which by nature tend to be more persistent. Longer-term follow up may provide an opportunity to assess this possibility.

Consistent with this possible explanation, in both the standard and tailored groups, lower back pain was the area in which workers most commonly reported pain. Given that lower back pain tends to be chronic, this may account for the failure to find significant differences in the total number of workers that reported any form of musculoskeletal pain at all following the implementation of interventions, despite significant reductions in certain body areas in the tailored condition. In terms of pain severity, the failure to find any significant differences could be due to factors influencing an individuals' ability to rate the severity of pain, such as recall bias (Nahit et al., 2001). Indeed, both pre- and post-intervention, in both the tailored and standard intervention groups, and for most body areas (possibly excluding the back) workers severity ratings were clustered in the mid-range of the scale. This may reflect difficulties in rating pain severity, particularly retrospectively.

Following standard interventions a number of factors were significantly related to worker stage of change (including tenure, musculoskeletal pain, and various elements of safety climate). Following tailored interventions, however, worker stage of change was only significantly related to industrial sector. It is speculated that the tailoring process generates motivation to change that may otherwise only be related to factors such as time, personal experience of musculoskeletal pain, or organisational safety climate.

9.2.5 Qualitative exploration of the change process

Following the implementation of interventions, in-depth interviews were conducted with the managers directly involved in their implementation. Interviewees identified issues relating to knowledge, attitudes, perceptions, and behaviour change, in addition to structural factors, as the main barriers and facilitators in the process of
implementing interventions to tackle MSDs. In addition, patterns in the data suggested that the attitudinal and structural factors were closely interrelated, and likely to be mutually influential. These findings have implications for practice, due to the lack of attention that is typically paid to the 'softer' side of the intervention process when tackling MSDs. In addition, the complex, interacting and systemic properties identified by this study as important barriers and facilitators in the process of the interventions provide indirect support for the power of the stage of change approach, as the tailored approach was found to significantly improve the effectiveness of such interventions, even in the face of this complexity.

9.3 Methodological considerations

9.3.1 The research design: Strengths and weaknesses

The aims of this research programme were challenging, constituting the first known application of the stage of change approach to interventions aimed at improving occupational health and safety. Whilst applied research such as this can be criticised for lack of experimental control (and indeed, a number of methodological limitations have been identified at the end of each chapter), one of the strengths of the approach adopted is its ecological validity. Such an approach is consistent with calls for a more ecological approach to behaviour (Sallis & Owen, 2002), in which behaviour is studied in the context in which it is enacted. Consequently, it could be argued that if significant differences can be found in real life environments, despite the 'noise' that typically accompanies these situations, these findings should be considered more valuable than those derived in laboratory (i.e. artificial) conditions. WHO (1998) argued that the use of randomized controlled trials to evaluate health promotion initiatives is, in most cases, inappropriate, misleading and unnecessarily expensive. Indeed, unless effects found in controlled laboratory conditions translate to practice, against the variation and complexity that exists in the real life situations in which they are to be applied, their value is limited. Zwerling et al. (1997) suggested that a sensible and economic approach to conducting intervention effectiveness studies begins with quasi-experimental and qualitative designs to explore the feasibility of interventions, with randomised controlled trials reserved for testing and validating the most promising approaches. Another strength of this research, therefore, was the adoption of multiple methods, not only in the use of
complementary techniques (e.g. interview, questionnaire etc.), but also in obtaining data from different personnel (i.e. workers and managers) within a given organisation.

Reflecting the complex and multifactoral nature of MSDs, the research presented in this thesis is cross-disciplinary in nature, applying behaviour change theory from health psychology to improving the effectiveness of ergonomics interventions in the workplace. This approach is also consistent with the call for intervention research to be more theory driven, in order to learn why and under what conditions work interventions are most effective (NIOSH, 2002). Furthermore, this research included workers from a variety of occupational groups, building on previous intervention studies that have been criticised for focusing on a single occupational group (Nahit et al., 2001). By including workers from a variety of occupational groups, with the same measurements being applied to all, this research enabled comparisons to be made across occupational sectors.

A number of potential weaknesses can also be identified in relation to the research design adopted. First, it is possible that a survivor bias, or healthy worker effect (e.g. Nordander et al., 1999), influenced the results of the study described in Chapter 7, perhaps reflected by the attrition between the pre and post-intervention data collection points. This effect refers to the possibility that workers with health problems may be more likely to leave their jobs, and as a result, the remaining population is likely to include a larger proportion of workers whose health has not been adversely affected by their jobs. However, analysis of pre-intervention data revealed no significant differences between those that were present and those absent at follow-up. Consequently, no evidence can be found to suggest that the attrition in respondents between the pre- and post-intervention was due to a healthy worker effect. Otherwise, one would expect a higher prevalence of reported pain among the “unhealthy” workers (i.e. those missing in the follow up survey), if this were the reason for the attrition. Despite this, however, the possibility of a healthy worker effect cannot be ruled out.

As in any intervention study, the Hawthorne effect is another important consideration. In the absence of a control group in the implementation study (Chapter 7), it is not
possible to rule out this eventuality. If a Hawthorne effect had influenced the results, a significant effect of time of follow-up might have been expected, as Hawthorne effects would be expected to dissipate over time, following the intervention. However, the reporting of musculoskeletal pain did not differ significantly according to the duration between pre- and post-intervention follow-up, either overall, or in relation to any specific body area. It could also be argued that the Hawthorne effect is less of a concern for the research presented in this thesis. As employers (and, to some extent, employees) have a legal duty to take steps aimed at reducing the risks of work-related MSDs, the aim of this thesis was not to explore whether or not such interventions are effective, but rather how they could be made more effective. As a result, in the study described in Chapter 7, given that both the standard and tailored intervention groups received interventions that may potentially have generated Hawthorne effects, such effects would be present to some extent in the two intervention groups.

Due to the constraints of conducting research in 'real life' environments (particularly workplaces), weaknesses can be identified in relation to the sampling strategy adopted. Although in smaller organisations, the questionnaire was administered to all workers involved in the interventions, in large organisations, the questionnaire was administered to a sample of the workforce. The size of this sample was determined largely by the level of access given by the employer, and therefore, was not entirely systematic. Where workers within the same organisation/section were engaged in a range of different tasks, efforts were made to stratify the sample in order to sample workers across the range of work activities. As discussed in Section 7.6.3, although the same workers were asked to complete the questionnaire both pre- and post-intervention, the extent to which the same workers completed the questionnaire on both occasions could not be proven. In future work, respondents could be asked to generate a unique and memorable identity code (e.g. first and last letter of their mother's maiden name and the month in which she was born), which could be entered onto both the pre- and post-intervention questionnaires. This would enable checks to be made of the proportion of participants that completed both the pre- and post-intervention questionnaires. However, this may introduce additional problems. For instance, although the selected code should be information that only the employee is privy to, requesting identification information such as this may raise
workers' concerns about confidentiality. Moreover, given that this study was
designed to measure group rather than individual changes (due to the ethical
limitations designed above), this matter was not considered a substantial limitation.

9.3.2 Self-reported MSDs: Measurement issues
Studies examining the effects of interventions to reduce the risks of MSDs have
typically adopted a range of outcomes measures, often including posture angles,
repetition, and workload (as was evident in the literature review presented in Chapter
2). Whilst there are a number of potential problems related to the use of self-reported discomfort, given the growing body of evidence associating psychosocial
factors with MSDs, it could be argued that it is imperative to include workers' subjective experience of MSDs as an outcome measure. For instance, even if
posture angles are found to be optimal following a given intervention, workers may still report problems due to other (e.g. psychosocial) factors. Consequently, although neutral posture angles would be a positive outcome following an intervention to change the physical work environment, arguably the ultimate concern is whether workers are still reporting musculoskeletal pain.

Methods of self-report such as body mapping tools are widely used and accepted methods of obtaining measures of self-reported pain or discomfort. However, self-reports are likely to be subject to a number of influences. For instance, evidence suggests that self-reported occupational ill-health tends to increase with heightened awareness of the problem (e.g. Abba et al., 2004). On this basis, in the implementation study presented in Chapter 7, increases would be expected in both standard and tailored conditions, particularly in the tailored condition, as interventions for precontemplation and contemplation involved raising awareness of the risks, and the need to take action. The fact that self-reported discomfort decreased in a number of body areas following tailored interventions, therefore, provides further support for the effectiveness of those interventions. Problems with self-report measures were also identified by Steingrimsdottir et al. (2004), who found that whilst no seasonal differences in self-reporting could be identified, high intra-individual variability in the reporting of pain was evident. As a result, future studies should optimally allow for more than two measurements to be collected over time when aiming to identify changes in subjective health conditions. However, when
conducting research in organisations, this would depend on employers’ willingness to grant the access required to achieve this.

9.3.3 The stage of change construct

A number of important issues were raised by this research in terms of the stage of change construct itself. For instance, as discussed in Section 3.5.5, some critics consider the arbitrary time periods that are used to define some stage divisions (i.e. contemplation – intending to take action in the next 6 months, and preparation – intending to take action in the next 30 days) – as a fundamental weakness of the stage of change framework (Sutton, 2005; 2001, 2000, 1996; Clarke & Eves, 1997). Specifically, Sutton argued that the use of arbitrary time periods such as this casts doubt on the assumption that the stages are qualitatively distinct. As a result, others have suggested the omission of the time-span and the development of a better staging algorithm (e.g. Kraft et al., 1999).

In both the tool development study described in Chapter 6, and the tool implementation study described in Chapter 7, very small numbers of workers and managers were identified as residing in the contemplation stage. As discussed in Section 7.5.3, this may be testament to the brief time that individuals reside in this stage, due to the specific time parameters that define this and the subsequent (preparation) stage. It could also suggest that the contemplation stage is less relevant in the context of occupational health, compared to other public health issues such as smoking. This may be related to the importance of ‘perceived pros’ in the contemplation stage, as the perceived pros of performing work activities in such a way as to put oneself at risk of MSDs (i.e. increased productivity) are unlikely to outweigh the risks to the individual (i.e. pain or even disability). Owing perhaps to the role of addiction in health-related behaviours such as smoking, however, individuals attempting to give up habits such as smoking or unhealthy eating are likely to linger longer in the contemplation stage. With these types of health issue, the relevance of a stage in between precontemplation and preparation seems clear. In the context of taking action to tackle MSD risks in the workplace, however, the practical use of the contemplation stage is less clear. Thus, future investigations could examine whether it is more appropriate and pragmatic in this context, for the contemplation and preparation stages to be combined. In the context of work-related MSDs, the practical benefits of combining these stages (in terms of simplifying the assessment and tailoring processes) may outweigh the
potential costs of reduced accuracy (particularly as few individuals were found to reside in the contemplation stage at any one time). However, the effect of such a modification requires systematic evaluation.

Time span has also been highlighted as an important consideration in terms of the maintenance stage (Fuchs, 2001; 1999). Use of a 6 month period to distinguish between the action and maintenance stages was supported by Lippke and Ziegelmann (2006), who highlighted that there are other differences between these two stages that are not solely due to time alone. Lippke and Ziegelmann argued that methods of identifying how these two stages can be distinguished according to differences other than time have not yet been developed. Consequently, it could be argued that the 6 months criterion reflects a practical method of distinguishing between the action and maintenance stages, in the absence of any alternative criteria.

Due to the numerous barriers that can impede the implementation of effective intervention programmes in organisations (some of which were identified in Chapter 8), ease of implementation in practice is an important consideration. In fact, the TTM was initially developed as a framework for practice, on the basis of observations from clinical settings (primarily in the context of psychotherapy and smoking cessation). This is one of the reasons that the TTM is considered a particularly pragmatic theory, with clear guidance for its application in practice (as discussed in Chapter 3, Sections 3.4.1, and 3.5). In the workplace context, flexibility should be an important consideration in applying the stages of change framework. Indeed, DiClemente (2005) argued that too much focus can be placed on assessment of the stages, and issues about time frames and labels. DiClemente cautioned against confusing the assessment and operationalising of a construct with the phenomenon that the construct is supposed to help explain. Thus, future research could usefully evaluate the most optimal balance in terms of theoretical precision and pragmatism (including ease of implementation). After all, the efficacy of an intervention is irrelevant unless it is implemented by organisations. The ease of implementation is likely to be a particularly important consideration for smaller organisations, which typically have limited resources to allocate to health and safety matters. As a result, future research could also be warranted in evaluating the relative effectiveness and cost-
benefit of different staging configurations. The most basic of distinctions could involve tailoring according to just two groups – those that do not perceive there to be a need for changes to be made (precontemplative), and those that do (contemplation, preparation, action and maintenance).

The stage of change approach has also been criticised for failing to take account of situational determinants of behaviour (e.g. Sutton, 2005). Indeed, the qualitative exploration of the implementation process presented in Chapter 8 provided some evidence to suggest that such factors (e.g. insufficient resources) may have acted as barriers to the efficacy of both standard and tailored interventions. The findings of that study also suggested that situational factors are closely interrelated with attitudes towards health and safety. Consequently, the implementation of interventions may be improved by ensuring that such barriers (both situational and attitudinal/behavioural) are identified as part of the preparation stage. It is also important to emphasise that tailoring does not mean that some individuals fail to receive the ‘practical’ elements of interventions. Instead, tailoring is about improving the likelihood that practical changes will be adopted and maintained.

Finally, the inclusion of intervention studies whereby the follow up was carried out more than six months after implementation is consistent with calls for future studies to give priority to longer term follow up studies and achieving activity adherence as well as adoption (Adams & White, 2003, 2002). Indeed, as already discussed, the findings presented in Chapter 7 suggested that an important determinant of the effectiveness of tailored interventions was the prevention of relapse. As the maintenance stage is classified by the criterion of having taken action more than six months ago, future testing of the model should ensure that follow up duration exceeds six months, to enable observation of movement across the full range of stages. With follow-up periods of less than six months, it is not possible to test whether individuals in the action stage prior to the implementation of interventions have maintained the changes and benefits gained from the changes made, or if they have relapsed. Clearly, this is a very important outcome in terms of reducing ill-health. An even longer-term follow-up (e.g. 12-18 months) would also be beneficial in order to ascertain the longevity of effects following interventions.
9.3.4 The research programme

One of the most significant challenges for conducting applied research within organisations is, perhaps, gaining the participation of organisations. With this research, particular difficulties were experienced in recruiting small organisations. Indeed, small workplaces have been identified as a specific challenge for occupational health practitioners (e.g. Eakin & Weir, 1995). This may be due to limited resources, especially the absence of a dedicated health and safety manager. In many cases, contact from potential participating organisations was made by the health and safety manager. To increase the participation of small organisations in research such as this, alternative approaches to recruitment may need to be developed. These could include the publication of press releases regarding the research in professional journals outside of the health and safety domain (particularly those targeted at senior managers of managing directors of small organisations), or incorporating resources into the project budget at the outset, to enable incentives to be offered in return for their participation (e.g. free health and safety advice). It must also be borne in mind that those organisations that do volunteer may have higher levels of interest in health and safety initially. Consequently, more innovative approaches need to be developed to encourage the participation of organisations that are less concerned with health and safety.

As discussed throughout this thesis, the reduction of work-related MSDs requires steps to be taken on behalf of both managers and workers. It was on this basis that tools were designed to measure both manager and worker stage of change, and to enable intervention approaches to be tailored accordingly. An important point, however, is the extent to which workers have the capacity or resources to make required/desired changes, or if they are constrained by limitations of their work environment (and their employer). It could be argued that workers have limited control over the factors that may pose MSD risks in their working environment, which are instead imposed on them by their employment. Indeed, in this research, the degree of control that workers had over their work environment, or the way in which their work tasks were organised, varied both within and between organisations. For the vast majority, however, there were at least small modifications that workers could make in order to reduce MSD risks. In circumstances where workers had very limited control over their working environment, it was agreed that 'action' on behalf of
workers could include the worker having made a request to their manager for changes to be made. It would be beneficial for future studies to more closely examine the implications of this modification, and in doing so, to explore the experiences of workers with limited scope for modifying their work environment. This notwithstanding, it is also important to note that the study described in Chapter 6 found that worker stage of change was not significantly related to employer stage of change. The absence of such an association suggests that overall, it was possible for workers to make changes independently of the actions of their employer.

Finally, as identified in Chapter 2 (Section 2.4.1), in 2000, HSE set targets to reduce the number of working days lost due to MSDs by 30% by 2010. As this target makes no discrimination between types of disorder (for example, back problems, or carpal tunnel syndrome), the research presented in this thesis included all types of MSD. However, there are important differences between various types of MSDs (in terms of both factors associated with their onset and methods for prevention), as outlined in Chapter 2. Back problems have been identified as being particularly complex, and there is growing evidence to suggest that these types of problem may require a different approach to that for other MSDs. Early screening for 'yellow flags' (specific psychosocial factors) is recommended as an important component to the management of work-related back pain, particularly to identify those workers who are at risk of developing chronic pain and disability (Waddell & Burton, 2000). These factors are quite different from the psychosocial factors associated with other forms of MSD (e.g. job control, ambiguity and social support). Instead, it is workers' own beliefs that their lower back pain was caused by their work, and their expectations about the inability to return to work, that are especially important considerations in relation to back problems. Consequently, the aim of the precontemplation stage — to raise workers' awareness of the risks of MSDs, the potential severity of these types of problems and workers' susceptibility to such problems — may be inappropriate for some back problems. This may be reflected in the results presented in Chapter 7, in that although significant reductions were found in self-reported pain in a number of body areas following tailored interventions, no significant reductions were identified in terms of reported back pain. Consequently, future work might consider tailoring approaches differently for back problems compared to other types of MSD.
9.4 Implications for practice

When tackling MSDs in practice, ergonomics practitioners appear to focus largely on the physical elements of the workplace or work tasks, neglecting behavioural or attitudinal factors (as identified by the study presented in Chapter 4). However, both behaviour change theory and practical recommendations for reducing MSDs (e.g. HSE, 2002; NIOSH, 1997) highlight the need to ensure that change recipients possess the knowledge, attitudes, and beliefs that promote the adoption and maintenance of changes required to prevent MSDs. The stage of change approach not only satisfies these criteria, but also acknowledges the cyclic nature of change, highlighting the need for ongoing efforts to maintain healthy behaviour and to prevent risks, rather than the typical approach of 'one-off' initiatives. Whilst current theory and practical guidance is unclear as to how HSE and NIOSH recommendations for reducing the risks of MSDs in the workplace might actually be put into practice, the staged approach offers a practical framework that can be used to guide the change process.

As outlined in Chapter 2, Ingelgard and Norrgren (2001) argued that the implementation of new technology affects the functioning of the system as a whole, and therefore cannot be considered as an isolated issue. From a macro ergonomics perspective, it is crucial to ensure that the individual components of the organisation (e.g. technology or personnel) are consistent with the system's overall structure. As a result, the ability of an organisation to successfully manage the change process is a key factor in the success of interventions. By adopting the stage of change framework to guide the implementation of ergonomics interventions, the scope of factors considered during in the context of implementation is automatically widened to consider issues relating to attitudes towards the risks, and behavioural intentions, for example. This approach is consistent with the argument made by Ingelgard and Norrgren (2001), that interventions should be evaluated on a variety of levels, including management or workforce attitudes to practices of changing work conditions, workplace changes, mechanical exposures, reporting of pain or discomfort, disability at work, and lost-time disability. This framework incorporates both broader organisational determinants and specific impacts at more micro-levels. Evaluating outcomes across a range of levels also allows the detection of more
subtle changes, particularly beneficial in the absence of long latency periods. In addition, the emphasis on attitudes and beliefs within the stage of change approach, and the awareness that follows for this, may help to overcome employers’ initial reluctance to address health issues such as MSDs. Douillet and Aptel (2000) suggested that potential barriers include a failure to perceive MSDs as work-related, and lack of appreciation regarding the wide range of contributory factors that can lead to MSDs. Consequently, it may be possible to improve compliance of management and employees to ergonomics advice, which was believed to be less than 60% (Loisel et al., 2001).

In addition to increasing the likelihood of implementation by reducing scepticism, an important determinant of the effectiveness of tailored interventions appeared to be the prevention of relapse. Due to the difficulty of making workplaces completely free from risks that may lead to MSDs, it is important that workers remain vigilant to the risks, and continue to follow working practices that reduce these risks. Evidence for increased effectiveness of interventions that are tailored according to the change recipient’s stage of change provided within this thesis has a number of possible implications for practice. If the promising results presented in this thesis are replicated in further research, wide-scale adoption of the approach could result in significant financial savings, due to the substantial costs related to MSDs. For instance, back disorders are estimated to cost employers between £315-335 million, and upper limb disorders £208-221 million (HSC, 2003). Adoption of the approach in practice might also help contribute towards the UK Government’s Revitalising Health Strategy, which in 2000 set out aims for a 20% reduction in the incidence rate of MSDs by 2010.

SMEs have been widely identified as a particular challenge for health promotion and occupational health practitioners (Eakin & Weir, 1995), as it is thought that they are often unable to access professional assistance in this regard (Lamm, 1997). Furthermore, as outlined in Chapter 5, 99% of enterprises are small, employing 47% of the workforce (DTI, 2004). The need for self-sufficiency is considered particularly important in the small business sector, where resources are limited. A specific benefit of the stage of change approach is that it offers increased capacity for organisations to manage problems independently of external professional services,
and enables employers to deal with risks on an ongoing basis. In addition, by tackling both managerial and worker stage of change, the approach developed by this research overcomes the problem highlighted by Eakin et al. (2001), that workers and employers have fundamentally different perspectives on health. Instead, the stage of change approach emphasises the importance of identifying these differences, and tailoring interventions accordingly. Finally, a potential benefit for all organisations, regardless of size, is the relative conciseness and simplicity of the tools developed by this research, for assessing stage of change in this context. This was a central consideration in the development of these tools, due to the value attributed to ease of implementation if the tools are to be implemented by organisations in practice.

It is important to note that these findings do not indicate that standard ergonomics interventions should not be implemented, but instead, that such interventions are likely to be more effective if workers and managers are concerned about the risks, are convinced about the benefits of making changes, and appreciate the need to maintain efforts to reduce the risks on an ongoing basis. The findings presented in this thesis extend previous case study evidence (Urlings et al., 1990), and demonstrate the value of the stage of change construct in the organisational context. The systematic assessment and tailoring of interventions according to workers' and managers' attitudes and intentions may provide a valuable lever for improving the effectiveness of MSDs interventions, and in moving beyond the current 'plateau' in reduction rates.

9.3.1 Recommendations for future work
Whilst these results are promising, further research is warranted to validate the findings, and to test the usefulness of the approach with other worker populations, other employer contexts, and with other health or safety issues. As previously alluded to, further benefits may also be gained from longer-term monitoring of interventions. A number of factors support this recommendation. First, behaviour change is a gradual process, which may involve relapse to previous ways of behaving. Given the importance attributed by these findings to behaviour change in the effective reduction of health and safety problems such as MSDs, monitoring workers over a more extended period would also allow investigation of the effects of
the specific factors that are associated with workers' relapse to previous ways of working, in contrast to workers' maintenance of risk-reducing method and practices. Second, monitoring intervention outcomes over a more extended period of time would allow investigation of the effects of interventions on organisational culture, which is typically slow to change. A third justification for conducting long-term follow-ups relates to the time it can take for organisations to implement changes to the workplace due to external constraints (e.g. finding appropriate tools, materials, or equipment). Even in situations where changes were implemented, a number of managers interviewed stated that it was 'too early to say' what the full effects of the interventions had been.

Future research in the area of health promotion or ill-health reduction also needs to focus on how to develop a 'population' approach. In order to achieve notable reductions in ill-health, it is important that researchers and practitioners develop more proactive approaches to recruitment. A major limitation to current approaches is the difficulty of obtaining participation from truly precontemplative organisations. Indeed, it could be argued that the effectiveness of many public health interventions is irrelevant considering the limited scale of adoption or participation. The effect on a given health problem is only ever going to be minimal if we only target those that are ready to change, as it is likely that the majority of those with health issues are those that are unprepared and unmotivated to take action. Prevention of relapse, or dropout from an intervention programme is another important issue in increasing the participation rates in such programmes, and the research presented in this thesis provides evidence to suggest that tailoring interventions can help achieve this. More proactive approaches to recruiting truly precontemplative organisations could facilitate movement towards a 'population' approach.

In terms of the wider implications of this research, having provided evidence for the effectiveness of the stage of change approach with respect to MSDs, potential exists for applying the approach to other work-related health issues. Work-related stress may be a particularly relevant issue, due to the importance of tackling both managerial and workers' perceptions and attitudes regarding the problem. Despite being one of the most common causes of occupational ill-health in this country, stress is an issue that organisations can be reluctant to tackle, perhaps due to
scepticism, perhaps due to lack of knowledge regarding how stress can be managed. The importance of the implementation process has also been identified in relation to work-related stress (Nytro et al., 2000; Griffiths, 1999), where it is acknowledged that positive outcomes may be more related to the process than the content of interventions. Landsbergis and Vivona-Vaughan (1995) identified several process-related explanations for the mixed results in their stress interventions study, recommending that the following issues are considered when implementing organisational interventions:

- formal involvement of unions
- integration of the intervention with ongoing organisational development projects and reorganisations
- establishment of structures for good communication between local participants
- development of implementation plans that involve entire organisations
- promotion of the view that the intervention is an ongoing activity of the organisation and not a time-limited project
- completion of a cost-benefit analysis

It is to be expected that local factors, such as worker safety legislation, insurance and compensation arrangements, will have an influence on the consultant/client interaction, although the primary issues of achieving implementation of recommendations and evaluation of their consequences appear generic. HSE have taken steps towards helping organisations understand how work-related stress can be reduced, through publication of the Stress Management Standards. These standards specify the types of psychosocial factors that should be tackled in order to reduce work-related stress. Consequently, in order to increase the likelihood that these standards are implemented, and to reduce the barriers that are likely to limit their effectiveness, it is important to ensure that attitudes towards the issue of stress, and other important factors affecting the implementation process (such as those identified by Landsbergis and Vivona-Vaughan, 1995), are addressed. The stage of change approach could be used to help identify managers (or even workers) who are unconvinced of the importance of reducing the risks for work-related stress, or reluctant to take action, in addition to many of the important factors identified by
Landsbergis and Vivona-Vaughan. For instance, tailoring interventions would ensure increased involvement of employees and other relevant groups in the intervention process, position the stress management intervention as an ongoing activity rather than a one-off initiative, and emphasise the need for evaluation to be carried out.

The stage of change model also has intuitive appeal for application to training development and evaluation. One of the main difficulties for evaluating training is considered to be the detection of subtle changes in behaviour (Patrick, 1992), a need that could be fulfilled using the stage of change approach. Furthermore, following a review of the literature, Hoel et al. (2001) concluded that generally, trainers do not perform proper evaluations of their courses. Ongoing monitoring of the effectiveness of measures, and efforts to ensure that changes recommended during training have been maintained, are fundamental aspects of the stage of change approach. Consequently, use of the stage of change approach by organisations, as a guiding framework for implementing and monitoring training, should increase the likelihood that training is evaluated. This is particularly important given that only 15% of organisations in Britain are thought to evaluate the training they provide (Bee and Bee, 1994). Without evaluation organisations cannot be certain that their training is effective. It is claimed that too often, training evaluation is a belated after-thought rather than an integral part of developing training (Beech & Leather, 2006). Reluctance to undertake evaluation of training is believed to be, at least in part, due to the belief that only rigorous and scientific evaluation is worthwhile (Sanderson, 1992). As argued by Sanderson, such methods are difficult or impossible to implement in the real world. The staged approach offers a pragmatic and meaningful method of evaluating training within an ecological framework.

9.4 Conclusion

MSDs have remained the most common form of occupational ill-health in Great Britain for over a decade. This is despite increased understanding of the factors associated with their onset, and ongoing attempts by health and safety researchers and practitioners to implement interventions aimed at tackling the associated risk factors. In their frameworks for tackling MSDs, both HSE (2002) and NIOSH (1997) advocated that in order to reduce MSDs, interventions not only need to be designed
to address both physical and psychosocial factors, but such attempts should also be embedded in a wider process involving gaining stakeholder commitment, educating change recipients about the risks, and encouraging ongoing evaluation of interventions.

- The stage of change model provides a practical framework for guiding the change process, from intervention development, to implementation, and monitoring. Whilst previous research has shown that stage-matched interventions tend to be more effective for health-related behaviours such as smoking, drinking, diet and exercise, the research presented in this thesis is believed to be the first application of the staged approach to workplace interventions in the field of occupational health.

- Tools developed to assess managerial and worker stage of change were found to possess high levels of reliability. Stage of change profiles of the managerial and worker samples were also distinctly different, suggesting that scope exists for tailoring approaches according to these different stakeholder groups. The implementation of these tools in practice provided evidence to suggest that tailored interventions are significantly more effective in reducing self-reported musculoskeletal discomfort. An important component of this appeared to be prevention of relapse following the implementation of changes. Thus, by tackling the attitudes, beliefs, and intentions that underpin behaviour in the workplace, approaches that are tailored according to recipients' knowledge, attitudes, and intentions appear not only to increase the likelihood that changes are implemented and adopted, but also the likelihood that they are maintained.

- The qualitative findings of this work provided further insights regarding the factors that are of importance in reducing the risks of MSDs in the workplace. Findings suggested that interventions should address knowledge, attitudes, perceptions and behaviour change, in addition to 'structural' factors such as insufficient resources, which appeared to be the main barriers and facilitators of the implementation process. This is particularly important given that these factors appeared to be mutually influential.
It is likely that the specific factors inhibiting or facilitating progression from one stage of change to the next (e.g. the type of pros and cons) vary for different health issues. For example, whilst it may be effective to highlight susceptibility and severity of upper limb disorders such as carpal tunnel syndrome among workers in the precontemplative stage, this may be inappropriate for back pain. Where back pain does not reflect an underlying organic cause, it may be more effective to highlight the benefits of remaining active.

Although certain limitations have been identified in terms of the methodology adopted, it is argued that these are balanced by the benefits of ecological validity. The research presented in this thesis is also interdisciplinary, integrating the disciplines of health psychology and ergonomics. It has been suggested that a crucial weakness of many ergonomics interventions is that they have traditionally focused at the micro level of organisations, such as human-system interfaces, rather than taking an holistic view of the interactive systems operating in the organisation as a whole (Hendrick, 1995). Despite the complex nature and causality of MSDs, involving factors relating to a range of disciplines from biomechanics, to ergonomics, psychology and physiology, approaches to prevention tend to derive from these individual disciplines in isolation from the others (Marras, 2004; Whysall et al., 2004). In fact, the failure to take a holistic approach to the problem is considered a fundamental limitation to our understanding of the causality and prevention of MSDs (Marras, 2004). Consequently, it is hoped that this research may prompt changes in practice and research regarding the implementation of occupational health and safety interventions.

To take forward the research presented in this thesis, it is recommended that further work is carried out to explore various potential applications of the stage of change model in the workplace context. For instance, whether effective results can be obtained by simplifying the tailoring process, perhaps by combining the contemplation and preparation stages. The staged approach could also be beneficial to a wider range of health-related issues in the occupational context, such as the implementation of health and safety training, interventions aimed at reducing work-related stress, or return-to-work initiatives.
MSDs have remained the most commonly reported type of work-related ill health in Great Britain for over a decade. In 2004/05, over a million people were estimated to have suffered from an MSD that they believed was caused or made worse by their work. On average, each worker suffering from such a problem took an estimated 20.5 days off work in that 12 month period (HSC, 2005). Unsurprisingly, the costs to employers are substantial. HSE has estimated that work-related musculoskeletal disorders cost employers between £590 million and £624 million (1995/96 prices) (HSE, 1999). Despite the growing body of evidence regarding risk factors associated with MSDs (reviewed in Chapter 2), comparisons between HSE surveys of self-reported work-related illness show that MSD prevalence rates appear to have plateaued in recent years (see Chapter 2, Section 2.4.1). Similarly, many organisations' accident figures have been found to plateau at a persistent level with further improvements seeming to have little effect (Donald & Young, 1996).

Behaviour has been identified as playing an important role in the effective reduction of health problems such as MSDs. For the risks to be reduced, action first needs to be taken by managers to implement risk-reducing measures (e.g. changes to the workplace layout, tools, equipment, or training). These changes then need to be adopted by employees, and integrated into their routine ways of working. Both HSE (2002) and NIOSH (1997) advised that in tackling work-related MSDs, attention must be paid to attitudinal and behavioural factors, in addition to factors relating to the physical work environment. However, the importance of attitudinal and behavioural change in reducing MSDs appears to be neglected in both practitioners' current practices and information leaflets available to employers (as discussed in Chapters 4 and 5). Given the ongoing prevalence of MSDs, it seemed that a new paradigm for tackling such problems was required. The research presented in this thesis has attempted to respond to this need, by developing the stage of change approach for application to occupational health and safety. The stage of change approach not only enables integration of both psychological and physical workplace factors, but also acknowledges the temporal nature of the change process. It is hoped that the promising results presented in this thesis may offer potential for improving the effectiveness of a wide range of health and safety interventions in the workplace.
10. REFERENCES


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Kilbom, Å. (1994). Repetitive work of the upper extremity Part II: the scientific basis (knowledge base) for the guide. *International Journal of Industrial Ergonomics, 14*, 59–86.


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APPENDICES
APPENDIX 1

QUALITY RATING FRAMEWORK
Quality Rating Framework

Rating
1 = Good (The majority of factors cited; >75%)
2 = Moderate (A moderate number of factors cited; ~50%)
3 = Poor (Only a small number of factors cited; <25%)

Possible factors relating to each stage:

<table>
<thead>
<tr>
<th>Precontemplation</th>
<th>Preparation</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Description of MSDs and MSD symptoms</td>
<td>• Risk assessment</td>
<td>• Monitor/evaluate effectiveness of changes (not just when significant changes have been made to the workplace)</td>
</tr>
<tr>
<td>• Severity – possible outcomes (e.g. disability)</td>
<td>• Attention to:</td>
<td>• Rehabilitation/return to work programmes</td>
</tr>
<tr>
<td>• Susceptibility (high prevalence)</td>
<td>• - Force</td>
<td>• Systems for ongoing feedback &amp; review</td>
</tr>
<tr>
<td>• Work-related causes</td>
<td>• - Frequency</td>
<td>• Health surveillance systems</td>
</tr>
<tr>
<td>- Loads</td>
<td>• - Duration of exposure</td>
<td></td>
</tr>
<tr>
<td>- Twisting</td>
<td>• - Posture</td>
<td></td>
</tr>
<tr>
<td>- Stooping/reaching</td>
<td>• - Psychosocial factors</td>
<td></td>
</tr>
<tr>
<td>- Pushing/pulling</td>
<td>• - Lighting, temperature, vibration</td>
<td></td>
</tr>
<tr>
<td>- Repetition</td>
<td>• Individual differences</td>
<td></td>
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<tr>
<td>- Lighting/temperature</td>
<td>• Possible solutions:</td>
<td></td>
</tr>
<tr>
<td>• Legal requirements (e.g. H&amp;SAWA)</td>
<td>• - Force</td>
<td></td>
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<tr>
<td>• Litigation/ Increased</td>
<td>• - Repetition</td>
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<tr>
<td>insurance premium</td>
<td>• - Breaks</td>
<td></td>
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<tr>
<td>• Bad publicity</td>
<td>• - Posture</td>
<td></td>
</tr>
<tr>
<td>• Sickness absence</td>
<td>• - Knowledge</td>
<td></td>
</tr>
<tr>
<td>• Turnover/training</td>
<td>• - Individual differences</td>
<td></td>
</tr>
<tr>
<td>• Productivity/quality</td>
<td>• - Incentives</td>
<td></td>
</tr>
<tr>
<td>• Fatigue</td>
<td>• - Lighting/temperature</td>
<td></td>
</tr>
<tr>
<td>• Cost-benefit of changes</td>
<td>• - Space</td>
<td></td>
</tr>
<tr>
<td>• Case studies of sufferers</td>
<td>• - Design of equip/processes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Workers’ demands</td>
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<td></td>
<td>• Alternative work</td>
<td></td>
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<td></td>
<td>• Training as secondary/supportive measure</td>
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<tr>
<td></td>
<td>• Participation of workers/supervisors</td>
<td></td>
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<tr>
<td></td>
<td>• Encourage early reporting of symptoms</td>
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</tbody>
</table>
APPENDIX 2

STANDARDISED INSTRUCTIONS
Work-Related Musculoskeletal Problems Survey

This survey is part of a study for the Health and Safety Executive, looking at attitudes towards work-related musculoskeletal problems and their management. The study is being conducted by researchers from the Health & Safety Ergonomics Unit at Loughborough University and the Institute of Work, Health, and Organisations at Nottingham University.

The term 'musculoskeletal problems' refers to a range of problems affecting the muscles, tendons, and other supporting structures of the body – that is, those affecting the arms and wrists such as repetitive strain injury, and also those affecting the back, neck and shoulders.

Please answer the following questions as accurately as you can.

All information is strictly confidential, and will be used only for research purposes.

Feedback will be given to [name of company] to help assess the causes of aches and pains affecting their employees.

Thank you

For further information about the study contact:
Zara Whysall, Health & Safety Ergonomics Unit, Loughborough University
Tel: 01509 228481 Email: Z.J.Whysall@lboro.ac.uk
APPENDIX 3

MANAGERIAL AND WORKER STAGE OF CHANGE ASSESSMENT TOOLS
MANAGERIAL STAGE OF CHANGE ASSESSMENT

1. Are you concerned about the risk of musculoskeletal problems in your organisation? Y / N (Circle as appropriate)

2. Are you thinking about taking action to reduce the risk of musculoskeletal problems in the next 6 months? Y / N (Circle as appropriate)

   → If no - please go to Question 5.

3. Do you have a clear idea of what you are going to do to reduce the risk of musculoskeletal problems in your company? Y / N (Circle as appropriate)

4. Are you considering taking action to reduce the risk of musculoskeletal problems in the next month or two? Y / N (Circle as appropriate)

5. Have any changes already been made? Y / N (Circle as appropriate)

   → If yes please go to Question 6.
   → If no - please go to Section 3.

6. Please describe what steps have been taken below (continue on reverse if necessary):

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7. How long ago were these changes implemented? ......................... Yrs / Mths / Wks (Circle as appropriate)

8. If more than 6 months ago, is any further attention to the problem planned? Y / N (If yes, please describe what before continuing to Section 3)

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361
WORKER STAGE OF CHANGE ASSESSMENT

1. Are you concerned about developing musculoskeletal problems from your work? Y / N (Circle as appropriate)

2. Do you think changes should be made to reduce the risk of musculoskeletal problems from your work in the next 6 months? Y / N (Circle as appropriate)

3. Do you think changes should be made in the next month or two? Y / N (Circle as appropriate)

4. Have you got any suggestions for changes that would reduce the strain of your work?

5. Has your employer made any changes to reduce the risk of musculoskeletal problems from your work? Y / N (Circle as appropriate)

6. Are you doing or have you done anything to reduce the risk? Y / N (Circle as appropriate)

7. If yes, please describe what you have done:

8. How long ago did you make these changes? wks / mths / yrs (Circle as appropriate)

9. If more than 6 months ago, do you intend to do anything more? Y / N (If yes, please describe)
APPENDIX 4

TOOL DEVELOPMENT PHASE:
LIKERT STYLE QUESTIONS
Please indicate the extent to which you agree / disagree with the following statements by placing a tick under the appropriate heading:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Neither agree nor disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employees here are at risk from developing musculoskeletal problems</td>
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<tr>
<td>There is no need to change the way we work with regard to the risk of musculoskeletal problems</td>
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<tr>
<td>It is a top priority that the risk of musculoskeletal problems is reduced in the next 6 months</td>
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<tr>
<td>It is a top priority that the risk of musculoskeletal problems is reduced in the next month or two</td>
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<tr>
<td>I currently do not have any specific ideas about the changes that should be made</td>
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<tr>
<td>The risk of musculoskeletal problems has been effectively reduced</td>
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<tr>
<td>There are further measures that need to be taken to reduce the risk of musculoskeletal problems</td>
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<td>Further time and resources need to be allocated to tackling musculoskeletal problems</td>
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<tr>
<td>The benefits of taking action to reduce the risks of musculoskeletal problems are likely to outweigh the costs</td>
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<tr>
<td>The risk of musculoskeletal problems is relatively low here</td>
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<tr>
<td>There is currently a lack of time/resources to tackle musculoskeletal problems</td>
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<tr>
<td>Problems in this organisation are more related to individual workers themselves than the work/workplace</td>
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<tr>
<td>Changes aimed at reducing the risk of musculoskeletal problems are likely to be effective</td>
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<tr>
<td>Employees have taken absence due to musculoskeletal problems</td>
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<tr>
<td>Productivity is suffering due to musculoskeletal problems</td>
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<td>Some people in the organisation have shown resistance towards making changes</td>
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<tr>
<td>Any remaining risk factors for musculoskeletal problems are factors that can’t really be controlled</td>
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APPENDIX 5

IMPLEMENTATION PHASE:
EMPLOYEE SAFETY CLIMATE CHECKLIST
Please indicate your level of agreement or disagreement by placing a tick in the appropriate box

<table>
<thead>
<tr>
<th></th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neither agree nor disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management acts decisively when a health and safety concern has been raised</td>
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<tr>
<td>In my workplace management acts quickly to correct health and safety problems</td>
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<tr>
<td>Health and safety information is always brought to my attention by my line manager/supervisor</td>
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<tr>
<td>There is good communication here about health and safety issues which affect me</td>
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<tr>
<td>Management here considers health and safety to be equally as important as production</td>
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<tr>
<td>I believe health and safety issues are assigned a high priority</td>
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<tr>
<td>Some health and safety rules and procedures don't need to be followed to get the job done safely</td>
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<tr>
<td>Some health and safety rules are not really practical</td>
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<tr>
<td>I am strongly encouraged to report unsafe conditions</td>
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<td>I can influence health and safety performance here</td>
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<tr>
<td>I am involved in informing management of important health and safety issues</td>
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<tr>
<td>I am involved in the ongoing review of health and safety</td>
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<tr>
<td>Health and safety is the number one priority in my mind when completing a job</td>
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<tr>
<td>It is important to me that there is a continuing emphasis on health and safety</td>
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<tr>
<td>I'm sure it's only a matter of time before I develop a work-related health problem</td>
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<tr>
<td>In my workplace the chances of developing a work-related health problem are quite high</td>
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<tr>
<td>Production targets rarely conflict with health and safety measures</td>
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</tr>
<tr>
<td>I am always given enough time to get the job done safety</td>
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</tr>
</tbody>
</table>
APPENDIX 6

IMPLEMENTATION PHASE:
MANAGERIAL SAFETY CLIMATE CHECKLIST
Please indicate your level of agreement or disagreement by placing a tick in the appropriate box

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neither agree nor disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Once a health and safety concern has been raised it is acted upon decisively</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In my workplace action is taken quickly to correct health and safety problems</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Health and safety information is always brought to my attention</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>There is good communication here about health and safety issues</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Health and safety here is considered to be equally as important as production</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>I believe health and safety issues are assigned a high priority</td>
<td></td>
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</tr>
<tr>
<td>Some health and safety rules and procedures don't need to be followed to get the job done safely</td>
<td></td>
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<tr>
<td>Some health and safety rules are not really practical</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I strongly encourage workers to report unsafe conditions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can influence health and safety performance here</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am involved in informing senior management of important health and safety issues</td>
<td></td>
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</tr>
<tr>
<td>I am involved in the ongoing review of health and safety</td>
<td></td>
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<tr>
<td>Health and safety is the number one priority in my mind at work</td>
<td></td>
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<tr>
<td>It is important to me that there is a continuing emphasis on health and safety</td>
<td></td>
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<tr>
<td>I'm sure it's only a matter of time before there is an accident or work-related health problem here</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>In my workplace the chances of developing a work-related health problem are quite high</td>
<td></td>
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<tr>
<td>Operational targets rarely conflict with health and safety measures</td>
<td></td>
<td></td>
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<tr>
<td>Employees always have enough time to get the job done safely</td>
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<td></td>
</tr>
</tbody>
</table>
APPENDIX 7

IMPLEMENTATION PHASE:
SELF-REPORTED PAIN/DISCOMFORT SCALE
1. Have you felt any discomfort in the last 7 days? Y / N

2. If yes, please mark a cross on the diagram below where you felt discomfort in the last 7 days.

3. For each part you have marked circle a number on the scales below to show how much discomfort you have felt:

If you have not experienced any pain or discomfort, leave this section blank.

<table>
<thead>
<tr>
<th>Minimal discomfort</th>
<th>Extreme discomfort</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Neck</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>2) Shoulders</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>3) Upper arms</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>4) Elbows</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>5) Forearms</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>6) Wrist</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>7) Hand</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>8) Upper back</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>9) Lower back</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>10) Legs</td>
<td>1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>
APPENDIX 8

TAILORED LEAFLETS
Workers - Precontemplation
3. Working Environment
- Working in the cold or handling cold items;
- Bad lighting, shadow or glare which cause workers to adopt awkward positions;
- Vibration may lead to conditions such as vibration white finger.

6. Workers' individual differences
Individuals differ in body size and reach, age and ability. This may lead to poor postures at shared stations.

New workers or people returning from illness may need time to adapt to the rate of work.

7. Other risk factors
A rate of work that encourages a fast pace.

Musculoskeletal Disorders (MSDs)
The Risks

What Are MSDs?
- Musculoskeletal Disorders (MSDs) affect the muscles, joints, tendons and other parts of the musculoskeletal system.
- MSDs arise in many forms, some exhibit well defined signs and symptoms (e.g. carpal tunnel syndrome, tennis elbow, vibration white finger).

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<th>Symptoms:</th>
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Loss of the ability to work
Loss of earnings - absence, early retirement
Legal requirements
Ill health; pain and discomfort
Impact on your social life

Real-Life Cases

After working in construction for 35 years, Sam is unable to grip small objects and his fingers go numb. He also suffers from constant pain to the base of his spine.

Phil, painter and decorator for 36 years. Suffers severe back pain caused by years of bending, twisting, stretching and lifting. Now finds it hard to bend, walk, stand and even sleep.

John, a 29 year old computer programmer, after 6 years of heavy computer use, is now unable to use the computer for more than a few minutes without severe pain in his arms. The pain is even continued by other activities such as driving or playing the piano. It is unlikely that John will ever fully recover.

Loss of Earnings
Each person forced to stop work due to work-related illness loses an average £51,000 before retirement age.

The Law
You have a legal responsibility to take care for yourself and others who may be affected by what you do or fail to do at work.

Risk Factors in Your Work:

1. Repetition
Repeating an action frequently for long periods uses the same muscles over and over again. The more a task is repeated the greater the risk.

2. Working posture
There is an increased risk of injury when postures are awkward and/or held for long periods.

3. Force
Using a lot of force - either from handling heavy loads or force in gripping can put you at risk.

4. Duration of exposure
Risk of injury increases with the length of time that a task is carried out.
Workers - Contemplation
**Why Make Changes?**

1. Reduced pain & discomfort
2. Reduced absence (& loss of earnings)
3. Reduced effort
4. Increased comfort
5. Reduced tiredness & boredom
6. Reduced errors & accidents
7. Ability to perform a wider variety of tasks
8. Increased job satisfaction

---

**Meat processing factory:**

Vacuum lifting device designed to lift heavy slabs of meat, job rotation introduced

→ More older employees, men and women, and those with symptoms of physical wear could manage the work.

---

**Chemical manufacturer:**

Redesign of workstations to avoid forced postures, mechanisation to avoid manual handling of loads

→ All employees reported increased job satisfaction, and took less time off due to illness and back pain.

---

**Musculoskeletal Disorders (MSDs)**

What you need to know

**What Are MSDs?**

- Musculoskeletal Disorders (MSDs) affect the muscles, joints, tendons and other parts of the musculoskeletal system
- MSDs arise in many forms, some exhibit well defined signs and symptoms (e.g. carpal tunnel syndrome, tennis elbow, vibration white finger)

---

Sample: This leaflet is for demonstration purposes only. Its purpose is to illustrate key ideas rather than act as a definitive resource. Copyright belongs to HSE
How you can benefit from making improvements

**Large news media organisation:**
Changes to workstation layout, work shifts, and software to reduce repetition in tasks and awkward postures

→ Reduced pain & discomfort, number of cases halved.

**Meat packing industry:**
Manual handling of loads and repetition reduced by using semiautomatic machines, distances for carrying loads shortened

→ Reduced risks of MSDs amongst the workforce and reduced accident rate.

**Secretarial duties using a computer:**
Adjustable chair height, new desk, use of a document holder, a wrist rest, trackerball, and rearrangement of workstation to remove twisting

→ The employee had no more long periods away from work due to wrist or neck problems after the changes.

**Small component manufacturer:**
Mechanised assistance with tasks, variable height workstations, training to allow task rotation

→ Benefits included lower levels of exertion, increased comfort, and reduced tiredness.

**Car parts assembly:**
Workstation modified to remove the need for operators to twist and bend to the side to pick up parts

→ All operators felt the changes greatly improved their overall comfort. One worker who had suffered back pain for years reported a reduction in this pain.
Workers - Preparation
Musculoskeletal Disorders (MSDs)

What you need to know

What Are MSDs?

- Musculoskeletal Disorders (MSDs) affect the muscles, joints, tendons and other parts of the musculoskeletal system.
- MSDs arise in many forms, some exhibit well defined signs and symptoms (e.g. carpal tunnel syndrome, tennis elbow, vibration white finger).

Large news media organisation:
Changes to workstation layout, work shifts, and software to reduce repetition in tasks
→ Number of cases halved, reduced pain & discomfort

Small component manufacturer:
Mechanised assistance with tasks, variable height workstations, training to allow task rotation
→ Benefits included lower levels of exertion, increased comfort, and reduced tiredness

What can be done?

Working Environment: Are there...
- Poor lighting conditions
- Vibration exposures likely to regularly exceed recommended levels
- Cold draughts, particularly cold air blowing over the hands
- Poor floors or variation in levels

Control options include...
- Use alternative lower vibration equipment
- Reduce exposure time to vibration
- Avoid working in the cold or handling cold items
- Wear gloves/warm clothing
- Introduce better flooring, avoid steps

Sample: This leaflet is for demonstration purposes only. Its purpose is to illustrate key ideas rather than act as a definitive resource.
The Job: Does it involve...
- Repeating the same movements every few seconds for 2 or more hours per day?
- Repetitive or still application of force (e.g. pushing, pulling, pinch grip, pressing, squeezing)

Improvements include...
- Job rotation
- Adequate breaks
- Varied work
- Reduce weights of items
- Alter task to allow use of stronger muscles
- Reduce carrying distances
- Use jigs to hold items

Working posture: Does it involve...
- Elbows being above shoulders for long periods?
- Repeatedly moving or holding upper arms out to side of body
- Awkward reaching
- Holding neck bent and/or twisted for long periods

Improvements for posture include...
- Move equipment to avoid reaching, bending, twisting
- Ensure working heights are appropriate
- Ensure items are within reach distances
- Arm support for precision work
- Appropriate seating
- Ensure lighting is suitable
Workers - Maintenance
Musculoskeletal Disorders (MSDs)

What you need to know

What Are MSDs?
- Musculoskeletal Disorders (MSDs) affect the muscles, joints, tendons and other parts of the musculoskeletal system.
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Examples of the Benefits

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Changes to workstation layout, work shifts, and software to reduce repetition in tasks
→ Number of cases halved, reduced pain & discomfort

Small component manufacturer:
Mechanised assistance with tasks, variable height workstations, training to allow task rotation
→ Benefits included lower levels of exertion, increased comfort, and reduced tiredness

Protect Yourself from the Risks

- Be aware of the risks in your work
- Monitor risk factors on an ongoing basis
- Assess any changes in the work tasks, work environment, or your own capability to perform the job for new risks
- Report early symptoms to your employer

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Risk Factors in Your Work Include:
- Repetition
- Poor working postures
- Force in gripping or handling loads
- Long duration of exposure to one task
- Vibration
- Lack of control over the pace of work

Why Make Changes?
1. Reduced pain & discomfort
2. Reduced loss of earnings through absence
3. Reduced effort
4. Increased comfort
5. Reduced tiredness & boredom
6. Reduced errors & accidents
7. Ability to perform a wider variety of tasks
8. Increased job satisfaction & morale

The Job: Improvements include...
- Job rotation
- Adequate breaks
- Varied work
- Reduce weights of items
- Alter task to allow the use of stronger muscles
- Reduce carrying distances
- Use jigs to hold items

Work Environment: Improvements include...
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Working posture: Improvements include...
- Move equipment to avoid reaching, bending, twisting
- Ensure working heights are appropriate
- Ensure items are within reach distances
- Arm support for precision work
- Appropriate seating
- Ensure lighting is suitable
Managers - Precontemplation
The Law
You have a legal responsibility to ensure, so far as is reasonably practical, the health, safety & welfare of your employees.

- To conduct risk assessments of work activities
- To plan, organise, control, monitor and review any required measures that follow
- To give employees information about health & safety matters

MSDs include a range of medical conditions:

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</tr>
</tbody>
</table>

Case Study: Cost-Benefit

- British Polythene Industries PLC
  - Company-wide scheme to prevent & rehabilitate musculoskeletal injury.
  - Initiative soon covered its own cost in reduced absence. In financial terms, the benefits outweighed the costs by 12:1

What Are MSDs?

- Musculoskeletal Disorders (MSDs) affect the muscles, joints, tendons and other parts of the musculoskeletal system
- MSDs arise in many forms, some exhibit well defined signs and symptoms (e.g. carpal tunnel syndrome, tennis elbow, vibration white finger)
- Increased absenteeism
- Damaged reputation
- Litigation
- Increased insurance premiums
- Increased levels of early retirement
- Increased recruitment & retraining costs
- Reduced productivity & quality
- Low morale
- Employee Ill-health

- In the UK, MSDs lead to loss of around 12.3 million working days each year
- Estimated to cause 30-60% of total absenteeism costs
- Direct and indirect costs of MSDs to enterprises £5,251 per injured worker

Bad Publicity – Real Litigation Cases

- Puretruce Ltd, non-compliance with improvement notice regarding manual handling. Substantial fine.

- UK Safety Group Ltd, footwear manufacturer, failed to assess risk of musculoskeletal injury despite recorded cases. Substantial fine.

Risk Factors Include:

- Repetition
- Awkward working postures
- Bad lighting
- Work in cold or hot environments
- Exposure to vibration
- Long periods of time performing the same task
- Force in handling loads or gripping
- Employees having little control over the pace of their work
- Excessive demands
- Employees having little control over their jobs
- Little social interaction for employees
- Payment systems that encourage a fast pace
- Workers’ individual differences can put them at risk (i.e. differences in size, or people returning from illness)

Recruitment & Retraining Costs

- Average cost of retraining employees due to injury, long term illness or early retirement £3,000 -£4,000 per employee
- Likely to be greater for experienced staff

Reduced Productivity

- Sickness absence leads to reduced productivity, taking up managers and operators’ time and energy, who then become unwilling or unable to deal with underlying problems

Health & Safety Given Low Priority
Why Make Changes?

1. Increased productivity & efficiency
2. Improved quality
3. Reduced errors & accidents
4. Reduced absence

5. Reduced prevalence of MSDs, pain & discomfort
6. Reduced tiredness & boredom
7. Lower attrition rates
8. Employees able to perform a wider variety of tasks

---

Computer use in nature and organisation:
Changes to workstation layout, work organisation including work patterns and shifts, changes to software to reduce repetition

→ After several years, the number of cases had halved

Large logistics firm:
Redesign of seating, most frequently used controls transferred to arm rests to eliminate twisting and improve posture

→ Enhanced job satisfaction, reduced absence due to illness, lower rates of attrition

---

Musculoskeletal Disorders (MSDs)

What you need to know

Large logistics firm:
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What Are MSDs?

- Musculoskeletal Disorders (MSDs) affect the muscles, joints, tendons and other parts of the musculoskeletal system
- MSDs arise in many forms, some exhibit well defined signs and symptoms (e.g. carpal tunnel syndrome, tennis elbow, vibration white finger)
- MSDs affect around 1.2 million people per year, the most common form of work-related ill-health in Great Britain

---

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- Repetition
- Poor working postures
- Force in gripping or handling loads
- Long duration of exposure to one task
- Vibration
- Lack of control over the pace of work

The Costs of MSDs:
- Increased absenteeism
- Damaged reputation
- Litigation
- Increased insurance premiums
- Increased levels of early retirement
- Increased recruitment & retraining costs
- Reduced productivity & quality
- Low morale
- Employee Ill-health

**Sportswear manufacturer:**
Improved seating, redesigned workstations to reduce amount of reaching required for factory quality control work

→ Output increased by over 30%

**Mattress manufacturer:**
Adjustable workstations to allow sitting or standing, foot pedal controls removed and replaced by automatic machines

→ Absence due to illness dropped from 7-10% to 1%

**Small component manufacturer:**
Mechanised assistance with tasks, variable height work stations, training to allow rotation

→ Benefits included lower levels of exertion, increased comfort, reduced tiredness & boredom.

**Chocolate box packing company:**
Redesigned operation to remove high risk task, change from piecework to salaried work, operators undertake whole assembly rather than just one component (job enlargement)

→ Assembly quality improved, comfort increased, fewer cases of wrist & hand problems
Musculoskeletal Disorders (MSDs)

What you need to know

What Are MSDs?

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What can be done?

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Improvements include...
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What can be done?

The Job: Does it involve...
- Repeating the same movements every few seconds for 2 or more hours per day?
- Repetitive or held (static) application of force (e.g. pushing, pulling, pinch grip, pressing, squeezing)?

Improvements include...
- Remove machine pacing
- Job rotation
- Adequate breaks
- Variation in the type of work
- Reduce weights of items
- Alter task to allow the use of stronger muscles
- Reduce carrying distances
- Jigs to hold items

Working posture: Does it involve...
- Elbows being above shoulders for more than 2 hours a day?
- Repeatedly moving or holding upper arms out to side of body
- Awkward reaching
- Holding neck bent and/or twisted for more than 2 hours per day

Improvements include...
- Relocate equipment to avoid reaching, bending, twisting
- Ensure working heights are appropriate for the worker
- Ensure items are within easy reaching distances
- Arm support for precision work
- Appropriate seating
- Ensure lighting is suitable
Managers - Maintenance
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Health Surveillance Action Guide

Because MSDs reoccur very easily, ongoing management of the risks is crucial.

It is recommended that you:
1. Involve employees and their representatives
2. Obtain specialist advice if appropriate
3. Identify the most suitable health surveillance procedure
   - Consider the degree of risk, likely health effects, affected employees, relevant procedures
4. Design a system, put someone in charge
5. Set up the programme
6. Carry out procedures/feedback information
7. Keep records
8. Monitoring, action and evaluation
   - Review risk assessments, improve risk control, discuss results with employee representatives

Musculoskeletal Disorders (MSDs)

Managing the risks: Information for Managers

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Loughborough University
Risk factors include:
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The Costs of MSDs:
- Damaged reputation
- Litigation
- Increased insurance premiums
- Increased absenteeism
- Increased levels of early retirement
- Increased recruitment & retraining costs
- Reduced productivity & quality
- Low morale
- Employee ill-health

What can be done?

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