AN INVESTIGATION OF MUSCULOSKELETAL DISORDERS IN HEALTHCARE PROFESSIONALS

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Abstract

The aims of the work within this thesis were to i) establish the prevalence of musculoskeletal disorders among hospital based nurses and physiotherapists and to establish both perceived and possible causes for these disorders, ii) obtain clinical diagnoses and prognoses of nurses and physiotherapy staff attending an Occupational Health Department, iii) to establish which occupational tasks have the greatest potential to cause musculoskeletal disorders and iv) to investigate the effects of simulated nursing tasks and a modified porters' work-rest schedule on spinal shrinkage.

In the epidemiological study the annual prevalence of all musculoskeletal disorders was estimated for nurses and physiotherapists in combination as 49%. The point prevalence was 20.7%. The anatomical area most affected was the lower back, buttocks, upper leg area. In total, musculoskeletal disorders accounted for 19% of all absences from work from all respondents within the previous year.

Of those staff attending the Occupational Health Department, the main anatomical area affected by musculoskeletal disorders was, again, the back. Whilst a clinical diagnosis could be given to some patients, others were categorised as having 'low-back pain' indicating the often idiopathic nature of the symptoms. Time off work was often extensive and some staff members were retired from their profession as a direct result of their disorder.

Patient handling was cited as the major perceived cause of the musculoskeletal disorders experienced. This variable was not significantly associated with the presence of musculoskeletal disorders in a logistic regression analysis. It is likely that all aspects of nursing and physiotherapy require some degree of manual handling and the category as a whole is too broad to enable an association with the presence or absence of a musculoskeletal disorder to be identified. Factors found to be associated with the presence of a musculoskeletal disorder or back pain were the specialty in which the individual worked, the age of the individual, whether physiotherapists' work regularly required the maintenance of stooped postures, the percentage time the individuals spent on their feet during a shift and the psychological variables of work pressure, happiness at work and job aspirations/motivations. The direction of causality for these variables was not established.

An ergonomic risk assessment indicated that the tasks with the highest risk potential were manual handling tasks and those involving a static hold/standing of a patient. Manual handling had a high risk score, mainly because of the awkward, non-optimum postures staff were forced to adopt to perform the task. Tasks requiring static flexions scored highly because they were often performed alone and the flexion was maintained for some time. The task's score was also related to other external factors.

The final set of studies considered the influence of nurses' and porters' tasks on spinal shrinkage. During a 4-hour simulation of nursing tasks, spinal shrinkage was significantly less with a 20-min seated break than with a 20-min standing break. Ensuring nurses take a 20-min seated break during each shift has the potential to reduce the prevalence of back-pain. A modified work-rest schedule for hospital porters did not have any effect on spinal shrinkage during a 4-hour simulation of occupational activities. The high prevalence of back pain among this group can not be reduced by adopting the modified work-rest schedule.

A model detailing the causal factors for musculoskeletal disorders and low-back pain in nurses and physiotherapists has been proposed based on current findings within this thesis. This ergonomic model requires validation in future work.

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1.0 Introduction

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1.1 Background

The physical demands of a number of jobs have been greatly reduced in the so-called western world with increased mechanisation and the use of computers. Nevertheless, the prevalence of musculoskeletal disorders, and in particular back problems remains high (Van Dieën and Oude Vrielink, 1998). In Great Britain in 1995, an estimated 1, 155, 000 people were suffering from a musculoskeletal disorder caused by their work and approximately 5% of these individuals were suffering from more than one musculoskeletal condition (Jones et al., 1988). In the United States of America in 1992, the total cost of musculoskeletal disorders and associated conditions was $149.4 billion, 2.5 % of the Gross National Product (Yellin and Callahan, 1995). Considering back pain alone, it has been estimated that 70-80% of all people living in the industrial work will suffer some problems at some time in their lives (Friedrich, 1994). Biering-Sørensen (1983) reported that 52-60% of the general population surveyed gave work as the primary cause of the back pain. The work-related musculoskeletal problem has escalated with time, not improved (Van Dieën and Oude Vrielink, 1998).

Musculoskeletal disorders encompass a wide range of symptoms, including acute and chronic injuries or diseases of the muscles, nerves, tendons and ligaments. Some individuals are only slightly incapacitated for a short period of time. Others will suffer reoccurring or chronic symptoms which cause them excruciating pain and potentially loss of earnings and incapacity. The aetiology of some musculoskeletal disorders is well understood. Back pain is often idiopathic and not predisposed by any physical abnormality. It is particularly difficult to identify the risk factors for back pain if the underlying mechanisms are not understood. Identifying multi-factorial risk factors is also difficult when two similar individuals with similar life-styles present themselves, one with pain and one symptom free.

A wealth of epidemiological data exists concerning back pain in the nursing profession. Hildebrandt (1995) identified nurses as the female occupation with the highest prevalence of back pain in the Dutch population. Numerous risk factors have been identified, including lifting and manual handling, static postures, bending and twisting and more recently the focus has turned to psychosocial factors (Toomingas et al., 1997). Despite comprehensive interventions, new lifting techniques and the introduction of lifting aids, back pain in the nursing population still constitutes a major problem. Symptoms of other anatomical areas are not so extensively explored but are incurred (Lagerstöm et al., 1995).

A range of healthcare professionals may be subject to musculoskeletal trauma. Physiotherapists are often neglected in research concerned with musculoskeletal disorders, possibly because it is assumed that these specialists have a high understanding of body mechanics and teach others how to take care of their backs. Bork et al. (1996) reported that 61% of 928 graduates of the University of Iowa's Physical Therapy Programme had experienced work-related musculoskeletal disorders in at least one anatomical area. Nurses and physiotherapists can not be considered as one homogenous group and data concerning nursing should not be assumed to be relevant to physiotherapists. Epidemiological studies of physiotherapists to establish the prevalence of musculoskeletal disorders and possible risk factors are needed. Hospital based porters also perform activities reported to be connected with musculoskeletal disorders such as lifting, pushing and pulling. Despite this, a comprehensive review of the literature failed to identify any studies relating to this group of healthcare workers and musculoskeletal disorders.

Conducting epidemiological studies is important in order to help understand the extent of the musculoskeletal problem and the possible causes. However, most studies adopt a cross-sectional design and causality is impossible to deduce. If there is an association between back pain and a poor fitness level, it is equally conceivable that the individual concerned became less fit through incapacitation from the injury as opposed to the low fitness level being a factor in the back pain aetiology. Longitudinal studies are required to attribute the direction of causality.

Questionnaire/interview data also rely on subjective memory and it is difficult to determine the validity of survey data. It is difficult to ascertain precisely when individuals first experienced their musculoskeletal problem when this may have been a considerable time ago. It is then impossible to evaluate his or her exact working practices at that time.

The validity of epidemiological work can be evaluated by an objective ergonomic risk assessment. This ensures that the tasks causing the greatest stress can be identified. Such assessments should not only take into consideration the task but the environment in which the task is being undertaken and the psychological state of the individual. Results of epidemiological work and risk assessments in conjunction are likely to give a fuller understanding of the problem.

Field based studies have high validity but it is difficult to concentrate on the manipulation of individual variables because not all other extraneous factors can be controlled for. Controlled laboratory experiments incorporating simulation of various nursing tasks can be used to assess the impact of one manipulated (independent) variable. Spinal compression is a potential risk factor in the onset of back pain (Eklund and Corlett, 1984). Changes in stature, caused by vertebral disc compression are directly related to the load acting on the spine and the exposure time (Leivseth and Drerup, 1997). Use of a stadiometer to measure spinal shrinkage can provide a reliable, precise and non-invasive procedure (Eklund and Corlett, 1984; Troup et al., 1985; Leatt, et al., 1985; Eklund, 1988). Measurement of the changes in stature may be used to assess compressionive forces acting on the spine during simulated work activities.

It is the aim in this thesis to investigate the impact of musculoskeletal disorders, and in particular back pain, on selected health professions. Epidemiological investigations, field based ergonomic risk assessments and finally, laboratory based work will be employed to highlight factors with the potential to cause musculoskeletal disorders in general, and back pain more specifically. Results could be used to formulate recommendations for hospital based healthcare workers to reduce the impact of this considerable problem. It will also elicit useful information for other related occupations where personnel are required to stand for long periods of time and perform repeated manual handling tasks.

2.0 Aims and Objectives

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This thesis utilises a multi-disciplinary approach in order to achieve the following aims:-

1. To establish the prevalence of musculoskeletal disorders among hospital-based nurses and physiotherapists.

2. To obtain a clinical diagnosis and prognosis of nursing and physiotherapist patients attending an Occupational Health Clinic.

3. To establish the perceived causes of these musculoskeletal disorders including the direction of causality.

4. To establish which nursing and physiotherapy tasks have the greatest potential to cause musculoskeletal disorders.

5. To establish the effects of simulated nursing tasks on spinal shrinkage.

6. To investigate the effects of a modified work-rest schedule on spinal shrinkage and the compressive loads on the spine during simulated porters' tasks.

Fulfilment of these aims will help to identify possible factors associated with the onset of work-related musculoskeletal disorders and in particular back pain. As a result of a synthesis of the work, recommendations can be made to reduce their prevalence within hospital-based healthcare professionals.

The above aims will be accomplished by means of the following objectives:

1. The design of a questionnaire for distribution amongst hospital based nursing personnel and physiotherapists. This questionnaire will be designed initially for cross-sectional use but will be adaptable to allow longitudinal data to be collected over a 20-month period.

2. Collection of data concerning any nurse or physiotherapist attending an occupational health clinic with a musculoskeletal disorder over a 12-month period.

3. Design of an ergonomic risk assessment procedure to allow for the identification of the most physically and mentally demanding nursing and physiotherapy tasks.

4. The application of precision stadiometry to measure changes in stature after laboratory simulated nursing tasks.

5. The design of a short questionnaire to identify whether back problems are evident amongst hospital based porters.

6. The application of precision stadiometry to measure changes in stature following an intervention study on the work-rest schedules of hospital based porters.

The collation and integration of all findings should allow for recommendations to reduce the prevalence of musculoskeletal disorders and in particular back pain to be made.

3.0 Review of Literature

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3.1 Musculoskeletal Disorders

3.1.1 Definitions; Musculoskeletal disorders encompass a broad spectrum of symptoms and include acute, cumulative and chronic disease or injuries of the muscles, nerves, tendons and ligaments. They are caused by mechanical stress, vibration, inflammation or irritation (Peate, 1994). Back pain can be defined as pain occurring between the gluteal folds inferiorly and the vertebra prominens superiorly, but shoulder girdle and brachial pain and sciatica and cruralgia are also included (Anderson, 1986). The most commonly reported musculoskeletal disorder is low-back pain which is restricted to the lumbar region of the back but may include sciatica. Figure 1 shows the lumbar and other regions of the vertebral column. Considering all occurring back pain, 80-90% is idiopathic in which no pathomorphological reason can be given for the symptoms (Ernst and Fialka, 1994a). It is therefore only a symptom with a variety of causes (Friedrich, 1994) and when considering the statistics relating to back pain, numerous different somewhat unknown pathological conditions are being considered (Steinberg, 1982).

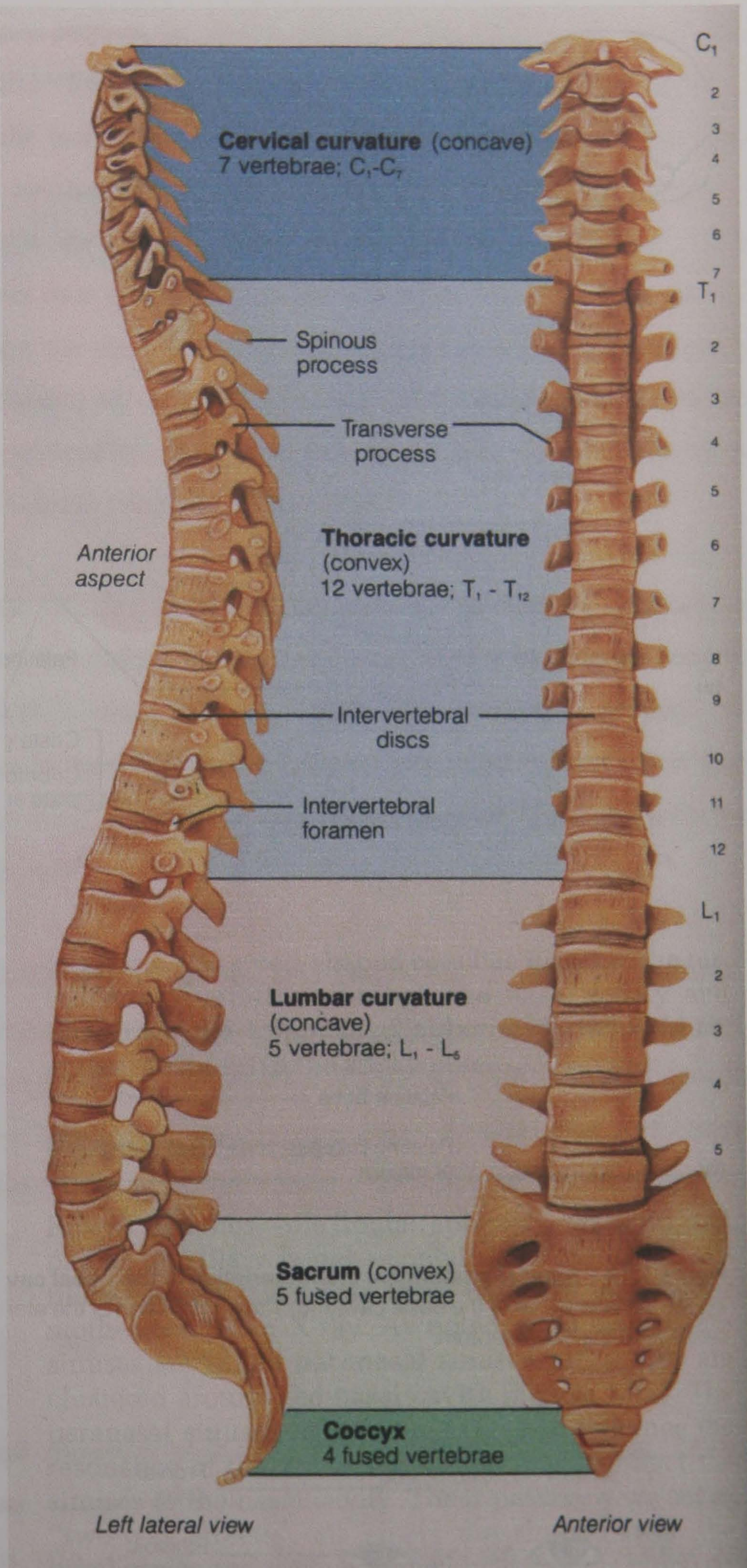

Figure 1. Regions of the vertebral column

The tendon sheath protects the tendon against mechanical friction when passing over a bony structure. Inflammation of the tendon and inflammation of the synovial membrane of the tendon sheath result in tendinitis and tenosynovitis, respectively. For example, inflammation of the abductor pollicis longus and lateral extensor pollicis brevis at the wrist is known as de Quervain's syndrome. Cumulative trauma of nerves over a prolonged period will injure the nerve or nerve entrapment will occur when the size of the nerve is incompatible with the anatomical space available. Peripheral nerve disorders include carpal tunnel syndrome, radiculopathy and vibration neuropathy; these disorders are usually characterised by pain and numbness and tingling (Hagberg et al., 1995).

Disorders of the muscles are termed myopathies. Myofascial syndrome relates to regional pain of the skeletal muscle tissue characterised by discrete body areas that are tender and from which pain may radiate when pressure is applied. When this situation occurs in the lower back it is sometimes called 'Chronic Pain Syndrome'. Localised myofascial syndrome in the neck is termed 'Tension Neck Syndrome' (Hagberg et al., 1995).

Other musculoskeletal symptoms are unspecified or involve multiple tissues. 'Cumulative trauma disease' and 'repetitive strain injuries' are examples and are caused by repetitive small movements. These two terms are used synonomously. The term 'non-specific diffuse forearm pain' is also used and describes the symptoms rather than the potential causes. Such disorders are usually characterised by recurring or persistent pain, numbness, aching, burning and stiffness in specific areas or the whole body. They are also sometimes associated with headaches (Hagberg et al., 1995).

Musculoskeletal disorders such as carpel tunnel syndrome and de Quervain's syndrome have recognised aetiologies and a diagnosis can be made. Such terminology is very specific and may not be known to individuals outside the medical profession. Specific defined conditions are not discussed further in this thesis which is primarily concerned with disorders of an idiopathic nature or for which the individual experiencing pain is unaware of the exact diagnosis but can describe the location of the injury and symptoms experienced.

3.1.2 Work-relatedness; Those suffering from back pain often cite their occupational activities as a causal factor. Biering-Sørensen (1983) indicated that 52-60% of the general population group surveyed gave work as the primary cause of back pain. Frymoyer and Gorden (1989) suggested that since 1980, evidence has accumulated with regard to the importance of work and psychosocial factors in the onset of long term disability compared with any anatomical pathology.

The World Health Organisation's expert committee described 'work-related' diseases as multi-factorial, where the work environment and the performance of the work contribute significantly to the disorder. These two factors are among a range of possible causes of the disease. 'Work-related' is in contrast to 'occupational' diseases where there is a direct cause and effect relationship between the hazard and the disease such as occurs in asbestosis (Hagberg et al., 1995).

Work-related musculoskeletal disorders may be the result of a single causal incident or arise from chronic strain over a period of time when the job demands are not matched by the individual's capabilities to meet those demands. This situation may occur in a variety of occupations, but certain occupations, particularly those involving manual handling, have been highlighted as having an increased risk. Hildebrandt (1995) reviewed three Dutch health surveys constituting 5840 men and 2908 women within the working population and reported that male construction workers and female nurses showed the highest prevalence rates for back pain. It can be concluded that some intervention to improve the situation in nursing is required.

3.2 Risk Factors for Musculoskeletal Disorders

3.2.1 Introduction; The location of musculoskeletal symptoms differs with the specific occupational demands. For example, symptoms of the lower back tend to be associated with physically heavy work, especially work involving manual handling of materials, while symptoms of the shoulder and neck region are frequently linked with jobs involving repetitive, high-speed work with the arms and hands (Christensen et al., 1995).

An understanding of the potential risk factors involved in the development of musculoskeletal disorders must be gained before measures can be implemented to reduce their prevalence rates. This is a difficult task, with the potential of suffering a musculoskeletal disorder depending on both the task and the individual performing it. Different individuals may perform the same task in different ways (Schierhout et al., 1995). Alternatively, two individuals performing a task identically may experience different physical outcomes, with one suffering musculoskeletal problems and the other remaining symptom free.

Most back pain is idiopathic. It is difficult to identify risk factors when the aetiological process underlying the non-specific health outcomes are not clearly understood. Mild back pain tends to reoccur and it is difficult to identify the specific window of time in which symptoms were first experienced (Burdorf et al., 1997). Despite these problems, numerous studies have attempted to identify possible risk factors for different musculoskeletal symptoms.

3.2.2 Manual handling; Repetitive lifting of heavy loads is recognised as increasing the potential for back pain by exceeding the strength of the anatomical structures involved (Videman et al., 1995). Poor muscle strength may not be related to increased low-back load (for example, caused by increased task duration or L5-S1 torques) but to a reduced capacity to withstand the load (de Looze et al., 1998). It is conceivable that exercise to strengthen the back muscles would be useful in compensating for this deficiency. Vallfors (1985) reported that strength training for the abdomen and chest muscles may decrease the load on the back when lifting, abdominals exerting torsional moments about the long axis of the spine, thereby acting as protection from externally applied torque (Adams, 1996). However, the benefit of strong abdominals in increasing intra-abdominal pressure to decrease spinal loading is questionable because the required pressures would occlude blood flow by squeezing the vascular tissue of the abdominals (Plowman, 1992).

Chronic low-back pain sufferers have reduced strength of flexor and extensor supportive musculature (Frymoyer and Cats-Baril, 1987) and spinal flexor and extensor isometric strength (Pope et al., 1985) and significant decreases in paraspinal and psoas dimensions (Ernst and Fialka, 1994b). All studies indicated that muscle atrophy may be a response to decreased usage as a result of pain symptoms and not a causal factor of back pain.

In a classic experiment, Cady et al. (1979) used a battery of tests including physiological responses to exercise, lumbar mobility, cycle ergometry and isometric lifting strength. They reported that the fittest fire-fighters (identified using information gained from a host of tests conducted by the Cardiopulmonary Laboratory of Occupational Health Service of the Department of Personnel of the County of Los Angeles) had the least incidence of low-back pain in subsequent years which would indicate the benefits of physical training. Just over 7% of the group classed 'least fit' had back injuries, compared to less than 1% for the 'most fit' group. The difference in the ages of the different fitness groups (mean age for the fittest group was 31.8 years and for the least fit group was 42 years) is likely to be an important confounding factor, and the study also showed that the 'fit' group had the more severe injuries inferring contradictory results. Using cardiovascular endurance (determined by means of a submaximal treadmill test) as a more valid measurement of fitness, Battié et al. (1989) showed fitness to have no predictive benefit, even though it may be important in slowing disc degeneration by increasing disc oxygenation, nutrition and waste removal by increasing circulation.

Skargren and Öberg (1996) observed the effects of an exercise programme on nurses and nursing aides from four geriatric wards. Subjects from two wards participated in an exercise programme twice a week for eight weeks whilst staff from the other wards acted as a control. After a wash-out period, the intervention was changed. The number of musculoskeletal symptoms, recorded using a version of the Nordic questionnaire, decreased after the period of exercise and cardiovascular capacity and muscular strength increased. The improvements were greatest for older non-regular exercisers. The effects were, however, short-term and only persisted while the 8-week period of exercise was being undertaken. It was suggested that the exercise temporarily increased endorphin levels which may have decreased the feelings of pain. This would mean that exercise only temporarily 'masked' back and neck symptoms, without actually strengthening anatomical structures to prevent problems from arising in the first place.

No significant difference in back pain between those who regularly exercise and those who do not was reported by Videman (1984). Other researchers have made similar observations (Arad and Ryan 1986; Niedhammer et al., 1994). The benefits of exercise in decreasing back pain have not been established conclusively, although it does appear that a high level of fitness may provide some protection against the effect of low-back pain and does seem to correlate with a more rapid reduction of symptoms and return to work (Kaplansky et al., 1998). Care must be taken in the interpretation of cross-sectional epidemiological studies because causality can not be stated. Problems in relating the results of various studies also arise because of the different outcome measures considered. There may also be no beneficial effects of exercise reported if the group under study has a good initial level of fitness (Skargren and Öberg, 1996).

The potentially detrimental effects of physically demanding work have been reported to affect other anatomical areas. De Zwart et al. (1997) analysed repeated questionnaire data over a four-year time period to evaluate changes in musculoskeletal complaints relative to age and work demands. It was concluded that for most complaints, there were significantly greater increases in prevalences for those working in heavy physical work than in the control group. This finding was particularly true of the group aged 40-49 years. It was suggested also that the increased prevalence of musculoskeletal disorders with age was because of an increased number of years exposed to physical stresses. The oldest age group only experienced increased complaints in the neck and upper arm. It was suggested that this group represented relatively healthy 'survivors' whose capabilities best suited the demands of the job.

3.2.3 Work-rest schedules; Rest breaks at work allow the body time to recover from the physical and mental demands of the job. Excessive rest breaks reduce productivity because of reduced work time, but insufficient breaks do not allow the body time to recover from fatigue, a situation which will also result in reduced worker productivity and illness. The optimum work-rest schedule, in terms of duration, frequency and time of both rest and recovery periods, must therefore be established for each individual occupation, depending on the different occupational demands (Genaidy and Al-Rayes, 1993; Kopardekar and Mital, 1994).

The physiological responses to altered work-rest schedules have been studied in a variety of occupations. Ganguly et al. (1981) measured heart rates of workers engaged in loading and unloading operations in a railway yard and reported that physiological strain increased towards the end of a shift with heavy loads, even when work remained the same due to cumulative fatigue and insufficient rest breaks. Rest periods were reported to slow down, but not preclude, the development of physiological changes associated with musculoskeletal disorders of the shoulder and neck region related to repetitive manipulation of light components in industrial settings (Mathiassen, 1993). When considering manual handling tasks, Genaidy and Al-Rayes (1993) concluded that the frequency of lifting must be taken into account when setting relaxation allowances as heart rate and psychological discomfort was found to exceed the recommended guidelines. It was also recommended, based on heart rate data and ratings of perceived exertion, that women required more frequent rest allowances than men.

Altered work-rest schedules have also been considered from a psychological perspective. Two hundred American telephone directory assistance operators, required to processes information from callers, worked under three different work-rest schedules. Quality of service, in terms of less errors made and faster processing time, was better with a 30-min working period followed by a 5-min rest break than either 60-min/10-min or 120-min/0-min work-rest schedules (Kopardekar and Mital, 1994). This result suggests that shorter work-rest cycles are advantageous for psychological functions such as attention/concentration.

The amount of time an individual is expected to work before a rest break is initiated, and the duration of the rest break, are key factors in offsetting of fatigue. This is because recovery from fatigue is exponential. Small but frequent rest breaks would therefore be most beneficial as they give the greatest relative decrease in fatigue (Konz, 1998). In addition to fatigue affecting the cardiovascular system (increased heart rate and ventilation rate) and brain (reduced concentration), the musculoskeletal system will be affected by long work times and insufficient breaks. The musculoskeletal system is primarily affected by postural stress (i.e. static work), and work requiring load manipulation (Konz, 1998).

The effects of altered work-rest schedules on the skeleton, and more particularly the spine, can be ascertained by considering spinal shrinkage. Shrinkage is directly proportional to the compressive forces acting on the spine (Leivseth and Drerup, 1997). Spinal loading is one of several factors possibly involved in the development of back problems (Althoff et al., 1992). Physical exertion or the adoption of postures which load the spine results in compressive forces acting on vertebral end-plates. Damage to the end-plates results in irreversible loss in disc height (Stålhammar et al., 1989), further disc degeneration and stiffness. It is this scenario that is believed to be important to the aetiology back pain (Corlett et al., 1987; Van Dieën and Toussaint, 1993).

Various research groups have used spinal shrinkage to assess the effect of vibration in the work place (Althoff et al., 1992; Van Dieën and Toussaint, 1993) and seat design/height (Eklund and Corlett, 1984; Magnusson et al., 1994). These variations will not be discussed further for the purpose of this thesis except to highlight the uses of this method of assessing spinal loading. Correlations between spinal shrinkage and perception of comfort/discomfort or exertion have been established and shrinkage has been positively related to perceived discomfort ratings (Eklund and Corlett, 1984; Foreman and Troup, 1987).

Helander and Quance (1990) considered spinal shrinkage in sedentary workers required to sit and type for a four-hour period. Forty minutes of rest were dispersed throughout this four-hour period. These rest breaks constituted 8 breaks of 5 min, 4 breaks of 10 min, 2 breaks of 20 min or a single break of 40 min. During the breaks, subjects were required to stand or walk. There was significantly less shrinkage when rest breaks were 20 min or 40 min than for the 5-min or 10-min breaks and it was suggested that the 5-min or 10-min breaks were insufficient to allow a change from compression to expansion of the vertebral discs. Subjects preferred the 20-min break because the 40-min break demanded a significantly extended work period.

In a similar study of poultry inspectors working at a conveyor belt in a slaughter house, the deformation of the spine, measured using a stadiometer, was not affected by alterations in the work-rest schedule (30-min work; 30-min rest, 30-min work; 15-min rest, 45-work; 15-min rest, 60-min work; 15-min rest). It was suggested that the absence of any effect of the altered work-rest schedule was due to the similarity between the load on the spine during work time and rest time. However, as stated above, even light administrative work has been reported to have an effect on spinal shrinkage (Van Dieën and Oude Vrielink, 1998). It could be surmised that, as all breaks were over 15 min, and the work was not very physically demanding, full recovery occurred in all test scenarios due to the exponential recovery rate. All four protocols for testing may have proven advantageous over a protocol with a shortened rest period of 5 min or 10 min.

3.2.4 Postural stress and repetitive motion; Sustained abnormal postures lead to muscle imbalance, with certain muscles being overused and opposing muscles being under-used. Muscles in either a lengthened or shortened position will be at a mechanical disadvantage and gradually become weak. Certain positions, for example forward flexion of the neck and extension of the head, render the worker more prone to this muscle imbalance (Higgs and Mackinnon, 1995).

Symptoms in the neck and shoulder region have been linked to static muscle activity and short work-cycle time. Christensen et al. (1995) reported an increased risk of injury in Danish wood and furniture workers due to prolonged forward and lateral flexions of the neck in certain tasks. A cross-sectional study of 637 randomly drawn Swedish subjects of the working population yielded similar results. Repetitive movements demanding precision were assumed to cause maintained static muscle contractions similar to the situation arising from postural stress (Ekberg et al., 1995). Similarly, Bergqvist et al. (1995) reported that continuously working in a sitting posture was associated with an increased likelihood for neck/shoulder and cervical disorders in a group of 260 visual display terminal workers. It is suggested that such working postures performed repeatedly would fatigue the muscles and pain or discomfort in the neck or shoulder area would result when repeated day after day (Chatterjee, 1987; Christensen et al., 1995). Prolonged isometric contractions of approximately 15-20% of maximum contraction are believed to impair the circulation resulting in tissue ischaemia and delayed clearance of metabolites (Chatterjee, 1987). Certain postures are known to be particularly strenuous. Repetitive elevation of the arms, inward or outward rotation of the arm, deviation of the wrist from the neutral position and a pinch grip are all especially stressful (Chatterjee, 1987).

As early as 1713, Bernardino Ramazzini recognised an association between repetitive work activities and injury among clerks and scribes (Armstrong et al., 1987; Chatterjee, 1987; Higgs and Mackinnon, 1995). Because of ever increasing automation within the western world, work is becoming ever more repetitive with constrained ranges of motion and infrequent task rotation. This situation places sustained demands on the same anatomical area (Peate, 1994). Repetitive work has been associated with neck, shoulder, elbow and wrist symptoms. Ohlsson et al. (1995) compared 82 women working in an industrial setting involving pressing and assembling fuses and other electrical equipment with 64 women whose work tasks were much more varied and mobile. The study group performed work of a highly repetitive nature, with short work cycles (mostly far less that 30 seconds) usually with a flexed neck and arms elevated and abducted intermittently. Those working in this group had a fivefold increase in the prevalence rate of neck/shoulder complaints and a fourfold increase in the prevalence rate of complaints to the elbow/hands. In a multivariate model, diagnoses in these anatomical areas were statistically associated with exposure to repetitive work.

A similar connection between the repetitiveness and forcefulness of manual work and signs and symptoms of hand/wrist tendinitis was reported by Armstrong et al. (1987). Highly repetitive jobs were defined as those with a cycle time of less than 30 seconds or with more than 50% of the cycle time involved in performing the same motion pattern and high-force jobs were those with estimated average hand force requirements of more than 40 N. The odds ratio for the high-force, high-repetitive group was 29.4 compared with the low-force, low-repetitive group ($p<0.001$).

3.2.5 Vibration; The most pronounced long term effect of whole-body vibration is damage to the spine. Vibration puts the muscles of the back under stress which is augmented by the need to maintain balance. Blood vessels are compressed by the internal pressure exerted by the static contractions, cutting off blood flow and resulting in a lack of oxygen and glucose supply to the muscles and an accumulation of lactic acid (Joubert, 1998).

Kelsey and White (1980) reported that prolonged periods of driving increased the risk of lumbar disc prolapses. Various reasons were postulated including lack of correct back support, mechanical factors of acceleration/deceleration, the position of the driver's legs, the driver's inability to alter position and finally vibration, a risk factor identified in its own right (Biering-Sørensen and Thomsen, 1986). Whole-body vibration is a particular risk factor for the onset of low-back pain for drivers, especially when coupled with other occupational activities believed to be harmful to the spine, such as loading and unloading the truck and prolonged sitting.

Magnusson et al. (1996) reported that bus and truck drivers were at increased risk of neck, back and shoulder pain due to vibration (resulting from driving) and when combined with lifting the risk was increased further. Neidhammer et al. (1994) showed commuting to work was a risk factor for back pain, a possibility suggested in previous studies (Biering-Sørensen and Thomsen, 1986: Biering-Sørensen et al., 1989).

Whilst the back is the anatomical area most affected by whole-body vibration, musculoskeletal disorders of other areas have been related to the vibration effects of hand-held power tools. Vibration has been linked to a variety of hand and wrist disorders, including carpal tunnel syndrome and Raynaud's phenomenon (characterised by poor blood flow to the extremities and feelings of cold in these areas) in carpenters (Atterbury et al., 1996). A prospective longitudinal study of workers in an electromechanical plant concluded that vibration caused by the use of power tools was a significant risk factor for upper limb disorders. Females were found to be particularly at risk, attributed to their small hand dimensions which left women exposed to higher stresses (Chatterjee, 1992).

3.2.6 Psychosocial risk factors;

3.2.6.1 Introduction; In a review of literature considering the causal relationship of work and upper extremity disorders, Vender et al. (1995) reported that most review articles have concentrated on occupational risk factors with little mention of other risk factors. The multi-factorial aetiology of musculoskeletal disorders is well recognised and psychosocial factors relating to the occupation and the individual must also be considered (Lungberg, 1995).

Psychosocial hazards can be defined as 'aspects of job content, work organisation and management and of environmental, social and organisational conditions which have the potential for psychological and physical harm' (Cox, 1993). Exposure can affect individuals directly, by physical mechanisms and indirectly, by mechanisms mediated by psychological stress. For example, noise, heat and humidity can be physically detrimental and also act as a psychological stressor.

Work is usually perceived as stressful when it involves demands which can not be matched by the individual's real and perceived capabilities, especially when workers have little control or support (Cox, 1993; Lungberg, 1995). It has been recognised for some time that stress at work has undesirable consequences for the health of individuals. Stress out of work can spill over into work or vice-versa, creating the general potential for physical problems (Cox, 1993). While the study of general stress and its associated physical problems is useful, it is more valuable to discriminate occupational stresses into their causative factors to establish which exact stress factors relate to poor physical health, and more specifically musculoskeletal disorders.

3.2.6.2 Work pace; Advancements in automation and specification have resulted in highly repetitive tasks to be completed at fast work rates. Ekberg et al. (1994) indicated that the pace of work showed a pronounced dose-response relation with musculoskeletal disorders of the neck and shoulder area. Increased work pace is obviously a physical work stressor with more movements per shift putting additional stress on the musculoskeletal system. It can also be perceived as a psychological stressor, demanding increased concentration and worry about being unable to keep pace with the demands of the job. Muscle tension will occur in response to a stressful stimulus and is sufficient to cause discomfort if maintained for long periods. The type of response will vary greatly between individuals which may help to explain the differences in musculoskeletal development amongst different individuals performing the same task (Westgaard and Bjørklund, 1987).

Again considering the pace of work, Bernard et al. (1994) indicated that 40% of 1050 newspaper employees reported moderate to severe symptoms relating to musculoskeletal symptoms in the neck and upper extremities. Musculoskeletal symptoms in these areas were mainly apparent in those performing prolonged typing and were seen to increase in those who worked the most time under deadlines. This may be due to a plethora of reasons including increased time of typing and decreased rest periods but it has also been attributed to the psychological stress of working at a fast pace to meet the imposed deadlines. Pressure to complete is likely to increase muscle tension and muscle fatigue (Faucett and Rempel, 1994).

Houtman et al. (1994) linked psychological stressors at work to cardiovascular pathology, immune system diseases and musculoskeletal problems. High work pace was associated with several indicators of health status including musculoskeletal problems, back pain, joint and muscle problems and more chronic back problems. When the regression model was adjusted for physical loading and moderating personal factors, the relationship between the psychological stressors and musculoskeletal problems remained significant.

3.2.6.3 Work load; Work load was one of the first aspects of psychological strain to receive attention, with both overload and underload being deemed potentially detrimental to health (Cox, 1993). Daniels and Guppy (1995) demonstrated, using multiple regression analysis, that quantitative workload (the amount of work to be completed) was related to general psychological well-being. Ohlsson et al. (1994) related work strain more specifically to musculoskeletal problems in studying women in the fish processing industry. An association between job strain and the increased risk of musculoskeletal symptoms was reported by Josephson et al. (1997) in a 4-year longitudinal study in which questionnaires were administered each year. The results were not conclusive with the results of two of the years being more uncertain. Increased mental stress has been related to back complaints among nurses in a review of thirty-five scientific reports (Burdorf and Sorock, 1997), but only one reference actually considered this variable.

Work strain and the resulting muscular tension and worry were associated with disorders of the neck and upper limbs (Ohlsson et al., 1994). Similar results were obtained when work-related mental overstrain was considered with physiotherapists used to assess subjects in an attempt to eliminate differences due to individual subjective reporting (Leino and Hanninen, 1995). It was suggested that psychological demands of the job were associated with emotional states such as worry. This could result in muscular tension relating to symptoms of the back, neck and shoulders (Theorell et al., 1991). Interestingly, there was no association between musculoskeletal disorders and physical work load and so the authors concluded that physical work load was less consistently associated with morbidity than some of the psychosocial factors (Leino and Hanninen, 1995). The 'healthy worker effect' must be considered in that those with musculoskeletal disorders were likely to have moved out of physically demanding jobs leaving only healthy workers.

Alternatively, over-simplified jobs (qualitative underload) with low work load can be detrimental to psychological health. Clegg and Wall (1990) showed that poor mental health occurred with simplified jobs, only for those employees who perceived their job demands as not utilising their skills and who also reported high levels of cognitive failure. Much short-cycle work can have quantitative overload and qualitative underload and there is evidence that this type of work is a threat to both physical and psychological health (Cox, 1993).

3.2.6.4 Control of work; Low control over one's role at work or loss of control (known as low decision latitude) has been repeatedly associated with stress, anxiety, depression, apathy, exhaustion and low self-esteem and physiologically, with cardiovascular symptoms (Cox, 1993). Leino and Hanninen (1995) indicated that the degree of autonomy over one's work load was one factor adding to psychological workload and that low autonomy was related to back and limb disorders. Low control over work is also associated with increased short and long term absence from work due to back pain (Hemingway et al., 1997), even when other factors were adjusted for. Lack of participation in decision making was also classed as contributing to musculoskeletal disorders in general in a study concerning newspaper employees (Bernard et al., 1994). Faucett and Rempel (1994) observed the interaction between work posture and psychosocial factors and suggested that increased job decision opportunities may buffer effects of poor workstation lay-out and can decrease negative health effects associated with stress. Ekberg and Wildhagen (1996) stated that low job autonomy, along with numerous other psychological factors, was associated with musculoskeletal disorders and other stress related diseases, and was also associated with those taking long term sickness absence as opposed to those who returned to work after a shorter period. They therefore concluded that long term sickness absence due to musculoskeletal disorders was attributed to the work situation rather than by their individual characteristics.

On this basis it could be argued that workers should, where possible, have control over their workloads and work-related problems. It should be remembered that increased control and choices in situations can in themselves be a source of stress (Cox, 1993). A balance must be achieved so individuals feel they have some control but not perceive the work as too mentally demanding.

3.2.6.5 Communication; Interpersonal relationships at work occur between colleagues, supervisors or subordinates. Poor communication or social interaction at work has been associated with musculoskeletal symptoms in general (Bernard et al., 1994) and problems of the lower back, neck, shoulder and upper and lower limbs (Leino and Hanninen, 1995).

Social relationships both at, and outside, work are commonly shown to have a moderating influence on the adverse effects of other psychological and physical stressors (Cox, 1993). Faucett and Rempel (1994) showed that good supervisory relationships and good workstation ergonomics resulted in less severe musculoskeletal symptoms, whereas bad supervisory relationships and good workstation ergonomics resulted in more severe symptoms.

Poor or muddled feedback from supervisors can create ambiguity in work roles, with the individual being either unsure about how to perform the work best or whether he/she is capable of performing it at all. Ekberg et al. (1994) claimed this to be a 'powerful determinant' of neck and shoulder diseases. This may be a result of increased muscle tension due to the stress individuals may experience when being unsure of what is expected of them.

(Faucett and Rempel, 1994) criticised research concerning many of the psychological factors because associations are discussed but causality is not stated. Hand/wrist symptoms are associated with lack of support by immediate supervisor (Bernard et al., 1994), but which came first? Are poor relationships with workers due to the negative feelings associated with work because of the musculoskeletal symptoms? A limitation of many studies is due to their cross-sectional design.

3.2.6.6 Individual and social characteristics; Equally important as the individual's psychological status in influencing the onset of musculoskeletal disorders are the personal characteristics and social background. The ability of tissues to tolerate external stresses decreases with age, and the wound healing process is slowed (Hagberg et al., 1995). Badley and Ibañez (1994), using information from the Canadian Health and Activity Limitation Survey (a cross-sectional study), indicated an increased likelihood of musculoskeletal disorders with increasing age. The general degeneration of tissues with increasing age makes certain tissues more susceptible to injury. Hagberg (1987) proposed that the immune system would react to any degenerative structures as 'foreign bodies' and trigger an inflammatory response resulting in pain and tenderness. The outcome of non-specific musculoskeletal pain was related to age, even when duration and level of exposure were controlled for (Hagberg et al., 1995).

Ohlsson et al. (1994) compared women in the general population to women working in the fish processing industry. Prevalence of disorders to neck and upper extremities substantially increased with age in the control group compared to the exposed women where the prevalence rates remained constant. It was concluded that increasing age is a risk factor for musculoskeletal disorders, and that this was not observed in the exposed group because the older group contained those individuals who were physiologically suited to the demands of the job, with those being unsuitable for the job having already left.

Sex differences for some musculoskeletal disorders also exist, with the incidence of some musculoskeletal symptoms being higher in females than males (Ekberg et al., 1994, Bernard et al., 1994 and Hagberg et al., 1995). It is not clear whether this higher incidence in women is due to genetic factors or to gender differences in exposure at work (Hagberg et al., 1995). Women may be over-represented in high risk jobs because of their reduced physical strength, thought to protect against musculoskeletal disorders. Ekberg et al. (1994) found an increased prevalence of musculoskeletal disorders in women but also that physical exercise (improving muscular strength) was actually a risk factor.

Cumulative trauma syndrome has been reported to be higher in females than males (Hagberg et al., 1995), but this may be due to the greater proportion of women in jobs related to this group of musculoskeletal disorders, such as typing, and it therefore represents increased occupational hazards. Non-occupational factors may also be greater for females and exacerbate occupational symptoms. Non-occupational stressors such as child-care and house-work may increase the risk for certain musculoskeletal disorders (Bernard et al., 1994).

Spinal shrinkage is used as a surrogate for loading, a factor believed to be associated with the onset of back pain; shrinkage is thought to have a greater potential to cause problems in females than males because female discs have a smaller cross-sectional area. When compressive loading is applied, either by weight or gravity, the smaller discs will be under higher stress and more fluid will be lost than from the larger male disc in response to a given load (Althoff et al., 1992).

As well as considering personal characteristics, the effects of social background on musculoskeletal disorders have also been studied. Low income and fewer years of schooling represent a low education level and have been associated with increased joint symptoms, especially knee pain and arthritis at any site. These symptoms may be a result of increased occupational knee bending and physical labour associated with low social class occupations (Mäkelä et al., 1993; Badley and Ibañez, 1994). In a one-year prospective study of 154 subjects, it was reported that low education predicted low-back symptoms in females, independently of physical work load characteristics (Viikari-Juntura et al., 1991). Socio-economic factors may be result of other underlying indicators. For example, low education may be a marker for increased smoking, poor diet and inefficiency in using medical services and other sources of assistance (Badley and Ibañez, 1994).

3.2.7 Interactions between physical and psychosocial risk factors; Physical and psychosocial risk factors are usually studied independently (Thorbjörnsson et al., 1998) but the interaction of the two is likely to be of equal importance to studying the effects in isolation. The exact connection between aspects of psychological job stress and musculoskeletal symptoms is not fully understood, but is thought to be linked with increased adrenaline levels and the resultant muscle tension. This theory could only account for muscular pain. Toomingas et al. (1997) reported that high mental demands or low social support were positively associated with muscular (soft tissue) tenderness in the neck and low back.

Back pain of four exposure groups of manual workers (high physical and high psychosocial, high physical and low psychosocial, low physical and high psychosocial and low physical and low psychosocial) was considered by Devereux et al. (1999). The high physical, low psychosocial had a high risk of suffering back pain so physical load had an independent effect, but those with the highest risk of back pain were participants in the high physical, high psychosocial category indicating some interaction.

Papageorgiou et al. (1998) reported that dissatisfaction with work status of a cohort free from back pain doubled the risk of reporting new episodes of back pain in both employed and unemployed individuals. They concluded that back pain was not solely related to work, but a product of general life. Burton et al. (1997) reported that Dutch nurses had a greater physical workload than nurses in Belgium but suffered significantly less musculoskeletal disorders and back problems, possibly because of their more 'positive' attitude.

A review of reports considering the interactions between work-stress and musculoskeletal disorders indicated that highly monotonous work elicited physiological stress responses (high blood pressure, heart-rate, catecholamine levels) that were relatively high for the simplicity of the job. These physiological responses took a considerable amount of time to return to base-level suggesting they also took their toll after work, with workers finding it difficult to unwind. Electromyographic activity, part of the stress response, increased under a situation of mental stress due to increased muscle tension. When individuals experienced both mental and physical stress, the EMG recordings were greater than the sum of the individual constituents (Melin and Lundberg, 1997).

The exact mechanism involved in mental stress acting as a trigger for muscle pain is not known but a connection between mental stress and muscle pain does appear to exist. Gatchel and Gardea (1999) suggested that biological disturbances may initiate physiological disturbances but psychological factors of the individual affect the perception and assessment of the physical stimulus. Social factors affect the individual's reaction to the experience of pain.

3.2.8 Environmental; Adverse environmental conditions have been associated with musculoskeletal disorders. There is substantial evidence that low ambient temperatures impair sensory and motor function of the hands, interfering with normal hand dexterity (Chatterjee, 1987). In the cold, the peripheral blood vessels vasoconstrict to maintain core body temperature. Less blood flows to the peripheral tissues, resulting in reduced sensitivity and impaired functioning of the hands. Performing highly repetitive and forceful tasks with the hands is associated with carpal tunnel syndrome. The risk of suffering symptoms is increased if repetitiveness is associated with cold (Hagberg et al., 1995).

Poor environmental conditions, for example excessively hot, excessively cold, noisy, humid or poorly lit work areas, may be perceived as a psychological stressor. Working in a noisy environment will be perceived as stressful if the individual is unable to concentrate and communicate with fellow workers. Working in a poorly lit environment may dictate that the individual has to adopt a non-optimal posture to enable clear visibility of their work. Noise and poor lighting are also likely to increase the risk of suffering an acute musculoskeletal disorder due to an accident, with individuals unable to see clearly any potential hazards or communicate effectively with one another.

3.3 Epidemiological Evidence for Musculoskeletal Disorders Amongst Nursing Professionals

3.3.1 Incidence and prevalence rates (back disorders); A wealth of epidemiological research considering musculoskeletal disorders has been conducted with various figures on the problem being quoted. Variation is due to a number of factors:- how back pain is defined, the methodology employed, the specific population considered, participant recall and non-response bias (Papageorgiou et al., 1995). It is estimated that 70-80% of all people living in the industrial world will suffer from back pain at some time during their lives (Biering-Sørensen, 1984; Waddell, 1987; Friedrich, 1994) with the annual incidence being around 5% (Friedrich, 1994). Treatment of low-back pain in the working aged population costs more than any other disease category (Peate, 1994). There is no evidence of changes in the pathological basis of low-back pain, but the problem continues to worsen (Waddell, 1996).

Hildebrandt (1995) reported that male construction workers and female nurses showed the highest back pain prevalence rates of Dutch men and women within the working population. If it can be assumed that nurses in the United Kingdom have similar working practices to those in Holland, they would therefore have a similarly high risk.

There have been numerous studies of back pain prevalence rates for the nursing profession, but these are often likely to be underestimated with minor problems going undetected and seen the by nursing staff as an inherent occupational risk. Prevalence rates are under-estimated particularly if the information is acquired from employee service data (Harber et al., 1985) or accident reports (Stubbs et al., 1983a). The variance in prevalence rates can also be attributed to different methodological approaches, and varying definitions of back pain.

Despite the potential under-estimation, nursing has shown some of the highest prevalence rates compared to other occupations (Hildebrandt, 1995; Guo et al, 1995). Reviewing the literature, Larese and Fiorito (1994) quoted annual prevalence rates of between 35% and 52%, being consistently higher than the general population (Pheasant and Stubbs, 1992), and comparable to rates found among workers in heavy industry (Larese and Fiorito, 1994). Buckle (1987) estimated the cost of the problem at 764,000 lost working days per year. Harber et al. (1985) and Stubbs et al. (1983a) quoted similar figures.

Despite the plethora of studies on various aspects of back pain in nursing and revisions of guidelines on various occupational activities, occupational back pain is still a prevalent problem. Comparing nursing back pain in 1979 to 1983, Stubbs et al. (1983a) showed more episodes of back pain and an increased frequency of the first episode of back pain occurred whilst nursing in the later period. Prevalence rates of recent studies show the problem of back pain in nursing is still very much in evidence.

3.3.2 Incidence and prevalence rates (other musculoskeletal disorders); In the United States, between 1981 and 1991, 'diseases associated with repeated trauma' rose from 18% to 61% of all total cases of work-related injuries (Schneider et al., 1995). The lower back is the most commonly affected anatomical area for musculoskeletal complaints but nurses also experience significant musculoskeletal strain in other body parts/joints. A questionnaire survey of four nursing homes in The Netherlands in which a 95% response rate was obtained reported musculoskeletal symptoms of various areas. Whilst 34% had low-back pain symptoms, 30% had arm or neck complaints (mostly in the shoulder), and 16% had leg complaints (mostly the knees) (Engels et al., 1996). Anatomical areas other than the back are therefore also affected.

3.3.3 Sickness absence and retirement from the nursing profession; In Sweden, musculoskeletal disorders, especially low-back pain and neck and/or shoulder pain are the most common causes of absence from work in both males and females between the ages of 30 and 65 years (Skargren and Öberg, 1999). In Jersey in 1994, work-related back pain accounted for 9.1% of total absences from work (Watson et al., 1998). Back pain, specifically, represents 25-40% of all workers' compensation claims. The cost of occupational low-back pain in the U.S.A. has been estimated at up to $100 billion per year and rising (Kaplansky et al., 1998). With other musculoskeletal disorders added, the costs become almost impossible to quantify. It may be assumed that the situation in other western countries is similar.

When occupational back pain becomes too severe, the understandable last option left to workers may be to change jobs or leave the profession entirely. Pheasant and Stubbs (1992) stated that 12% of nurses questioned cited back pain as the main/contributory factor for leaving the profession, and half of these said back pain was the sole factor. It has been estimated that the cost of replacing nurses who leave the profession because of back problems is approximately £50 million per annum (Gillman, 1992).

The incorporation of other musculoskeletal disorders into these figures is likely to increase the numbers leaving the profession yet further. Sickness payments and rehabilitation following an injury are costly and funds need to be found to train new nurses to replace those who have left. Because of the diverse nature of the factors associated with musculoskeletal disorders, and indeed because of the inconclusive evidence for the significant association of some factors, it is not possible to screen out those believed to be unsuitable to join the profession. The only viable alternative is to adapt working practices to reduce this occupational strain.

3.4 Potential Risk Factors for Musculoskeletal Disorders Amongst Nursing Professionals

3.4.1 Back pain; Back pain tends to be idiopathic, with the underlying causes of the symptoms being unknown (Ernst and Fialka, 1994a). It is likely that most symptoms result from a multitude of confounding factors, but to date there is little agreement on the exact risk factors responsible. Static posture, heavy physical work demands, frequent bending and stooping, twisting, sudden unexpected movements, exposure to vibration and tasks involving lifting, pushing and pulling have all been described as having the potential to cause back problems (Kaplansky et al., 1998). With the exception of vibration, nursing involves all the above components at some time. Figures 2,3 and 4 show nurses engaged in activities requiring some of the above actions.

Figure 2. Nurses involved in manual handling a patient

Figure 3. Nurses involved in pushing and pulling

Figure 4. A nurse performing a task with a twisted torso

3.4.1.1 Lifting and manual handling; Back injuries are closely associated with frequent patient lifting/handling. A search of literature between 1988 and 1998 indicated that many studies showed a link between patient lifting frequency and low-back pain (Lagerström et al., 1998). Therefore, it may not be the occupation per se that is associated with a greater than average risk of back trouble but certain occupational components. Nurses performing lifting tasks less frequently (high and low frequency lifting groups arbitrarily decided upon after consultation with a nursing supervisor or head nurse) still suffer back pain, but the initial onset may be delayed (Stobbe et al., 1988). Injury from manual handling may be caused by an accidental injury, over-exertion or cumulative damage (Busse and Bridger, 1997). Videman et al. (1984) showed the relationship between heaviness of physical work load and low-back pain was most evident in the under-30 age group. It is these younger nurses that have been quoted as having the highest prevalence rates (Troup et al., 1987).

Lifting a patient is frequently cited as the most frequent event precipitating an episode of low-back pain. Ryden et al. (1989) divided the causes of 84 back injuries into 4 categories - lifting, bending, fall, unknown. Lifting was recorded as being responsible for 55.4%. Burdorf and Sorock (1997) considered 35 published research papers and found that 16 of 19 reported a positive association between manual handling and back disorders and the 6 studies concerning nurses all stated that patient lifting was an important risk factor.

This situation is perhaps not surprising when it is considered that 90% of adult patients weigh more than 50 kg. Loads of this magnitude are rarely lifted manually in other western industries and this is especially important when the majority of people working in the nursing profession are female (Pheasant et al., 1991). Subjective ratings from nurses have been recorded and these also identify patient handling and transferring tasks as having the highest stress level in terms of the hardest and most frequent tasks (Caboor et al., 1993). Owen and Garg (1989) assessed which patient handling tasks were perceived as most stressful. The top 10 tasks were all lift/transfer tasks with the most stressful tasks involving movement of the patient from one destination to another. Toileting was most stressful, especially moving the patient from toilet to chair.

There is still no consensus on which is the best technique for lifting (Hsiang et al., 1997; Kaplansky et al., 1998). The National Institute of Occupational Safety and Health (NIOSH) developed the Work Practice Guide for Manual Handling which considered frequency of lifting, weight lifted, posture and load location. This guide assumes secure grip on the load which can not always be obtained in patient handling (Stobbe et al., 1988). Keeping the object close to the centre of gravity is a biomechanical principle well supported in the literature (Kaplansky et al., 1998), but lifting in nursing is very different because the load can not always be brought close into the body, the load does not possess handles, and the patients can be uncooperative or combative to increase further the resistance to movement (Owen, 1985; Harber et al., 1985).

Generally, research supports a lifting limit of 13.5 kg but this does not assume repetition of task or nature of the object (Johns et al., 1994). A bulky, non-uniform weight is much more stressful compared to a compact object even if the weight is identical. Care must be exercised when applying lifting regulations because, by stating a maximum acceptable load, it is assumed that lifting less than this is considered safe (Grieco et al., 1997). De Looze et al. (1998) reported that poor muscle strength of seventeen nurses was not related to increased load on the back, but that these 'weaker' nurses may still be at an increased risk because of a reduced capacity to withstand the load. Decreased muscle strength requires increased muscle action intensity to produce the same L5-S1 torque. The resultant increase in disturbance along muscle fibres is assumed to play a part in muscle fibre damage and potentially low-back pain. Actions requiring a combination of flexion, rotation and compression, even at low loads, over adequate time, have the potential to induce annular separation and subsequent disc prolapse (Hsiang et al., 1997).

Burton et al. (1997) questioned whether reducing the work load would necessarily reduce the prevalence of musculoskeletal disorders. A retrospective survey of nurses working in hospitals in Belgium and the Netherlands showed that Dutch nurses reported significantly less musculoskeletal disorders and back trouble than Belgian nurses. There was a significantly higher proportion of Dutch workers engaged in the wards with a 'heavy' workload. It was suggested that the 'positive' attitude of the Dutch nurses was protecting them from musculoskeletal symptoms.

Obstruction to lifting is also likely during patient care when equipment and furniture prevent employment of the correct technique. Harber et al. (1988) showed 30% of all actions to have patient attachments present to hinder patient moving, particularly in the intensive care department. The working environment forces nurses to support loads in extremely disadvantageous positions (Busse and Bridger, 1997) and the strain on the spine increases exponentially the further away the load is from the spinal axis (Carey, 1989)

If lifting is considered from an engineering standpoint, experts would advocate lifting with a straight back and flexed knees. This method has been taught for 50 years and yet back injuries continue to rise (Owen, 1985). Other lifting techniques have been considered and need more investigation. Stubbs and Osborne (1979) analysed intra-abdominal pressure in the orthodox, three-person and shoulder (Australian) lift. The pressures were 77.13, 69.69 and 38.56 mmHg, respectively, indicating the shoulder lift to be least physically stressful to the spine. Pheasant et al. (1991) indicated that even this so-called 'safe' shoulder lift still increased the risk of low-back pain.

All nurses are required to attend a manual handling training course indicating safe lifting practices. Biomechanical analysis of healthy persons and strength testing of impaired persons showed that the same technique of lifting may not necessarily be universally useful but that nurses should be allowed to examine their own work and requirements (Harber et al., 1985). Weight limits are imposed, but it may be the cumulative effect of lifting that results in back problems, and it is not guaranteed that lifting repeatedly below this weight will not cause damage (Anderson, 1980).

If the work is intrinsically unsafe, no amount of training can affect the situation (Stubbs et al., 1983b).

Lifting aids have been introduced to assist manual handling. These assistive devices range from simple pat slides and draw sheets to mechanical hoists. Using such aids requires less physical effort than manual lifting (Bell et al., 1979). Hofmann et al. (1994) showed increased low-back pain in the Czech Republic and Germany which had unsatisfactory lifting aids compared to the more ergonomically developed conditions of France and Sweden. Using a motion analysis system, two force platforms and a three-dimensional biomechanical model, Zhuag et al. (1999) reported that mechanical lifting devices reduced the compressive forces acting on the back by two thirds when transferring patients from bed to chair. The authors stated that using such lifting devices also eliminated potentially dangerous jerky movements associated with moving a patient from the bed to a chair.

The above results would appear to advocate usage of such equipment, but comparative studies are difficult to analyse, with differences being potentially due to other compounding factors. A review of literature between 1988 and 1998 highlighted reports that had advocated the benefits of lifting devices, but also others which had indicated no such beneficial effects. In fact, some authors reported that work postures were awkward when lifting devices were used (Lagerström et al., 1998). Besides, having aids on the wards does not necessarily mean they will be used.

Despite indications of their benefits, aids are not always used (Lee and Chiou, 1995). Paediatric wards have no hoist because it is considered unnecessary for lifting children (Pheasant et al., 1991). Obstruction and space constraints (for example moving the patient using a draw sheet requires access to both sides of the patient) also pose difficulties Harber et al., 1985). Using a hoist usually takes more time than manually moving the patient (Bell et al., 1979).

In other instances, aids are simply not used by nurses who choose instead to lift manually. Harber et al. (1985) showed assistive devices commonly employed for transfers involving beds, gurneys and wheel-chairs but not when considering movements to and from toilet and commodes; actions putting considerable stress on the lower back. Pheasant et al. (1991) advocated the use of lateral transfer devices (easy slide and slide board), believing them to lower the risk to the back compared to the three-person lift, but stated that, whilst these devices were largely made available they also remained largely unused. Training and the introduction of ergonomic lifting aids can only be beneficial in decreasing back pain if nurses see their value, their job is not adversely affected by such changes and assistive devices are made fully available.

While considerable back pain research cites patient handling/lifting as a potential causative factor, back pain does not relate to patient transfers alone (Harber et al., 1987a). Harber et al. (1987b) found nurses performed more non-patient contact actions than contact actions, especially involving lifting, pushing, pulling and manipulation of objects (furniture and equipment) often weighing more than 25 kg. Carrying, pushing or pulling equipment may be a major contributor to the back pain problem, but this indirect cause is often neglected by research and training programmes (Harber et al., 1987a). No procedures, like the NIOSH procedure for lifting, are available for assessment of exposure to pulling, pushing or carrying (Grieco et al., 1997).

3.4.1.2 Maintained static postures; The handling and lifting of patients imply actions involving motion. Static activities (defined here as being held for more than 30 seconds) are also regularly adopted during nursing tasks. Of these static actions, 78% were performed in squat or semi-squat positions thought to be potentially responsible for increased low-back problems due to prolonged back flexion (Harber et al., 1987b). Lee and Chiou (1995) reported that 15.9% of 8,629 postures showed trunk flexion of more than 15% and the percentage of poor postures (categorised using the Ovako Working Analysis System, OWAS, system) (Karhu et al., 1977) was significantly higher for the low-back pain group than the 'non-low back pain group', although causality could not be identified. The Occupational Safety and Health (OSHA) guidelines (US Department of Labour, 1991) identified the following as a risk factor for back disorders:- 'poor body mechanics, including continued bending over at the waist - and twisting at the waist, especially when lifting'. Nurses frequently work in awkward positions and spend much of their time leaning forward (Blue, 1996). Batty and Stubbs (1987) (cited by Busse and Bridger, 1997) reported that nurses may spend 22% of their working time in a stooped position.

When tiring postures were combined with lifting, the risk of musculoskeletal injury was even higher than when one factor was present in isolation (Estryn-Behar et al., 1990). This observation persisted when other potentially confounding factors were adjusted for.

Bed height was normally selected for the comfort of the patients as opposed to the safety of the nurses (Pheasant, 1987; Lee and Chiou, 1995). Even when beds are of adjustable height they are often maintained in the low position due to the extra time involved in raising them or the stress felt in using the manual crank (Owen and Garg, 1989). Such isometric, maintained static flexions become particularly necessary when equipment is not at an adequate height or because of physical constraints (Harber et al., 1988). Arad and Ryan (1986) studied 1033 nursing females and concluded that during a 40-hour working week, subjects spent 9.5 hours in a posture with their back in lateral flexion. Again, this static component must be considered in training programmes (Staker, 1990).

3.4.1.3 Work specialty; The association between the specialty in which the nurse works and occurrence of musculoskeletal disorders has been considered. Bell et al. (1979) claimed the highest number of back injuries occurred in the geriatric specialties. In contrast, Harber et al. (1985) indicated no such difference between the nursing divisions, believing that all aspects of nursing entailed some sort of 'dangerous' component, and that nurses would 'select' themselves out of a specialty they deemed particularly detrimental. Stubbs et al. (1983a), in a study of 3912 nurses, also indicated no significant difference between the various ward specialities and nursing grades, but Adams (1996) stated that nurses may be at risk from suffering back problems when joining the profession because of the time needed for the intervertebral discs to 'catch up' with the strengthening muscle and bone. Lagerström et al., (1998) in an extensive review of literature, concluded that work in orthopaedic, geriatric and rehabilitation wards, with physically demanding nursing tasks, was a risk factor for low-back problems in several studies. It may be concluded that certain specialties have a higher risk than others, for example those with heavily dependent patients, but nurses in other specialties also suffer musculoskeletal symptoms so the degree of dependency of the patients can not be the only factor involved. There must be some 'dangerous' component of the job in all specialties.

Nurses have a tendency to move between different specialties during the course of their working profile. Mercer (1979) showed that nurses did not tend to remain in one specialty for a long period of time, with 37% of nurses studied being in the current post for less than 1 year. When correlating back pain prevalence and nursing divisions, the effects of previous work cannot be ignored. It is difficult to state exactly when the first episode of trouble occurred and what precipitated it when relying on memory.

3.4.1.4 Individual characteristics; The relationship between anthropometric data and back pain has been studied extensively but results are conflicting. Kumar (1990) and Harber et al. (1987a) showed no relationship between back pain and stature, contradicting a previous study by Kelsey and White (1980) where low-back pain with sciatic symptoms was associated with tallness. Aran and Ryan (1986) reported that all nurses over 1.85 m had low-back trouble, whilst Smedley et al. (1995) showed a weak association but only in females. It may not be tallness per se but a proportionally long back that has predictive value for back pain. This would be particularly important in situations of spatial constraints (Troup, 1984) and also because a long back means a longer lever arm and increased forces on the lumbar spine (Adams, 1996).

The use of obesity for predicting back pain has also been considered. Obesity may be particularly problematic if working in confined spaces where it would be difficult to adopt a stable or comfortable posture due to the limited space available (Troup, 1984). Plowman (1992) postulated that obesity would increase the spinal load and therefore potentiate back pain, but others have reported no correlation between the two variables (Harber et al., 1987a; Kumar, 1990; Estryn-Behar et al., 1990; Niedhammer et al., 1994). Burdorf and Sorock (1997) reviewed 35 scientific reports and concluded that the associations between back pain and height and weight measures were not conclusive. An increased prevalence of back disorders among taller nurses was reported but the results were not statistically significant.

Fitness, stature, obesity and the like can be termed internal risk factors, but other researchers have turned their attention to external variables. An association between smoking and back pain has been reported. (Vallfors, 1985; Biering-Sørensen and Thomsen, 1986; Ready et al., 1993; Niedhammer et al., 1994). Smoking was a significant indicator for both first time and recurrent low-back pain (Biering-Sørensen et al., 1989) and was associated with 53% of medically reported severe low-back trouble by Frymoyer et al. (1983). Owen (1986) found no difference between smokers and non-smokers in the incidence of back pain. However, when injured and non-injured smokers were compared, the amount each group smoked was an important factor. The injured group smoked, on average 23 cigarettes per day whilst the non-injured smoked 10 per day. The link is not conclusive, with a recent study of 2405 hospital based nurses showing no connection between back trouble and smoking (Smedley et al., 1995) and numerous reports of contradictory findings (Lagerström et al., 1998).

While the exact link is not fully established, smoking may exert its effects on back morphology in the following ways. Firstly, coughing increases intradiscal pressure resulting in injury and pain. Gyntelberg (1974) showed that coughing and chronic bronchitis were associated with back pain and not smoking itself, but other studies have shown coughing not to be related (Frymoyer et al., 1983; Biering-Sørensen and Thomsen, 1986; Ryden et al., 1989). Secondly, smoking may exert a direct adverse, physiological effect on spinal tissue. Laboratory tests have shown the effects of nicotine in one cigarette decreases vertebral body blood flow (Frymoyer et al., 1983), rendering it more susceptible to mechanical deformity (Ryden et al., 1989). Finally, a positive correlation has been indicated between smoking and diminished bone mineral content. Such osteoporosis in vertebrae may result in microfractures of trabecular, giving rise to back problems (Biering-Sørensen and Thomsen, 1986; Ryden et al., 1989). The vertebrae have a high percentage of trabeculae bone, which is characterised by a good deal of open spaces (Marieb, 1992). Loss of mineral content and microfractures of this type of bone are likely to be of more importance than damage to more dense cortical bone which may be why the vertebrae are particularly affected by smoking.

Arad and Ryan (1986) showed a clear trend between alcohol consumption and one month prevalence rates of back pain in 1033 female nurses. Those with the heaviest alcohol consumption had the highest incidence of low-back pain. When comparing non-injured nurses with nurses with back injuries, Ready et al. (1993) showed the injured group was slightly more likely to drink alcohol. Vallfors (1985) reported that 31% of patients with no objective findings, who had chronic back pain had signs of alcoholism. The first study was cross-sectional in design and the second considered nurses already suffering chronic back pain so a cause and effect link must be questioned.

3.4.1.5 Time of day; Basing their work on research by Buckle et al. (1980) which showed that 40% of injuries occurred within the first hour of work starting and 65% between 06:00 hours and midday, Ryden et al. (1989) suggested a time of day effect on back injuries in nursing. It was reported that 42% of injuries occurred in the initial hours of work with the midnight peak supporting this as the night shift begins at 23:00 hours. The peak in injury in the morning could be attributed to the type of activities being performed at this time with patients being manually assisted out of bed. This factor would not account for the peak at 23:00 hours when patients are in bed. Existence of a more biological reason for increased back injury at the beginning of a shift would seem likely. A mid-afternoon cluster was also highlighted corresponding to the end of the shift when tiredness sets in or workers are in a hurry to finish tasks and leave work.

Warm up sessions could be initiated prior to starting work so that nurses are less 'cold' when work begins and muscles would be warmed up. A voluntary 10 minute warm up session was introduced to the beginning of work sessions on Swedish construction sites. The benefits of the warm-up sessions were monitored by questionnaire over a six-month period and of those who participated, 90% reported that their feeling of well-being and comradeship had improved since the sessions' initiation (Cederqvist, 1994). Conclusions regarding the effects of the warm-up programme on injury prevention could not be drawn, especially because no control was used with which to draw comparisons. The participation rate was 36-59% so a response bias can also not be ruled out.

3.4.1.6 Summary of risk factors for back pain in nursing; The above section (3.4.1) illustrates the difficulty of identifying risk factors for back pain. It is usually the cumulative effects of many factors in conjunction that is responsible for the onset of symptoms and studying these factors together poses a difficult challenge. Occupational, organisational, personal and psychosocial factors all play a role in the aetiology of back pain in nursing. The relationship of risk factors responsible for other musculoskeletal disorders is likely to be as complex.

3.4.2 Other musculoskeletal disorders; The lower back is the most commonly studied anatomical area for musculoskeletal disorders in nursing staff. Problems of other anatomical areas are not so extensively explored. A study of Swedish nursing personnel indicated that different occupational and individual factors were related to the five different musculoskeletal disorders considered. Neck symptoms were related to age, perceived low fitness, low commitment to work tasks and less frequent support from supervisors related to ongoing symptoms. Shoulder symptoms were related to age, low perceived fitness and low work control. Symptoms of the hand were related to age and lack of stimulation at work and severe symptoms were also related to the type of ward in which the individual worked. Age was also associated with symptoms of the knee, with more severe symptoms being related to a high body mass (Lagerström et al., 1995). Due to the cross-sectional design of the study, causality could not be inferred, and in the case of the ward in which the individual worked, the influence of past work in other wards can not be ignored. Detailed data concerning which wards were associated with which musculoskeletal problem were not reported, all wards being divided into two classes; 'medical and geriatric/surgical' and 'other' departments.

The widespread introduction of computers into all aspects of life has led to an increase in carpal tunnel and other cumulative trauma disorders (CTDs). In the past, nurses have been very limited in the use of computers and the risk of CTDs has been small. Recently, more hospitals are placing more and more patient records on computer documentation systems and nurses may be beginning to be exposed to a significant risk of CTDs (McHugh and Schaller, 1997). Problems of the back, neck and shoulders may result from sitting at the computer. This prolonged sitting would have to constitute a considerable part of the working day so is only likely to affect those more senior nurses with a more administrative role.

Risk factors with the potential to cause back pain in nursing personnel are extensively explored in the literature. The links between back pain and some risk factors are well established. The link between back pain and other factors is less conclusive. The investigation of risk factors for other musculoskeletal in nurses should not be ignored. Table 1 summarises the main epidemiological work considering risk factors for back pain and musculoskeletal disorders.

Table 1. Main epidemiological work considering risk factors associated with back pain or musculoskeletal disorders in nurses.

Source	Population	Data collection	Outcome measure	Main finding
Stobbe et al. (1988)	415 nurses	Discussion with nursing supervisors, hospital registration data	Back injuries during 40 months	Lifting frequency was significantly related to back injuries
Videman et al. (1984)	199 qualified nurses	Anthropometric data, strength and psychometric tests, skill assessment, questionnaire	Back pain during 12 months of graduation	Poor patient handling skills, low number of repetitions in sit-up test and high work load scores were risk factors
Ryden et al. (1989)	84 nurses with low-back injuries and 168 matched controls	Employee health records	Reported low back injuries	History of previous low-back pain and working the day shift associated with back pain. No association between back injuries and smoking
Burton et al. (1997)	1216 nurses	Questionnaire	Current back problems, history of low-back pain	Prevalence of low-back pain was not dependent on work-load. Dutch nurses were less depressed, more positive about work, had a higher workload but lower back pain prevalence
Estryn-Behar et al. (1990)	1505 female hospital workers	Questionnaire, medical examination	Musculo-skeletal disorders in the preceding 12 months	Posture and lifting index developed. Musculoskeletal disorders were twice as frequent among nurses with a high index
Harber et al. (1985)	550 nurses	Questionnaire	Low-back pain in the preceding 6 months	Back pain rates were not related to speciality
Harber et al. (1987a)	550 nurses	Questionnaire	Back pain in the preceding 6 months	Frequency of 'carrying and pushing' and 'patient care activities' associated with back pain. Personal factors did not predict outcome
Niedhammer et al. (1994)	469 nurses	Questionnaire	Back pain in the preceding 12 months	Back pain more frequent among nurses who smoked, experienced symptoms of psychological disorders, reported physical work as stressful, were older, had experienced musculo-skeletal disorders, had longer time commuting to work

Table 1. continued

Ready et al. (1993)	119 female nurses	Questionnaire, fitness and Isometric strength tests	Back injuries during 18 month follow up	Injured nurses more likely to be from high risk wards, received compensation pay, smoke and be less satisfied with work. Fitness and life-style did not differ significantly between the injured and non-injures group
Smedly et al. (1995)	1659 nurses	Questionnaire	Low-back pain	Specific manual handling tasks were associated with increased risk of back pain. No association with smoking and reproductive history
Stubbs et al. (1983a)	3912 nurses	Questionnaire	Back pain	Back pain was not significantly associated with speciality or grade
Lagerström et al. (1995)	688 female nurses	Questionnaire	Musculo-skeletal symptoms of the neck, shoulder, low back, hands and knees	Different factors related to different symptoms. Neck; age, perceived low fitness, low commitment to work and less frequent support form supervisors. Shoulder; age, low perceived fitness and low work control. Hand; age, lack of simulation at work and type of ward. Knee; age and high body mass scores. Back; low perceived fitness, work category and little support form supervisors

3.5 Investigative Tools

3.5.1 Stadiometry; Spinal loading is one factor associated with the risk of suffering low-back pain (Eklund and Corlett, 1984). Measuring spinal loading would appear to be beneficial in an ergonomic assessment of task and work station design. A variety of different techniques exist for the measurement of spinal loading. Stadiometry relies on measurement of stature, with changes in stature in a variety of different conditions being related to the level of spinal compression (Foreman and Troup, 1987).

Such changes in human stature result when the compressive load on the discs exceeds the interstitial osmotic pressure of the discs' tissue and fluid is expelled from the nucleus pulposus (Helander and Quance, 1990; Van Dieën and Toussaint, 1993). Secondly, elastic deformation of the disc and vertebrae occurs which results in bulging of the annulus and deformation of the end-plate and underlying bone (Van Dieën and Toussaint, 1993). Bulging decreases the distance to nerve roots and increases the probability of nerve root pressure and pain (Eklund and Corlett, 1984). Once pressure is reduced, fluid can be re-absorbed and the disc will return to its original height and volume (Helander and Quance, 1990). Figure 5 illustrates the vertebral disc and vertebrae.

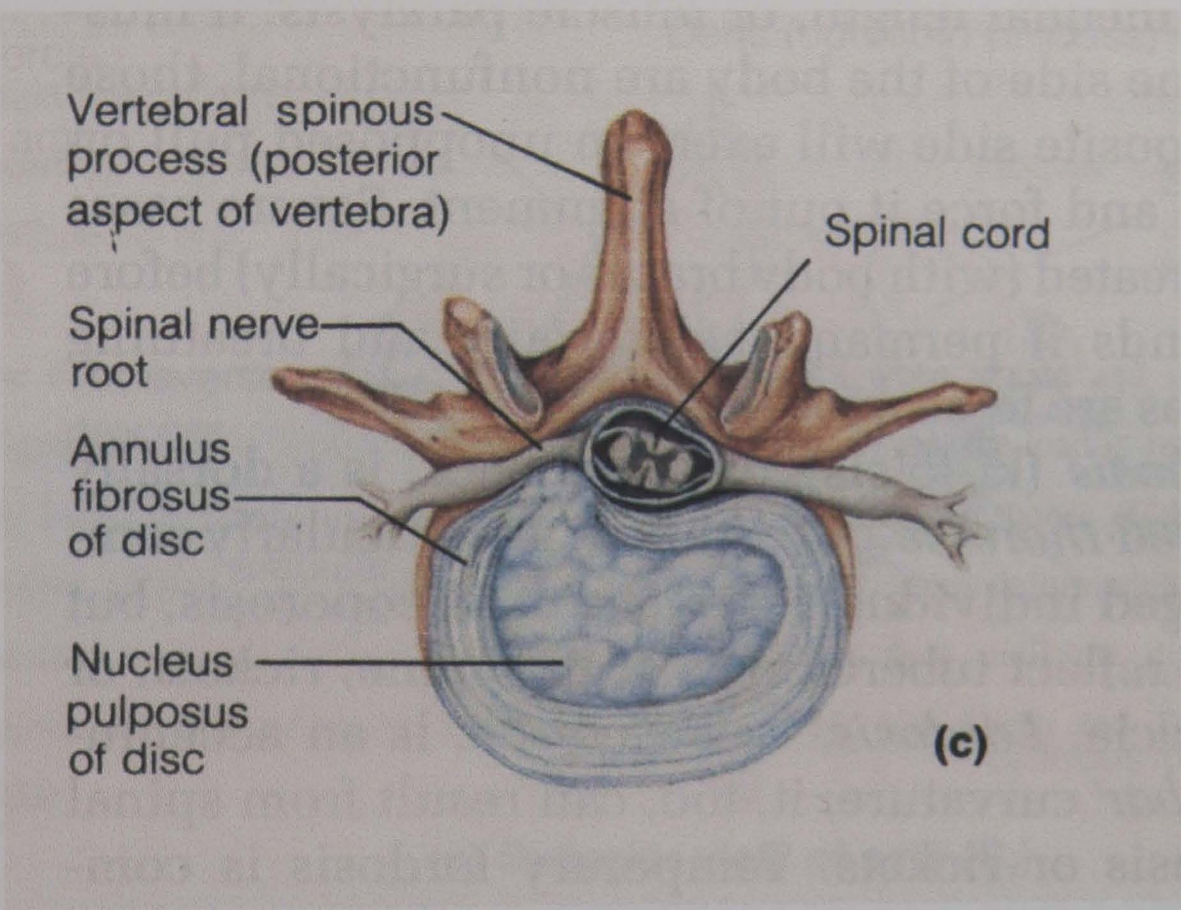

Figure 5. Vertebrae and vertebral disc

The vertebral column accounts for approximately 40% of the total body height, with about 33% of spinal length occupied by the intervertebral discs (Reilly et al., 1984). With no external load acting on the discs, human stature oscillates within the course of a twenty-four hour day, losing height during the active day and gaining height in the supine position of sleep. Total diurnal changes are about 1%. Changes in stature are rapid when changing from one condition to the other with 80% of total height loss occurring within the first three hours of rising and 71% of height regain occurring in the first half of the night (Reilly et al., 1984; Foreman and Troup, 1987; Reilly et al., 1988).

The discs therefore respond elastically, losing height when loaded and regaining height when unloaded for short periods of time. If, however, the load is applied for any length of time, creep occurs in addition to the elastic response (Eklund and Corlett, 1984). The principle of creep refers to a continuous deformation under a constant load and occurs at a decreasing rate over time until the disc is in equilibrium with its load (Eklund and Corlett, 1984; Van Dieën and Toussaint, 1993).

Spinal shrinkage has been used as an indication of spinal load because rate of change in stature has been shown to be directly related to levels of spinal compression (Foreman and Troup, 1987). The relationship between compression forces and shrinkage in axial loading is approximately linear with the slope being dependent on the individual (Van Dieën and Toussaint, 1993). Corlett et al. (1987) indicated that loss in stature was due to the magnitude of lumbosacral compression, levels of postural discomfort and also the perception of exertion.

Equipment utilised in the measurement of spinal shrinkage must be extremely precise as the magnitude of shrinkage due to loading is in the range of millimetres. Eklund (1988) and Troup et al. (1985) indicated a standard deviation of less than 1 mm over 10 measurements was achieved in the determination of body height changes when subjects had adequate training with the measurement procedure. Eklund and Corlett (1984) claimed a standard deviation of 0.63 mm and Leatt et al.

(1985) a standard deviation as low as 0.33 mm. Tyrrell et al. (1985) claimed 'the sensitivity of the method (stadiometry) is, however, fully confirmed and its potential as a method of assessing spinal loading with a variety of ergonomic, occupational and therapeutic applications is assured'. This accuracy is achieved when diurnal variations are accounted for and when, due to the large inter-subject variations, subjects are only compared with themselves and not with each other.

While stadiometry is used to assess one aspect of work load only, the visco-elastic compression of intervertebral discs (Van Dieën and Toussaint, 1993), it has advantages over other possible methods. Most importantly the method is non-invasive, equipment is inexpensive to build and operate and can be utilised in both laboratory and field situations (Eklund and Corlett, 1984). It also creates the possibility to quantify the effects of varying load duration or loading sequences or to assess the effects of different loading factors - posture and whole-body vibration, posture and external loading (Van Dieën and Toussaint, 1993).

It has been questioned whether the observed loss in height is wholly attributed to the compression of the spine and not other soft tissues, most notably the heel pad. Foreman and Linge (1989) indicated that compression of this area of soft tissue averaged 4.4 mm and was therefore a confounding factor in the measurements of stature change. It was concluded that this potential source of error could be eliminated if a 2-min delay was adopted before measurements to allow for the heal pad to compress sufficiently. Eklund (1988) also indicated the lower extremities had little influence. McGill et al. (1996) compared shrinkage of subjects in standing and seated postures and found that there was no difference in stature change when comparing the two approaches. Measurement of 'sitting height' ensures that the spine is isolated; they concluded that changes occurring in stature were a result of spinal compression and not compression of any of the other soft tissues.

Rate of viscous height loss depends on magnitude of the load on the discs (Eklund, 1988). Eklund and Corlett (1984) showed a height decrease of 3.2 mm when shoulders were loaded for 1 hour with 14 kg and a decrease of 1.4 mm without load under the same time duration. Stålhammar et al. (1992) showed subjects lifting 900 kg during 30 minutes averaged a spinal shrinkage of 5 mm. Reilly and Peden (1989) also indicated a significant increase in spinal shrinkage with external loading at 15 kg compared to unloaded with female subjects performing a 10-min repetitive bench stepping task.

The relationship between loss of stature and magnitude of the load appears to be established, but the nature of the loading and its effect on shrinkage have also been investigated. Corlett et al. (1987) reported that repetitive lifting resulted in greater shrinkage than the equivalent static loading. Such repetitive lifting would increase the risk of damage, especially in the afternoon as disc height and therefore shock absorbing capacity has already been diminished (Stålhammar et al., 1989). Dynamic movements may be less instrumental in spinal damage than static work, as activity facilitates movement of fluid in and out of the discs, thus increasing the nutritional supply (Stålhammar et al., 1992).

Whilst the magnitude and type of load are important factors affecting shrinkage and potential back pain, equally important is the initiation of rest periods when the spine is unloaded. Daily alternation between loading and unloading promotes metabolism of intervertebral discs, but the periods of unloading are vital, off-loading being inversely related to loss of stature (Foreman and Troup, 1987). Stålhammer et al. (1989; 1992) showed that height regain was very rapid at the beginning of the rest period and concluded that even short, frequent breaks would be beneficial to aid spinal metabolism Eklund and Corlett (1984) reported fast rates of recovery when subjects were asked to lie down. Tyrrell et al. (1985) reported that height regain was more rapid when subjects lay in Fowler's position compared to post-exercise recovery in a standing position.

3.5.2 Risk assessments; Objective ergonomic risk assessments are used to evaluate which occupational tasks are most stressful and have the greatest potential to cause musculoskeletal problems by outweighing the capabilities of the individual

(Garg et al., 1992). Only when such investigations have been performed can changes to the existing work situation be made. Assessments should not concentrate only on the tasks being performed, but also on the environment in which the tasks are being undertaken and the psychological state of the individual carrying them out.

Numerous risk assessment procedures have been validated. These can be adapted for individual purposes. Risk assessments may be performed instantaneously or recorded on video and analysed later. If the risk assessment is to be completed instantaneously, including a large number of observed factors will reduce the accuracy of the observations (Kilbom, 1994). Training and pilot work must be undertaken to ensure that the risk assessments are reliably completed.

3.6 Epidemiological Evidence for Musculoskeletal Disorders Amongst Physiotherapists

While a wealth of information relating to musculoskeletal disorders in nurses exists, physiotherapists are often neglected in research, possibly because it is assumed that they have superior understanding of body mechanics and in particular back protection (Molumphy et al., 1985). Despite the highlighted sample design bias (considering only graduates of the University of Iowa's Physical Therapy Programme), Bork et al. (1996) showed 61% of the 928 respondents experienced work-related musculoskeletal problems in at least one anatomical site with 45% of these concerning the lower back. This figure compares to 29% of 500 registered physical therapists suffering low-back pain for more than 3 days (Molumphy et al., 1985) and an annual prevalence of 38% shown by Scholey and Hair (1989), a percentage similar to their control group of females in various other occupations.

Scholey and Hair (1989) concluded that either 1) being aware of what to do to avoid back troubles was insufficient, or the techniques employed were not appropriate or not used by the physiotherapists, 2) physiotherapy was a demanding and physically stressful occupation and prevalence rates would be even higher if training was not employed, or 3) back pain occurs irrespective of occupation, training, or life-style so that individuals working in 'heavy' occupations will not always suffer and those in 'light' occupations sometimes will.

As in nursing, lifting and handling patients was cited as a major causative factor. Of those who responded, 83% attributed low-back injuries to direct patient contact with 'lifting with a sudden maximal effort' being a frequently selected mechanism for injury (Molumphy et al., 1985). Bork et al. (1996) showed that 58% of respondents indicated lifting and transferring dependent patients as a most problematic job factor.

While back problems constituted a major proportion of all musculoskeletal disorders, the back is not the only area identified. Musculoskeletal symptoms of the hands and wrists have been linked to exposure to force, repetition, awkward posture and vibration (Atterbury et al., 1996). Armstrong et al. (1987) reported a significant association between signs and symptoms of hand-wrist tendinitis and repetitiveness and forcefulness of manual work. Nearly one third of physiotherapists who responded to a self-administered questionnaire complained of wrist and hand symptoms with those involved in more hours on manual therapy showing higher prevalence rates. Considering all respondents, 6.5% stated they had altered their manual therapy activities due to pain in their hands and fingers (Bork et al., 1996).

Molumphy et al. (1985) stated the initial onset of low-back pain usually occurred in the first 4 years of work, between ages 21 and 30, with the initial onset being less likely with increasing age. The likely cause of this was that experienced physiotherapists tended to move away from direct patient care to more administrative positions. Similar trends concerning age were reported by Bork et al. (1996), whereby prevalence after the age of 50 decreased in the lower back, neck, upper back, wrists and hands, This decreased prevalence with age could not be attributed to changes in duties with the physiotherapists aged over 55 having higher average patient contact hours per week than younger ages. This trend was attributed instead to survivor bias, with older physiotherapists employing numerous coping strategies to offset the physical demands of the occupation. Alternatively it may be a result of a 'healthy worker' effect.

No difference in back pain prevalence rates between males and females was shown by Molumphy et al. (1985). In contrast, females were found by Bork et al. (1996) to have higher prevalence rates than males in all anatomical areas except the knees. This difference was attributed to the women's small size, making them disadvantaged when lifting or transferring larger patients. Female respondents also highlighted the confounding problems of work during pregnancy, especially sciatic symptoms (Bork et al., 1996).

Finally, specific areas of physiotherapy were found to be more hazardous in terms of increased musculoskeletal problems than other areas. Studies showed increased low-back pain in hospital based physiotherapists, especially acute care and rehabilitation facilities, where patients are more dependent and therefore require more lifting and transferring and intensive functional training (Molumphy et al., 1985, Bork et al., 1996). These are also often areas attracting newly graduated physiotherapists due to the variety of clinical experience they offer which may be a contributing factor (Molumphy et al., 1985).

3.7 Epidemiological Evidence for Musculoskeletal Disorders Among Hospital Based Porters

The job of a hospital porter can be assumed to be physically demanding, with elements of lifting, pushing, pulling and long periods of standing and walking. Despite this, a review of literature failed to show any reports considering musculoskeletal injuries in hospital based porters in the United Kingdom.

Evanoff et al. (1999), quoting American Bureau of Labour Statistics for 1995, reported that nursing aids and orderlies ranked third among all occupations in the number of days lost to injuries for that year. They also stated that nursing aids and orderlies were at a higher risk of work-related injuries than healthcare workers as a whole. Unfortunately statistics for orderlies alone were not given. While the exact job description may vary between American orderlies and porters within the United Kingdom, the tasks are assumed to be similar. Hospital porters in this country may be at a similarly high risk of suffering musculoskeletal disorders.

3.8 Overview of the Literature

Musculoskeletal disorders, especially problems of the lower back, continue to plague the working population of the western world. Experiencing a musculoskeletal disorder can constitute considerable stress for those individuals suffering symptoms, and a significant financial burden for their employers. Nurses are one group of employees who are particularly at risk from suffering back problems and research indicates that they also suffer from other musculoskeletal disorders. Little information exists regarding the musculoskeletal disorder problem experienced by physiotherapists and hospital porters.

The study of musculoskeletal disorders is difficult because of two factors. Firstly, musculoskeletal pain is often idiopathic, having no obvious underlying pathology. Secondly, the cause of a musculoskeletal disorders is usually multi-factorial, including occupational and non-occupational factors, social factors and personal factors both relating to the individual's present status but also cumulative stresses over many years. Despite these difficulties, this thesis aims to provide a better understanding of musculoskeletal disorders experienced by the healthcare professionals mentioned above.

4.0 Epidemiological and Ergonomic Investigations of Musculoskeletal Disorders Among Nurses and Physiotherapists

4.1 Epidemiology of Musculoskeletal Disorders: A Cross-Sectional Survey of Nurses and Physiotherapists

4.1.1 Introduction

Nursing is frequently cited as an occupation with a high risk of back problems (Hildebrandt, 1995) constituting a huge financial burden and long periods of sickness absence from work. Whilst there has been a plethora of studies concerning back pain within the nursing profession, this area of research is rarely expanded to include other anatomical sites where symptoms of the musculoskeletal system may be evident. Only recently have other healthcare professionals been cited in the literature on musculoskeletal disorders and studies are mainly limited to the consideration of physiotherapists only. Bork et al. (1996) found 61% of the 928 physiotherapist respondents experienced work-related musculoskeletal problems in at least one anatomical site, with 45% of these concerning the lower back. It was also indicated that one third of physiotherapists complained of wrist and hand symptoms.

In order to quantify the prevalence of various musculoskeletal disorders and to enable comparisons to be made between the nursing and physiotherapy professions, comprehensive epidemiological work must be undertaken. The aim of this study is quantify the musculoskeletal problem experienced by nurses and physiotherapists via a questionnaire and identify some of the possible factors associated with these symptoms. Considering the neck, shoulder and thoracic region of the spine, Björkstén et al. (1999) compared questionnaire responses relating to musculoskeletal symptoms with clinical diagnoses. The authors concluded that the questionnaire was a valid assessment tool.

4.1.2 Methodology

Two questionnaires were designed for the purpose of the study. The questionnaire for nurses and physiotherapists were fundamentally identical to allow valid comparisons to be made between the two occupations. Musculoskeletal disorders were defined as 'injuries or diseases of the musculoskeletal system which may be attributed to work and are characterised by symptoms of pain, numbness or inflammation'. Diagrams of the front and back of the body were included for respondents to indicate the site of their symptoms.

The Nursing Personnel Questionnaire (Appendix 1)

The questionnaire consisted of four sections and 45 questions. Some questions had multiple sub-sections. There was also an additional sheet attached for respondents suffering from more than one musculoskeletal disorder. The four sections detailed 1) general information relating to job characteristics; 2) prevalence of musculoskeletal disorders, symptoms, effect on nursing activities and treatment; 3) work activities and opinions on the work environment, including work psychosocial profile (happiness at work, self-perceived job competency, job aspirations, job satisfaction, work pressure and happiness outside work) (Warr, 1990); 4) personal data (age, height and so on). The second section could be ignored by those not suffering any musculoskeletal problems.

A pilot study was conducted in January 1997 whereby student nurses (n=41) completed an initial form. Minor alterations were subsequently made to the structure of the questionnaire.

The Physiotherapist Questionnaire (Appendix 2)

This questionnaire consisted of the same four sections and included 46 questions in total. Slight alterations were made to the third section after consultation with a senior physiotherapist, and this consultation resulted in the inclusion of an additional question relating to the adoption of bent/stooped postures. All other sections were identical to the nursing questionnaire.

Sample Altogether, 5029 questionnaires were distributed, 4235 to nurses and 794 to physiotherapists. The nurses were recruited from 7 hospitals within the Merseyside area but, in order to obtain an adequate sample, the physiotherapists were selected from 20 hospitals within a larger geographical radius. Nurses and physiotherapists of all grades and specialities were requested to complete the form, irrespective of whether or not they were suffering, or had previously experienced, any symptoms of musculoskeletal disorders.

Distribution Questionnaires were distributed in February 1997. They were sent via post or delivered by hand to the head manager, the superintendent physiotherapist or the personnel department depending on the wishes of each hospital, and the number of questionnaires involved. It was not possible to standardise the distribution. The individual recipient was then responsible for distributing the questionnaires to various departments and wards to obtain a cross-section of the nursing/physiotherapy personnel. Each questionnaire, once completed, could be returned to the distributor to be forwarded en masse, or could be returned independently in an attached addressed envelope. The questionnaire was totally confidential so it was not possible to follow up those individuals who had not completed the questionnaire.

4.1.2.1 Analysis of Data

Data were analysed using the statistical software SPSS (version 6.01). To establish the relationship between two or more categorical variables, chi-squared analyses were used. Logistic regression analysis was used to identify risk factors associated with musculoskeletal disorders (i.e. presence or absence). Initially, those variables most likely to be significantly related to the presence of symptoms were added into the logistic regression analysis. The variables with the least significance were discarded from the analysis and replaced with other variables. All variables were entered into the analysis and discarded if non-significant. In the case of two similar, possibly related variables (for example self-perceived pressure at work and happiness at work), both were entered independently and in combination. If the variable remained significant independently and in combination it remained in the model. Changes in the level of significance for each variable indicated which variable was most strongly related to the presence of symptoms.

4.1.3 Results

Responses to cross-sectional questionnaire A response rate of 44% (n=349) was obtained for the survey of physiotherapists; the questionnaire was completed by 19.3% (n=813) of the nursing personnel sampled. Sixty-four of the questionnaires returned were unsuitable for analysis due to incorrect completion or they included domicillary nursing. The sample characteristics of both populations are shown in Table 2.

Table 2. Sample characteristics of questionnaire respondents (mean ± standard deviation).

		Nurses	Physiotherapists
Age (years)	(mean) (SD	36.5 9.1	33.5 9.7
Sex	(male) (female)	67 705	33 292
Height (cm)	(mean) (SD)	164 8.4	166 13.1
Mass (kg)	(mean) (SD)	66.0 12.9	64.0 9.5
Sample size		774	325

There was no significant difference between the percentage of males and females in the nursing and physiotherapist groups ($p>0.05$). There was no significant difference between the ages of nurses and physiotherapists ($p>0.05$).

The height and weight both differed significantly between the nurses and the physiotherapists. Physiotherapists tended to be taller and concentrated within the 55-65 kg category, compared to nurses who were shorter and had a wider range of body mass (both $p<0.05$).

Epidemiology of musculoskeletal disorders The annual prevalence of musculoskeletal disorders of various locations for nurses and physiotherapists combined was 49%. The point prevalence was 20.7%. Almost half of the sample (42.2%) who had suffered symptoms in the past year were therefore exhibiting symptoms at the time of the questionnaire.

Respondents indicated the site of musculoskeletal symptoms on an anatomical diagram. These sites were grouped into specific areas for analysis; for example, low back, buttocks, hips, pelvis and upper legs were included in one category. The anatomical areas and corresponding percentage of nurses and physiotherapists who had experienced symptoms in the past year are shown in Figure 6.

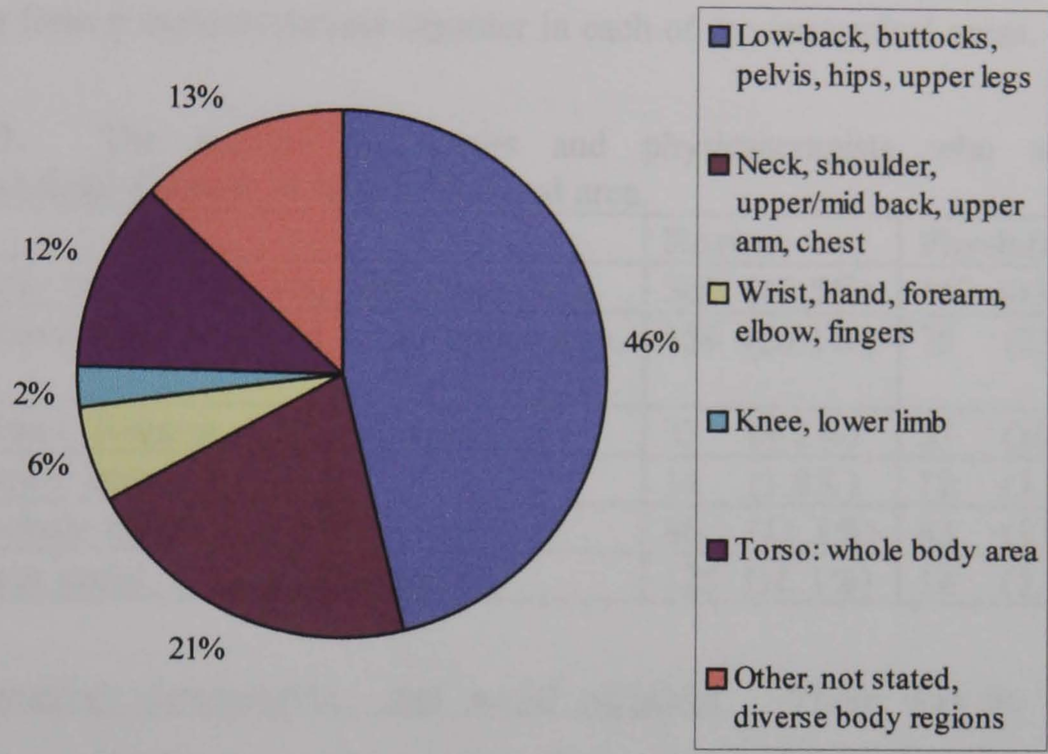

Figure 6. Percentage of nurses and physiotherapist who suffered musculoskeletal disorders in each anatomical area.

There was no significant difference in the relative percentages of nurses and physiotherapists who had suffered a musculoskeletal disorder during the past year ($p>0.05$). The location of disorders did differ significantly ($p<0.05$) between the two samples. Physiotherapists experienced more symptoms relating to the wrist, fingers, hand and forearm, knee and lower limb ($p<0.05$). Table 3 considers nurses and physiotherapists separately and indicates the number of personnel suffering from a musculoskeletal disorder in each of the anatomical areas.

Table 3. The number of nurses and physiotherapists who suffered a musculoskeletal disorder in each anatomical area.

	Nurses	**Physiotherapists**
Low-back, buttocks, pelvis, hips, upper legs	360 (46.5%)	142 (43.7%)
Neck, shoulder, upper/mid back, upper arm, chest	156 (20.1%)	75 (23.1%)
Wrist, hand, forearm, elbow, fingers	33 (4.2%)	35 (10.8%)
Knee, lower limb	14 (1.8%)	12 (3.7%)
Torso: whole body area	86 (11.1%)	43 (13.2%)
Other, not stated, diverse body regions	125 (16.1%)	18 (5.5%)

Anthropometric, demographic, and social variables There was no significant difference in height or weight between those suffering and those not suffering musculoskeletal symptoms. There was also no difference concerning smoking habits, how many units of alcohol they consumed in the average week and their perceived fitness level. There was no significant difference between the ages of nurses and physiotherapists in the sample and an approximately equal percentage of nurses and physiotherapists reported a musculoskeletal disorder ($p>0.05$).

Personnel were grouped into six categories according to their age. Age was found to have a significant effect on the reporting of musculoskeletal disorders ($p<0.05$). Nurses and physiotherapists showed a significantly higher percentage of musculoskeletal disorders between the ages of 30 and 59 than above or below this range (seven subjects being of over 60 despite this being the recognised retirement age). The prevalence of musculoskeletal symptoms was proportionately the greatest for those staff aged between 50 and 59 years.

Absence from work Absence from work due to musculoskeletal symptoms at any time during their working life was indicated by 25% of respondents. In the past year, the mean number of days to be taken off was 1.5 (± 14), but five of the participants had taken more than one hundred days off work, with the maximum duration of absence being 335 days. In total, musculoskeletal disorders accounted for 19% of all absences from all respondents within the previous years.

Perceived causes Regarding their lifetime experiences, 36.4% of respondents with musculoskeletal symptoms could recall a specific causal incident. For 66.7%, the cause indicated was patient handling and lifting. Similarly, of those personnel who attributed their symptoms to continued exposure to a stressor, 'patient handling and lifting' was implicated by 51.3% of respondents.

Medical consultation Respondents were asked to indicate from whom treatment for their musculoskeletal disorder had been received. A general practitioner was consulted by 29% of respondents, a physiotherapist by 9% and these two practitioners in combination by 11%. Other sources of advice included consultant/specialists, complementary therapists (e.g. acupuncturist, chiropractic, osteopath), the occupational physician, the Accident and Emergency department or combinations of these. A significantly small proportion of physiotherapists consulted a medical practitioner regarding their musculoskeletal disorder than nurses did ($p < 0.05$).

Treatment The main treatment prescribed for musculoskeletal disorders was physiotherapy (31%), followed by medication (22%) and these modalities in combination (16%). Surgery had been required by only 3.5% of sufferers and rest alone had been the therapy prescribed for 3% of respondents. Those using complementary therapy (e.g. acupuncture, chiropractic, osteopathy) alone numbered 2%, although 8% had received complementary therapy in combination with other treatment. Following treatment, the symptoms had become less severe for 64% of respondents and 22% had indicated that the musculoskeletal disorder had disappeared. There was no significant difference between the number of physiotherapists and the number of nurses receiving treatment for their musculoskeletal disorders despite fewer physiotherapists consulting a medical practitioner, because more physiotherapists relied on self-treatment, or informal treatment from a colleague.

Occupational Adaptation Symptoms had forced 4% of sufferers to change job/specialities. Over half (56%) of all sufferers had modified the way they performed their tasks to alleviate any discomfort. The main ways of modifying their tasks were to change their technique/posture (23%), to avoid (where possible) carrying out specific problematic tasks (18%) and to seek assistance, either from staff or patients (12%). Again the main tasks in which changes were implemented were mainly concerned with lifting or transferring patients and equipment (54%), but 13% of respondents stated they found 'all tasks' to be problematic and require changes in the way they were performed.

Suitability of work environment The working environment was deemed to be unsuitable by 40% of respondents. Personnel perceived the main problems to be i) a poorly designed work area or space constraints (61%) and ii) unsuitable equipment. The regular performance of overhead tasks was indicated by 40% of the whole sample, with cupboards/shelving (33%) and medical attachment (21.5%) cited as the main reasons for this action.

Lifting and patient handling It was indicated by 92% of nurses that they were involved in the lifting and handling of patients. Three quarters (n=380) of those individuals carried out less than 10 manual transfers per shift without the use of any assistive devices, and one-quarter (n=127) carried out more than 10 transfers, with the maximum per shift indicated as 60. This value was comparable to the number of lifts that physiotherapists performed without the use of assistive devices (77% less than 10 per shift and 23% more than 10 per shift).

The reasons given for not always using assistive devices differed between the nurses and physiotherapists. Nurses indicated that assistive aids were not always available/appropriate (49%) or not required (42%). Physiotherapists also rated these reasons highly, 21% and 31% respectively, but 28% of respondents felt the main reason was that lifting and manually transferring patients were part of the rehabilitation process, with patients encouraged into normal functioning requiring manual assistance in movement.

Predictive variables for musculoskeletal disorders The results of the logistic analysis are given in Table 4. The risk of incurring a musculoskeletal disorder increased by 6% for every unit increase in perceived work pressure, and by 13% when the staff felt their work often involved repetitive tasks. High risk and low risk specialties were identified and are illustrated in Table 6 and Table 8 for nurses and physiotherapists respectively.

Table 4. Variables in overall logistic equation for musculoskeletal disorders (nurses and physiotherapists combined).

Variable	B	S.E.	df	p<	Esp(B)
Perceived work pressure	0.062	0.014	1	0.001	1.064
Performance of repetitive tasks	-0.140	0.067	1	0.038	0.870
Work specialty	-0.323	0.068	1	0.001	0.724
Constant	1.357	0.314	1	0.001	

All variables except work specialty are all arbitrary units. 'B' are the coefficients of the logistic regression model (Norusis 1994).

Predictive variables for musculoskeletal disorders in nurses Logistic regression analysis considering nurses only is given in Table 5.

Table 5. Variables in logistic equation for musculoskeletal disorders (nurses only).

Variable	B	S.E.	df	p<	Exp(B)
Perceived work pressure	0.066	0.017	1	0.001	1.069
Work specialty*			1	0.001	
Specialty (1)	-0.617	0.123	2	0.001	0.540
Specialty (2)	-0.098	0.112	1	0.380	0.906
Age (years)	0.031	0.009	1	0.001	1.031
Constant	-2.451	0.489	1	0.001	

* Initial logistic regression analysis indicated specialties below -0.04, between -0.04 and +0.04 and above +0.04. These 3 groups were used in subsequent analysis.

The risk of nursing staff suffering musculoskeletal disorders increased by 7% for every unit increase in perceived work pressure, and 3% for each yearly increase in age. A low risk group of specialties was identified and nurses working in these specialties were 46% less likely to incur symptoms than those in the other included specialties. This is shown in Table 6.

Table 6. Low and high risk specialties for musculoskeletal disorders in nurses only.

High risk specialties	**Low risk specialties**
General medicine	Surgery
Orthopaedics	Paediatrics
Theatre/recovery	Care of the elderly
Intensive care	Psychiatry/mental healt
Accident and emergency	Out patients
Oncology	Dermatology
E.N.T.	Haematology
Plastics/burns	
Rheumatology	
Spinal injuries	
Respiratory care	
Rehabilitation	
Coronary care	
Midwifery/obstetrics/gynaecology	
Renal/urology	

Predictive variables for musculoskeletal disorders in physiotherapists The logistic regression analysis considering physiotherapists only is given in Table 7.

Table 7. Variables in logistic equation for musculoskeletal disorders (physiotherapists only).

Variable	**B**	**S.E.**	**df**	**p<**	**Exp(B)**
Regular stooped posture	-0.267	0.117	1	0.023	0.766
Work specialty	-0.614	0.214	1	0.004	0.541
Constant	-0.536	0.215	1	0.013	

Those physiotherapists whose work required the regular adoption of stooped positions were 23% more likely to suffer musculoskeletal symptoms than those who answered no to this question. Those personnel working in the identified high risk specialties had a 46% greater likelihood of incurring musculoskeletal symptoms. These specialties are listed in Table 8.

Table 8. High and low risk specialties for musculoskeletal disorders in physiotherapists.

High risk specialties	Low risk specialties
General medicine	Surgery
Paediatrics	Intensive care
Orthopaedics	Accident and emergency
Care of the elderly	Oncology
Psychiatry/mental health	Coronary care
Out patients	Spinal injuries
Burns and plastics	
Midwifery/obstetrics/gynaecolog	
Neurology	
Rheumatology	
Respiratory care	
Rehabilitation	
Musculoskeletal	

In all the above analyses, the anthropometric data had no significant predictive value. Age, smoking, alcohol consumption and fitness level were also not significant indicators. The number of lifts performed did not have overall significance when the nurses and physiotherapists were considered independently. The number of lifts performed by nurses and the years in the job showed some significance, but this result was not independent, with the significant effect of one variable being eliminated when the other was included. The age of the nurse remained a significant predictor in all analyses, so was deemed to be a more important indicator than the number of years in the job.

Predictive variables for low back pain (nurses and physiotherapists combined) The logistic analysis is given in Table 9.

Table 9. Variables in logistic equation for low back pain (nurses and physiotherapists combined).

Variables	B.	S.E.	df	p<	Exp(B)
% of time on feet in shift	-0.012	0.005	1	0.013	0.989
Perceived work pressure	-0.075	0.017	1	0.001	0.928
Job aspiration/motivation	0.121	0.029	1	0.001	1.129
Perceived work happiness	-0.025	0.010	1	0.016	0.976
Constant	3.275	0.556	1	0.001	

The risk of nursing and physiotherapy staff suffering from low-back pain increased by 1% for every percentage increase in the time they spent on their feet during the course of an average shift. The psychological well-being of the individual also had predictive qualities. The risk increased by 7% for each unit increase in work pressure, and by 2.5% for each unit increase in work happiness. Conversely, the risk decreased by 13% for each unit increase in job aspiration.

Predictive variables for low back pain (nurses only) The results of the logistic regression analysis are given in Table 10.

Table 10. Variables in logistic equation for low back pain (nurses only).

Variables	B.	S.E.	df	p<	Exp(B)
Job aspiration/motivation	0.125	0.035	1	0.001	1.134
% of time on feet in shift	-0.016	0.007	1	0.013	0.984
Perceived work happiness	-0.028	0.012	1	0.023	0.972
Perceived work pressure	-0.094	0.021	1	0.001	0.910
Constant	4.163	0.750	1	0.001	

The risk of the nurses suffering from low-back pain decreased by 13% for every unit increase in job aspiration. The risk increased by a small percentage with increased time spent on their feet by the nurses, increased happiness at work and increased job pressure.

Predictive variables for low back pain (physiotherapists only) The results of the logistic analysis are shown in Table 11.

Table 11. Variables in logistic equation for low back pain (physiotherapists only).

Variables	B.	S.E.	df	p<	Exp(B)
Work specialty			2	0.001	
Specialty (1)	0.717	0.415	1	0.084	2.048
Specialty (2)	0.208	0.275	1	0.449	1.231
Constant	1.711	0.227	1	0.001	

The only risk variable of predictive value for low-back pain in physiotherapists was the specialty in which they worked.

In the above analyses of low-back pain, the anthropometric data and the variables considering the psychosocial status of the individual outside work again had no predictive value. Carrying out manual lifts and the number of manual lifts performed by the nurses and physiotherapists were also not significant indicators of the prevalence of low-back pain.

4.1.4 Discussion

Response rate The questionnaires were distributed to head managers, the superintendent physiotherapist or the personnel department. This targeted individual was then responsible for forwarding the questionnaires to various heads of specialties and from there to the staff. It was not possible to record the number of questionnaires which had been sent to the hospital but not distributed to the staff due to questionnaires being lost or left over due to over-estimation of the number of staff in each specialty. It is therefore possible that fewer questionnaires than stated actually reached staff which can partially account for the seemingly low response rate from the nurses. Financial restriction dictated that enclosing pre-pain envelops for the return of questionnaires was not possible and staff may have been reluctant to return the completed questionnaire to their manager.

Prevalence of musculoskeletal disorders and sickness absence The annual prevalence of musculoskeletal disorders was 49% and the point prevalence was 20.7%. Considering only low-back pain in nurses, Stubbs et al. (1983a) quoted an annual prevalence of 43% and Burton et al. (1997) an annual prevalence of 36.9%

which are higher than the 22.5% annual prevalence for the lower back area in this study. However, the present study considered different regions of the back separately so comparisons with other studies are difficult. An annual prevalence and point prevalence of 38% and 14% respectively have been reported by Scholey and Hair (1989) for low-back pain in physiotherapists. Figures relating to other areas of the body affected by musculoskeletal disorders are harder to find and vary greatly according to the methodology employed.

The literature suggests nursing is a profession with a high risk of back problems (Hildebrandt, 1995) but the results of this study indicate that nurses are at a high risk of musculoskeletal disorders in general. There was no significant difference in the relative percentage of nurses and physiotherapists who had suffered symptoms during their working life, indicating the problem is of the same magnitude in the physiotherapy staff as nursing staff, despite physiotherapists being a group seldom studied (Molumphy et al., 1985).

Symptoms in the lower back, buttocks, pelvis, hips and upper legs accounted for the majority of problems; 46.3%. Physiotherapists were found to suffer significantly more symptoms than nurses relating to the wrist, fingers, hand and forearm and the knee and lower limb. This confirmed the findings of Bork et al. (1996) that nearly one third of the physiotherapists studied complained of wrist and hand symptoms. These symptoms were thought to be associated with prolonged manual therapy, for those involved in the most hours of manual therapy activities showed higher prevalence rates.

The magnitude of the problem is evident when sickness absence is considered. Of the respondents suffering musculoskeletal symptoms, 25% had indicated time off work, and musculoskeletal disorders accounted for 19% of all sickness absences of all staff surveyed within the previous year.

Risk factors within the profession Regarding the lower back alone, Ready (1993) identified certain high risk nursing wards as being associated with the greatest risk of injury. Vasiliadou et al. (1995) and Owen (1986) showed the risk of injuries was greater in specialities requiring the performance of physically demanding tasks. However, Harber et al. (1985) indicated no such difference believing that nurses with symptoms would 'select' themselves out of particularly detrimental roles, and that all nursing carried some 'dangerous' component.

High and low risk specialties were identified, with nurses and physiotherapists being at a significantly higher risk of suffering musculoskeletal disorders if working within one of the high risk groups. Considering only the nurses, those working in surgery, care of the elderly, paediatrics, psychiatry/mental health, out patients, dermatology and haematology were 46% less likely to incur symptoms than staff working in other specialties. All other specialties were considered higher risk. Considering only physiotherapists, low risk specialties were surgery, intensive care, accident and emergency, oncology, coronary care and spinal injuries and again staff were 46% less likely to suffer symptoms when working in these areas.

Despite some specialties being identified as high risk for both nursing and physiotherapist staff, the differences between the groups reflect the heterogeneous nature of the two occupations. Caution should be exercised in relating the results of nurses to healthcare personnel in general. Specialties concerned with mobile patients, for example dermatology, haematology and out-patients, may be expected to feature in the low risk group with minimal staff assistance being required. The varied nature of those specialties constituting the high risk group also indicate the magnitude of the musculoskeletal problem, as it is not only in the departments where increased manual handling may occur that nursing and physiotherapy staff are at risk. This finding supports the view that it is not patient handling alone that constitutes a risk for the onset of musculoskeletal symptoms. Harber et al. (1987b) found that nurses actually performed more non-patient contact actions than patient contact actions and were frequently required to lift, pull, push and manipulate other objects often weighing more than 27.3 kg.

While speciality appeared to be an important risk factor, the grade of work did not have significant influence on musculoskeletal prevalence with all grades being equally affected. This observation contradicts the results of McGuire et al. (1995) who concluded that more untrained (auxiliary) nurses had time off work than other groups because this group was engaged more in 'heavy' work and increased manual handling.

Mercer (1979) showed nurses to have a short stay occupational profile, with 37% of the nurses studied being in their current post for less than 1 year. When correlating musculoskeletal disorders with speciality or grade, the cumulative effects of previous work may therefore be a cumulative factor and can not be ignored. Longitudinal research work may potentially overcome this problem.

The number of years working within the healthcare profession had previously been highlighted as significant. Specifically referring to back pain, Adams (1996) stated that newly qualified/trained nurses were most at risk from injuries because their intervertebral discs had had insufficient time to 'catch up' with strengthening muscle and bone. It could therefore be argued that an initial period of physical learning and strengthening is required before the staff have increased protection from symptom onset. Pain in the arm and neck has also been associated with the number of years in the job (Engels et al., 1996). Leg and back pain was not associated with years at work but this finding may be due to the 'healthy worker effect', with those suffering leg and back pain leaving the profession because their symptoms are more debilitating (Engels et al., 1996). Other researchers have found no association between the number of years in the healthcare profession and pain in the neck and shoulders, but there was a 'tendency' towards an association between years of work and low-back pain (Ahlberg-Hulten et al., 1995).

The number of years working in the profession did not have a significant predictive value for annual prevalence, but the age of symptomatic and asymptomatic individuals was significantly different ($p<0.05$). Nurses and physiotherapist showed a higher percentage of musculoskeletal disorders between the ages of 30 and

59, and particularly between 50 and 59 than staff at the higher or lower age spectrum. The logistic analysis also highlighted age as a significant risk factor for the prevalence of musculoskeletal disorders in the nursing group only, with nurses having a 3% increase in risk for each yearly increase in age.

The above analysis would appear to suggest the importance of the relationship of work and a physiological ageing response to be responsible for the occurrence of symptoms, with time spent working in the job having less relevance. Vertebral discs are known to weaken with time (Hsiang et al., 1997). If this was true, it would be expected that the over-60 category would have more individuals with, than without musculoskeletal problems, which was not shown. This finding may be due to the limited number of subjects within this age category, poor recall of distant memories required when completing the questionnaire, or potentially the healthy worker effect in which individuals susceptible to musculoskeletal problems had left the profession before reaching the age of 60, leaving only those with low susceptibility within this age category.

Medical consultation and treatment profiles Only 29% of sufferers had consulted a medical practitioner concerning their musculoskeletal disorder. The Royal College of Nursing (1979) (cited by Stubbs et al., 1983a) is quoted as saying that back pain "has been and still is regarded as an occupational hazard of nursing" It would appear that this view still prevails, with few nurses and physiotherapists seeking help. The general practitioner (G.P.) was the service most often used, followed by a physiotherapist and these two methods in combination. The hospital occupational health department was rarely visited as the only source of treatment, but was more often used in combination with other methods. Complementary therapy (e.g. acupuncturist, chiropractic, osteopath) appeared to be an attractive alternative for many sufferers.

A significantly smaller number of physiotherapists compared to nurses consulted a medical practitioner ($p < 0.05$). It is conceivable that many physiotherapists rely on self-treatment or treatment from a colleague on a more informal basis than formally visiting a practitioner, having the knowledge and expertise to do so. In such cases, a medical practitioner may only be consulted in more severe cases.

Physiotherapy was the major treatment prescribed, followed by medication and the two in combination. Commonly, individuals took analgesics to reduce the pain without seeing the doctor and returned to work with no sickness absence. Surgery had actually been required by 3.5% of respondents. There was no significant difference in the number of nurses and physiotherapists receiving treatment ($p<0.05$), confirming the premise that physiotherapists were often relying on self-treatment. Treatment seems to be successful in most cases, with 64% of respondents indicating their symptoms were less severe, and 22% indicating they had disappeared completely following treatment. The remaining 14% constitutes those individuals with chronic and recurring problems and indicates the problem faced in treatment of a group of disorders where a cure is still not available and physiological cause unknown.

Precipitating factors (physical) Considering individuals' experiences of musculoskeletal disorders, 36.4% of respondents suffering musculoskeletal symptoms could recall a specific causal incident. Of these individuals, 'patient handling and lifting' was stated as the cause by 66.7%. Of those personnel who could not attribute their symptoms to a single incident, but rather to continued exposure to a stressor, 'patient handling and lifting' was implicated by 51.3%.

Patient handling is frequently cited as the most common cause precipitating a period of low-back pain in both nursing (Jensen, 1990) and physiotherapy (Bork et al., 1996). Subjective ratings from nurses have been taken which indicate that patient handling and transferring tasks have the highest stress scores, both in terms of the hardest and most frequent tasks (Owen and Garg, 1989; Smedley et al., 1995).

There has been little attention given by researchers to the role of lifting and patient handling and the onset of other musculoskeletal disorders and this present study failed to draw a connection between these types of task and musculoskeletal problems. Of the nursing group, 92% indicated that they were involved in 'patient lifting/manual handling'. Considering both nurses and physiotherapists, approximately three-quarters of those involved carried out less than 10 manual lifts per shift without the use of assistive devices and about one-quarter carried out more than 10 per shift.

A multitude of assistive devices have recently been introduced into hospitals to reduce the physical effort of manual handling (Bell et al., 1979). Again, numerous reports have advocated the benefits of such devices (Hofmann et al., 1994; Smedley et al., 1995; Zhuag et al., 1999), but this current work demonstrates manual handling still occurs. Nurses indicated that assistive aids were not always available/appropriate (49%) or not required (42%). Physiotherapists highlighted the same reasons as being important, 21% and 31% respectively, but 28% of respondents felt the main reason was that manual handling was an important part of patient rehabilitation, with patients encouraged to bear weight with manual assistance from the physiotherapist. McGuire et al. (1995) showed similar results, with 60.5% of the respondents to the nursing questionnaire admitting not using aids in all appropriate situations. The main reason was unsuitability to the task. This would appear to suggest that the installation of aids and the training of staff are not necessarily sufficient, and that the situation must be considered more closely to ensure aids are appropriate for the varying demands of the departments and that staff are able to see their value. Garg et al. (1992) showed that transfers using mechanical hoists were slower than manual transfers, requiring an extra 65 minutes per shift, or 14% of the work shift, to perform the same work tasks. The additional time required when using aids can only be compensated for by increased staffing levels.

Despite the focus of much research on lifting and patient handling and its accepted detrimental affect, this study failed to identify lifting as having a predictive value for the onset of musculoskeletal disorders when the associated factors were entered into the logistic regression analysis. The number of lifts performed was entered into the analysis of both general musculoskeletal disorders and low-back pain specifically, and failed to yield significant results. The number of lifts per shift performed by nurses only and the years in the job showed some predictive significance for musculoskeletal disorders in general, but this result was not independent, with the significance of one variable being eliminated when the other was included. As mentioned, age remained a significant predictor in all analyses, so was deemed more important than these two associated factors.

It is conceivable that lifting and manual handling have become such popularly accepted causes of back injuries that healthcare personnel and researchers alike have until now seen no cause to explore these factors in more detail or other potential causes. Garg et al. (1991) showed that pulling the patient with a sling or belt resulted in significantly lower forces in the erector spinae and compressive forces at L5/S1 compared to lifting. In many analyses, this activity would still be labelled manual handling so the precise detrimental actions/methods of handling could not be ascertained.

Static actions (defined here as being postures held for more than 30 seconds) have been shown to occur in nursing almost as commonly as dynamic actions. The association between cumulative stress from the maintenance of static postures and back pain was demonstrated by Kumar (1990) with job assessments showing load to be greater in back pain sufferers than non-sufferers. Interestingly, this research showed those physiotherapists whose work regularly required the adoption of stooped positions were 23% more likely to suffer musculoskeletal symptoms than those who gave a negative response to this question. This was the only variable showing predictive value for the physiotherapy group except for the specialty in which they worked. Garg et al. (1992) indicated that many nursing tasks entailed bent over postures and ensuing fatigue of back muscles. It was suggested that transferring a patient immediately afterwards could be especially detrimental. This question was not included within the questionnaire for nurses as it was deemed more specific to physiotherapy work than nursing tasks, so comparisons can not be drawn. It is nevertheless interesting to identify its relative importance among the physiotherapists compared to the lack of statistical significance shown by the lifting variables.

Staff who felt their work often required the performance of repetitive tasks were 13% more likely to suffer a musculoskeletal disorder than those who answered 'no' to this question. In this case, repetition is unlikely to mean highly repetitive tasks with a short task cycle (for example assembly line work where task cycles can be approximately 30-seconds). It is more likely to mean the repeated performance of a task throughout the day, such as stripping and re-making beds, toileting patients or re-dressing wounds. The association between repetition of tasks and musculoskeletal disorders may therefore be due to some 'dangerous' component of the tasks that is being repeated. Repeatedly assisting patients to the toilet involves manual handling and dressing wounds entails static trunk flexion, both of which increase the risk of suffering a musculoskeletal disorder.

When considering the working environment, 40% of respondents deemed it to be unsuitable for the completion of required tasks. The main problem cited was a poorly designed work area or space constraints (61%). An example of a nurse working in a cramped space is given in Figure 7. Bathrooms, especially in older hospitals, are often cramped because considerable amounts of equipment, including a hoist, are required for use in a small space.

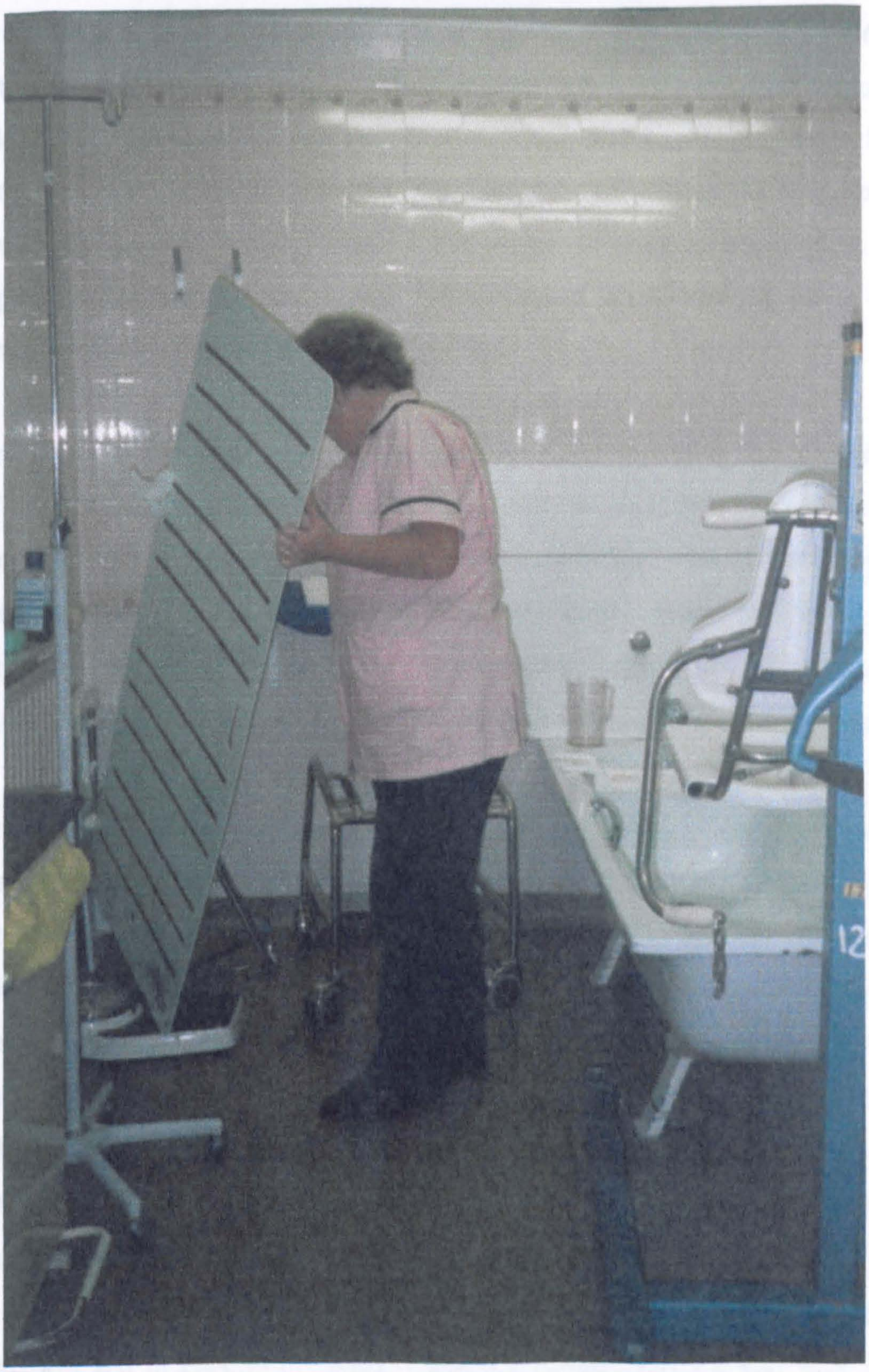

Figure 7. An example of a nurse working in a confined space

The problem of space has been reported in other studies (Engels et al., 1996), with limited space between the beds being reported by 41% of questionnaire respondents. Lack of space compounds the problems of lifting and handling patients because optimum lifting positions can not be assumed, and trunk twisting becomes increasingly necessary (Blue, 1996). It is important to recognise the need to address design of space and equipment, not just implement lifting devices which are not appropriate to the situation (Garg et al., 1992).

As mentioned, the other potential precipitating factor regarding the physiotherapy staff was the involvement in manual therapy. Bork et al. (1996) believed this to be responsible for the increased percentage of musculoskeletal problems relating to the wrist and hands. Physiotherapists had significantly more problems in this anatomical area than the nurses, and the subsequent ergonomic risk assessment of the work environment should shed light as to the possible causes of this finding.

Low-back pain in the nursing personnel was significantly associated with the percentage of time on the feet within a working shift. This was not significant when musculoskeletal disorders in general were considered, so prolonged standing must be somehow detrimental to the back only. Prolonged standing/walking, may increase the rate of natural spinal shrinkage; shrinkage refers to the process by which fluid is expelled from the nucleus pulposus when the compressive loads on the discs exceed the interstitial osmotic pressures of the discs' tissues (Helander and Quance, 1990; Van Dieën and Toussaint, 1993). The result is damage to the end-plates, leading to irreversible loss in disc height (Stålhammar et al., 1989), further disc degeneration and stiffness. Bulging on the annulus decreases the distance to nerve roots and increases the probability of nerve root pressure and pain (Eklund and Corlett, 1984). Prolonged standing is likely to accentuate this process, and the situation will be compounded if the individuals are increasing the compressive forces acting on the spine by undertaking further physical activity or the adoption of postures which load the spine. Alternatively, prolonged standing results in strain on ligaments, with the accompanying muscular contraction leading to fatigue, strain and discomfort (Blue, 1996).

Spinal loading may potentiate back pain, but the resultant spinal shrinkage can quickly be reversed with the initiation of rest periods where the spine will be unloaded, with off-loading being inversely related to loss of stature (Foreman and Troup, 1987). Gains in stature are very rapid at the beginning of rest periods so even short, frequent breaks would be beneficial to aid spinal metabolism (Stålhammar et al., 1989 and 1992). Eklund and Corlett (1984) showed that lying down and adopting the Fowler position induced greatest increases in stature.

Taking short but frequent breaks and lying down for a period whilst at rest may be beneficial, if possible, in reducing back pain in the nursing staff. It may also be beneficial for the nurses to perform tasks sitting down where possible. Such measures may help reduce the likelihood of back pain due to spinal loading.

Precipitating factors (psychosocial) As musculoskeletal disorders are multi-factorial in nature, it is no longer adequate to consider only the biological and biomechanical aspects of the occupation. An increased focus on psychosocial characteristics of the individual, both relating to work and general life, is essential if the whole picture is to be understood. Cox (1993) defined psychosocial hazards as 'aspects of job content, work organisation and management and of environmental, social and organisational conditions which have the potential for psychological and physical harm'. Work was felt to be a stressor when the demands could not be matched by the individual's capabilities, especially when the individual has little control and support.

This present study indicated that the psychological variables proved to be the most useful set of factors in predicting those individuals likely to report both musculoskeletal disorders and low-back pain specifically. Work pressure was especially important, having significance in the overall analysis of musculoskeletal disorders and low-back problems both for all subjects and when nurses were analysed independently. The risk of incurring a musculoskeletal disorder increased by 7% for nurses with every unit increase in work pressure, and the risk of sustaining an injury to the low-back region increased by 9%. These results were highly significant. This variable had no predictive value for the physiotherapists, again highlighting the danger of generalising nursing results to other healthcare professionals. The importance of the psychological factors has been reported in other studies (Engels et al., 1996). Multivariate analysis indicated that aspects of work pressure were associated with all three musculoskeletal disorders studied but ergonomic aspects (i.e. poor layout of ward, non-height adjustable beds and so on) were not. However, Engels et al. (1996) also reported that musculoskeletal disorders were associated with physical work load, so the psychological factors were not solely responsible for the presence of symptoms.

Psychological demands, such as are implicit in high work load and high work pressure, may be associated with emotional states such as stress and worry, thought to cause an increase in adrenaline hormone levels and increased muscle tension through calcium mediated muscle contractions. Ohlsson et al. (1994) related work overstrain and resultant muscle tension to disorders of neck and upper limb in females working in the fishing industry. Leino and Hanninen (1995) reported similar results when mental overstrain was considered in workers in the metal industry. Physiotherapists were used to eliminate subjective findings. The authors found no association between musculoskeletal disorders and physical work load and concluded that the psychosocial factors were more related to morbidity than physical factors. The stress induced theory would only account for muscular pain and not pain relating to the skeletal or nervous systems

Staff with increased perceived work pressure may be more likely to perform tasks hurriedly, possibly resulting in accidents or falls and musculoskeletal problems. Of those nurses and physiotherapists who could recall a specific causal incident, 7.5% indicated a fall to be responsible. Staff working hurriedly, may also be less likely to take the extra time involved in the implementation of assistive devices and therefore move patients manually. The extra time involved in using assistive aids was the reason given for lifting manually by only 1.2% of nurses and the same percentage of physiotherapists. However, it may only take one manual patient transfer to damage vertebral structures.

Job aspirations and happiness at work were also seen to be significant indicators for low-back trouble for the nursing population. Those nurses with higher job aspiration were less likely to suffer low-back pain. It may be that nurses highly motivated to move up the professional hierarchy would be less likely to notice slight musculoskeletal problems with more of their time devoted to improving their nursing skills. Alternatively, nurses already suffering symptoms which they perceive to be work related may be more disillusioned with the occupation and less motivated to improve their job status.

Increased happiness at work was related to an increased risk of nursing staff suffering low-back pain, although this variable was not as highly significant in the analysis as work pressure or the percentage of time spent on the feet. It is possible that 'happiness' refers to mood state in which nurses could be more care-free and more vulnerable to musculoskeletal damage as a consequence of lack of concentration for personal welfare.

Finally, caution must be exercised in attributing causation from results of the logistic analyses. It is just as conceivable that respondents have low job aspirations and little desire to move up the professional hierarchy because a musculoskeletal disorder is reducing their enjoyment of their job, as it is that low aspirations may be a predictive cause of symptoms. This possibility is true for perceived work pressure, with musculoskeletal problems being responsible for, or a result of, increased work pressure. Longitudinal work should assist in determining the direction of the causal chain.

In addition to individual psychological variables, personal characteristics and social background are thought to be equally important in the potential development of musculoskeletal symptoms. The incidence of certain musculoskeletal disorders is reported to be higher in females than males (Ekberg et al., 1994; Bernard et al., 1994; Hagberg et al., 1995). Additionally, height, strength/fitness and body mass (in terms of obesity) have also been thought to increase the risk of occurrence (Arad and Ryan, 1986; Frymoyer and Cats-Baril, 1987; Mäkelä et al., 1993), but the evidence is far from conclusive. Engels et al. (1996) reported no correlation between self-reported musculoskeletal complaints in nurses and gender, body mass index and height. When entered into the logistic regression analysis of this study, gender and anthropometric data were not significantly associated with the presence of symptoms.

Other factors thought to be associated with increased musculoskeletal problems are smoking (Niedhammer et al., 1994), alcohol consumption (Ready et al., 1993) and mechanical vibration (Niedhammer et al., 1994). When considering the connection between smoking and vibration to musculoskeletal disorders, conclusive evidence is somewhat lacking and again, the cross-sectional design of many studies makes the attribution of causality impossible. The social and individual factors examined in the present study failed to show any predictive value. Smoking, alcohol consumption, fitness level, commuting distance and suffering from metabolic diseases were all entered into the logistic equation and all failed to show any significant results to support a positive connection. In the case of smoking, Owen (1986) found no difference between smokers and non-smokers and back pain, but the injured group smoked on average 23 per day and the non-injured smoked only 10 per day. The detrimental effects may therefore be attributed to the amount smoked and this work only considered yes/no responses to smoking. Happiness outside work was also not significantly related to the presence/absence of a musculoskeletal disorder or low-back pain.

4.1.5 Conclusions

The main observations from this study were:-

- The annual prevalence of musculoskeletal disorders was 49% and was the same for nurses and physiotherapists.
- Symptoms relating to the lower back, buttocks, pelvis, hips and upper legs accounted for the majority of problems.

- Physiotherapists suffered more symptoms relating to the wrists, hands, fingers and forearm and the knees and lower limb.
- 'Patient handling and lifting' was identified as the main perceived cause of musculoskeletal disorders.
- Physiotherapists suffer musculoskeletal symptoms if their work regularly required the adoption of stooped postures.
- Nurses who stated a high perceived work pressure had a higher musculoskeletal and low-back pain prevalence than those who stated a lower perceived work pressure.

Longitudinal work is required in this area to address the problems of causality which can not be identified using cross-sectional research. The next section of this thesis considers musculoskeletal disorders over a 20-month period to clarify some of the associations reported in the present study.

4.2 Epidemiology of Musculoskeletal Disorders: A Longitudinal Survey of Physiotherapists

4.2.1 Introduction

The cross-sectional design of most epidemiological studies makes the attribution of causality between two linked factors impossible. Longitudinal data collection is less frequently undertaken because of the time, and therefore cost, involved but allows the direction of cause to be established. The aim of this study was to identify the direction of causality between factors shown to be associated in the detection of musculoskeletal disorders in the cross-sectional questionnaire.

4.2.2 Methodology

The longitudinal questionnaire was similar to the cross-sectional questionnaire in the previous section (4.1) except for the omission of questions which elicited information which could not be different from the first questionnaire, such as the sex and age of the subject. The questionnaire consisted of thirty-eight questions with some questions having multiple sub-sections. Like the cross-sectional questionnaire, the questions were divided into four sections detailing 1) general information relating to job characteristics; 2) prevalence of musculoskeletal disorders, symptoms, affect on job activities and treatment; 3) work activities and opinion on the work environment, including work psychosocial profile; 4) personal data. This questionnaire is included in Appendix 3.

<u>Sample</u> The physiotherapists all worked within hospitals within Stoke-on-Trent. These were chosen to participate in the survey because the head physiotherapist expressed a willingness to be involved in the study and because this group as a whole constituted a sufficiently large sample set. Eighty-six physiotherapists were recruited to participate in the study. Initially, the manager of a personnel department at a hospital in the Merseyside area agreed to assist in the distribution of nursing questionnaires. The response rate for the third questionnaire distributed to the nursing staff was very low due to the co-ordinating individual at the hospital

failing to distribute the questionnaires as instructed so the longitudinal study concerning nurses was abandoned.

Distribution Stoke-on-Trent Hospital had been included in the cross-sectional study. At the time of distribution within this hospital, each questionnaire was numerically coded. The head physiotherapist assigned each individual physiotherapist a code and each questionnaire was sent to the corresponding personnel. The subsequent longitudinal questionnaires were distributed every four months until October 1998. The code on the questionnaire ensured that each physiotherapist could remain anonymous, but the individual's musculoskeletal status could be monitored over the 20-month period. Questionnaires could either be returned individually in the addressed envelope provided or returned via the head physiotherapist.

4.2.2.1 Analysis of Data

Logistic regression analysis was performed on the data using a Multi-Level Modelling (Mln) package (Rasbash and Woodhouse, 1995). This statistical package was chosen because of its ability to analyse information with missing data points. Subjects were still be included in the study if one to four of the six questionnaires was missing.

4.2.3 Results

Responses to longitudinal questionnaire A response rate of 81.5% (n=70) was obtained when considering the number of individual physiotherapists included in the analysis. Some of the physiotherapists included in the analysis did not complete all six questionnaires. The response rate for the number of individual questionnaires returned over the 20-month period was 60% (n=309).

Predictive variables for musculoskeletal disorders The risk of suffering a musculoskeletal disorder was significantly greater for physiotherapists working in the high risk specialties than in the low risk specialties ($p<0.05$). The probabilities of physiotherapists suffering a musculoskeletal disorder were 26% and 13% for high risk and low risk specialties respectively. Initially, variables found to be significantly associated with musculoskeletal disorders in the cross-sectional questionnaire were entered into the logistic regression analysis and are shown in Table 12. All other variables were entered into the analysis sequentially and removed if not significant. Other than specialty, no variable gave significant results ($p > 0.05$).

Table 12. Variables significantly associated with musculoskeletal disorders as identified by logistic regression analysis from the cross-sectional study.

Parameter	Estimate	S. Error
High risk specialty	-1.032	0.06852
Low risk specialty	-1.888	0.7835
% of time of feet	0.01042	0.008182
Perceived happiness at work	-0.02951	0.02288
Perceived competence at work	0.06738	0.06211

A female physiotherapist spending less than 50% of their time on their feet, scoring zero on the happiness at work scale and zero on the perceived competence at work scale was used as the baseline measurement in the analysis

An example of how the accumulative effects of more than one variable (i.e. working in a high risk specialty and spending more than 50% of the time on the feet) influence the risk of suffering a musculoskeletal disorder is as follows;

$$\text{a log } (-1.032 + 0.01042) = -1.02158$$
$$= 0.26472$$

The added risk of a physiotherapist spending more than 50% of the time on his/her feet was marginal, the computed risk of suffering a musculoskeletal disorder changing from 26% to 26.5% ($P > 0.05$). Increased perceived competence at work also only marginally affected the probability of suffering a musculoskeletal disorder for both high and low risk specialties. Male physiotherapists had a reduced probability of experiencing musculoskeletal symptoms but the number of males in the study was extremely small. It must be remembered that these results were not significant.

4.2.4 Discussion

<u>Response rate</u> In total, 81.5% of the original sample of physiotherapists returned more than one questionnaire. Not all physiotherapists completed all six questionnaires, but 60% of all the questionnaires sent out over the 20-month period were returned. The coded questionnaires were sent to one physiotherapist who distributed them to the corresponding personnel. Some questionnaires may not have reached their designated physiotherapist because some staff rotate to different specialties or because of staff holidays or illness. These reasons may account for some questionnaires not being returned.

<u>Risk factors for musculoskeletal disorders</u> The cross-sectional epidemiology identified certain risk factors associated with the occurrence of occupational musculoskeletal disorders. By recording the musculoskeletal status and job characteristics of the physiotherapists over a 20-month period, the risk factors pre-empting the onset of musculoskeletal symptoms could be identified and causality attributed. The cross-sectional analysis identified high and low risk work specialties. These categories were used in the longitudinal analysis and the specialty in which the physiotherapist worked was identified as a significant risk factor.

Regarding back pain in nursing, Bell et al. (1979), Owen (1986) Vasiliadou et al. (1995) and Ready et al. (1993) cited specialty as being an important risk factor. Other authors have contradicted this (Stubbs et al., 1983a; Harber et al., 1985). The association between specialty and musculoskeletal disorders of physiotherapists has not been established but this work appears to show that the specialty in which staff work is a significant risk factor. However, few staff reported changing specialty during the course of the research. The lack of reported changes in specialty may be because staff tend to stay in one specialty for many years or because, once a physiotherapist had moved specialties, the questionnaire failed to reach them so that the change in specialty, along with the other information, could not be recorded. A link between musculoskeletal disorders and specialty was identified but the lack of covariance means this result can not be used to state the direction of cause. The exact connection between work specialty and musculoskeletal symptoms requires further investigation. The influence of work in other specialties during the course of the physiotherapists' past work profile can not be ignored.

No other variable yielded significant results in the logistic regression analysis. The risk of physiotherapists suffering musculoskeletal disorders increased as the perceived percentage of time they spent on their feet increased but this result was not significant. This variable had been shown to be a significant risk factor for back pain in nurses in the cross-sectional questionnaire. Prolonged time on the feet increases the rate of spinal shrinkage and the discs lose height (Stälhammar et al., 1989). Bulging of the disc increases the pressure on the nerve root and pain may result (Eklund and Corlett, 1984).

It is suggested that the percentage of time spent on the feet during a shift is greater for nurses than physiotherapists, thereby explaining why this factor was significant in the analysis of low-back pain for nurses but not physiotherapists in the cross-sectional epidemiology. Physiotherapists sometimes sit down whilst the patients perform their rehabilitation exercises and when they are writing notes concerning the patients progress. Nurses may be on their feet for the duration of the shift. Unless physiotherapists change grade or specialty, it is likely that their work activities would be similar on a day to day basis although the patients and patient care administered would change. Few staff members changed specialty or grade during the course of this study and the percentage of time the physiotherapists spent on their feet during each shift may therefore not have changed greatly over the 20-month period.

Increased perceived happiness at work and decreased reported job competence were two variables shown to be significant factors associated with musculoskeletal disorders in the cross-sectional work. When entered into the analysis of the longitudinal study these factors did not reach statistical significance.

It is suggested that a greater time frame needs to be employed to assess which factors have a significant predisposition to cause musculoskeletal disorders. Unfortunately extending the time of the study was not possible for this thesis. Asymptomatic nurses or physiotherapists just joining the profession would be the ideal group to study. As they would be symptom free initially, it would be easier to track which occupational and personal factors triggered the onset of a disorder. The influence of past work in the profession would then be largely eliminated. The above methodology could not be employed in this study because new staff joined the chosen hospital infrequently and enlisting enough new staff to make the study viable would have taken a considerably longer time than was available.

4.2.5 Conclusions

- Once established in a healthcare post physiotherapists tend to stay for numerous years with the working practices and their attitudes towards work remaining relatively constant.
- An association between the absence/presence of a musculoskeletal disorder and the specialty in which the physiotherapist worked was identified but the lack of co-variance means causality could not be ascertained.

4.3 Epidemiology of Musculoskeletal Disorders: A Prospective Study Within an Occupational Health Department

4.3.1 Introduction

McGuire et al. (1995) showed that of 3,548 nurses suffering injuries due to moving and handling patients, just over 50% completed an accident report form. Many nurses continue to work, believing that back pain is an accepted hazard of the job (Stubbs et al., 1983a). This opinion, and the fact that nurses also feel their job may be in jeopardy if the management becomes aware of their suffering any physical problem may be responsible for the low report form completion. The previous cross-sectional epidemiological study (4.1) showed the main sources of treatment for musculoskeletal disorders were the General Practitioner and physiotherapist with a much smaller percentage consulting the Occupational Health Department. It can therefore be concluded that basing injury prevalence data on accident report forms alone will lead to an under-estimation of the number of injuries occurring.

The aim of this study was to estimate the number of individuals seeking assistance from the Occupational Health Department of an N.H.S. Trust whilst acknowledging that consultation with this medical practitioner was not the only option available. A further aim was to obtain a clinical diagnosis and prognosis of those patients seen by the Occupational Health Physician and elicit detailed information regarding the perceived cause of the injury. This approach is prospective in nature and is advantageous because individuals recall recent situations and causative incidents, not situations in the distant past as is required in the questionnaire.

4.3.2 Methodology

The number and details of the participants within this study could not be estimated in advance. The sample group was totally dependent on the number of individuals reporting their musculoskeletal disorders and the characteristics will vary accordingly. The definition used to determine inclusion in the study was broad but covered musculoskeletal disorders to any anatomical site which could be attributed to work. Individuals who attended the Occupational Health Department were given a full clinical examination by the Occupational Health Physician and any patients suffering musculoskeletal problems were noted. Inclusion in the study was therefore left to the discretion of this individual, and the information collected was obtained after a full clinical assessment.

Data Collection

The Broadgreen Hospital N.H.S. Trust Occupational Health Department was recruited to assist with this study, consisting of two parts. Case studies of individuals suffering *severe* musculoskeletal symptoms (serious disorders, requiring active treatment and inability to continue work) were recorded and their progress followed over a 12-month period (1st October 1996- 31st September 1997). Information included a clinical diagnosis and the treatment initiated, the severity of the problem and sickness absence and the perceived cause of the injury. Information from patient records was transferred onto a data collection pro-forma (Appendix 4) through consultation between researcher and physician to maintain confidentiality and avoid any compromise of patient records. Secondly, the number of individuals consulting the Occupational Health Department was recorded over a one-month period (August 1997) to ascertain the number of people using this practitioner as the mode of treatment. Some details relating to the location of the disorder and the perceived cause were also recorded.

4.3.2.1 Analysis of Data

The information collected in this study was largely qualitative to supplement the quantitative data from the other epidemiological studies (4.1 and 4.2). Case studies of this type are useful to identify individual scenarios, but more data would need to be considered before any generalisations could be made.

4.3.3 Results

In August 1997, all individuals visiting the department with musculoskeletal disorders were recorded for the study which totalled 9 nursing staff and 2 physiotherapists. The characteristics of these 11 are given in Table 13. It was indicated by the participating Occupational Health Physician that this constituted a typical month in the department, in terms of the number of individuals presenting with musculoskeletal disorders and the types of problems experienced.

Table 13. Characteristics of individuals consulting the Occupational Health Department in August 1997.

Job title	Musculoskeletal Disorder	Perceived Cause
Radiographer	Low back pain and sciatica	Lifting patient
Radiographer	Low back pain and sciatica	Lifting equipment
Healthcare Assistant	Fractured scaphoid on left wrist	Trapped hand in cot side
Senior Enrolled Nurse	Rotator cuff aggravation	Lifting
Senior Enrolled Nurse	Rotator cuff aggravation	Lifting
Senior Enrolled Nurse	Rotator cuff aggravation	Lifting
Sister	Cervical spondylosis	Lifting
Staff Nurse	Cervical spondylosis	Lifting
Staff Nurse	Cervical spondylosis	Lifting
Physiotherapist	Neck injury	Lifting patient
Physiotherapist	Low back pain and left sciatica	Lifting

It was not possible to keep detailed accounts of all musculoskeletal injuries being presented at the Occupational Health Department within the 12-month period due to the increased work load this would incur for the Occupational Physician. Information was collected on 7 patients with severe problems and their treatment and progress was followed as case studies. The sample characteristics are presented in Table 14.

Table 14. Sample characteristics of case study subjects.

Ref no.	Job title	Specialty	Age	Sex	Disorder
1	Auxiliary	Orthopaedic	28	Female	Lumbar spondylosis, L3, L4, L L5/S1, S1 nerve root entrapmen = low back pain and sciatica
2	Auxiliary	Orthopaedic	32	Female	Lumbar spondylosis, L3, L4, L L5/S1 = low back pain and left sided pain
3	S.E.N.	Out patients	49	Female	Nerve root narrowing, C4, C5, C6 = neck pain and bilateral brachialgia
4	R.G.N.	Renal Unit	26	Female	Narrowing at L5/S1 = low back pain, right sided sciatica, loss of ankle flexion
5	R.G.N.	Elderly	38	Female	L5/S1 disc prolapse; S1 nerve root narrowing = low back pain and sciatica
6	Radiographer	Radiography	37	Female	C5 C6 disc protrusion = restricted cervical movement and brachialgia
7	Auxiliary	Orthopaedic	41	Female	Lumbar/sacral spondylosis = left sided sciatica

S.E.N. = State enrolled nurse
R.G.N. = Registered general nurse

Location of musculoskeletal disorders The highest number of problems concerned the lower back, with patients usually suffering additional sciatic symptoms. The second most commonly injured area was the neck, with 2 of the 6 individuals also suffering brachialgia. Three staff had shoulder disorders and the final subject had a fractured scaphoid.

Absence from work All subjects who had visited the Occupational Health Department in August had had a period of time off work. The average time of sickness absence for the stated neck and shoulder injuries was approximately one month. However, the physician estimated that the physiotherapist with low-back pain and left-sided sciatica would be absent from work for anything up to one year depending on the response to treatment. Considering the seven case studies, the

Occupational Health Physician was asked to record the number of days off work so far, due to the musculoskeletal disorder. This ranged from 153 days for subject 3 to 335 days for subject 4. Absence from work was continuous for all subjects with the exception of subject 1 who returned to work between two periods of sick leave.

Treatment and outcomes All injuries were new problems, with the exception of the physiotherapist with low-back pain and sciatica which was an old recurring problem. Assuming that August was a typical month, it can be deduced that 120 *new* cases are presented at the Occupational Health Department each year. All subjects who visited in August were treated at the Occupational Health Department with physiotherapy. The treatment initiated for the case studies and the outcome of that treatment are given in Table 15. Of the 7 individuals, it can be seen that 4 had to be retired from nursing and the remaining 3 continued to work having had symptoms relieved.

Table 15. Treatment and outcomes for the case study subjects

Ref no.	**Diagnosis**	**Initial Treatment**	**Follow Up**	**Follow Up**
1	MRI scan	Epidural injections	Retired from nursing	
2	MRI scan	Physiotherapy	Changed to specialty with no lifting	No problems
3	MRI scan	Epidural injections	Pain free and back to work	No problems
4	CT lumbar scan	Physiotherapy and rest	Retired form nursing	
5	MRI scan	Rest, awaiting surgery	Discectomy. Still severe sciatica. Off work	Likely to be retire from nursing
6	MRI scan	Rest, awaiting surgery	Discectomy. Back to symptom free	
7	MRI scan	Rest, not suitable for surgery	Retired from nursing	

MRI = Magnetic Resonance Imaging
CT = Computerised Tomography

Perceived causes The majority of subjects attributed their symptoms to lifting activities. Of the case study subjects, 6 indicated a single lift as the cause, and subject 6, the radiographer, felt the injury was attributed to the cumulative effects of lifting heavy equipment over a number of years. Lifting of both patients and equipment was therefore given as the cause of the injuries in all but one case.

4.3.4 Discussion

Valuable information can be gained from this in-depth study which relies less on subjective recall than a questionnaire based approach. Due to the small number of subjects involved in the study, it is not possible to make generalisations to nursing and physiotherapy as a whole, or identify risk factors pertaining to the individuals or job characteristics.

Usage of the Occupational Health Department and sickness Ten new musculoskeletal cases were presented at the department in the month considered, giving approximately 120 new cases each year. Re-occurring problems further increased the number of individuals being treated for musculoskeletal problems. The cross-sectional epidemiological survey (4.1) considered the number of individuals who sought treatment from the various practitioners available. It indicated that only 10% of sufferers consulted the Occupational Health Department in conjunction with other practitioners, and that only 0.4% consulted the department as the only mode of treatment. If these figures were to be applied to this present study, the 120 new cases each year may only constitute part of the whole musculoskeletal problem. The magnitude of the problem seen from the questionnaire responses would appear to be confirmed here.

All subjects who visited the Occupational Health Department in August had a period of time off work due to the musculoskeletal disorder, averaging approximately one month. The more serious injuries illustrated in the case studies showed absences up to one year with treatment failing to ease symptoms to allow continuation of work. This indicates the difficulty of treating sufferers whose injury has an unknown underlying pathology, or whose symptoms are too severe to respond to treatment. Indeed, 4 of the 7 case studies seen in the 12-month period were retired from the profession entirely. This is not a problem affecting only older nurses and physiotherapists who have been working for some time. The ages of those retired from work as a direct result of their musculoskeletal symptoms were 26, 28, 38 and 41 years.

Harber et al. (1985) believed that nurses would 'select' themselves out of detrimental roles and specialities that caused physical problems, leaving only those in the demanding jobs that had no physical difficulty in performing strenuous tasks. Case study 2, an auxiliary nurse working in orthopaedics, was forced to take this option, moving from orthopaedics to clerical work requiring a physically lighter work load. This option is likely to be considered only after an injury has occurred and, whilst the symptoms are eased; this is not a solution for preventing musculoskeletal disorders in the first place.

Subject 3 suffered reoccurring symptoms approximately every 6 months, with pain being relieved by epidural injections until symptoms returned. The Occupational Health Physician believed patients such as this returned to work too early and should not be working when symptoms re-occurred but in many instances nurses returned to work quickly because of fear of losing their job. Suffering back pain is also still regarded as an occupational hazard of nursing (Stubbs et al., 1983a).

<u>Location of injuries and perceived causes</u> Considering both the injuries reported in August and the case studies, the main location affected was the lower back, with most sufferers also reporting sciatic symptoms. The second most affected anatomical region was the neck region and the shoulders. These results confirmed the findings of the cross-sectional questionnaire which also indicated these areas as being the most commonly affected.

With the exception of one individual, all subjects cited lifting of patients or equipment as the cause of their problems and most could recall a single causal incident. This finding would appear to indicate lifting to be a highly detrimental aspect of the job, causing a variety of injuries affecting different anatomical locations and appears to support the wealth of information regarding lifting/patient handling and back injuries (Ryden et al., 1989; Owen and Garg, 1989) but also implicates lifting in response to other reported musculoskeletal disorders.

It is perhaps not surprising that manual handling is deemed responsible for many musculoskeletal injuries, with 90% of patients weighing over 50 kg and equipment being heavy. The majority of nursing staff are also female which naturally compounds the problem (Pheasant et al., 1991). Lifting in the nursing profession is also different from other jobs because the load can not often be brought close to the body, it is unstable and often uncooperative and does not possess handles (Owen, 1985; Harber et al., 1985; Molumphy, 1985).

The prospective nature of this study signified that subjects did not have to rely on long term memory recall, as causal incidents occurred recently. Despite the small numbers involved in this study, an extremely high percentage indicated lifting as being responsible and should therefore lead to the conclusion that lifting is the aspect of the profession directly causing the high prevalence of musculoskeletal disorders. Whether or not staff lifted, or the number of lifts staff normally performed during their shift was not shown to have strong predictive value in the cross-sectional epidemiology (4.1). It may be that other, more subtle factors are also playing a role, but lifting is so prominent in the minds of healthcare professionals that other possible factors are often neglected. The ergonomic risk assessment of nursing and physiotherapy tasks will provide a greater understanding of the causal factors.

<u>Clinical diagnosis and treatment</u> Of the 7 case studies, 6 had received a Magnetic Resonance Imaging (MRI) scan to determine the exact site of the injury. Magnetic Resonance Imaging is a relatively new technique but is now used extensively to assist in diagnosis. It measures the response of protons to a pulse of radio waves as the protons are being magnetised and produces a blueprint of the cellular chemistry. This blueprint is interpreted to detect anomalies in blood flow and metabolism (Tortora and Reynolds Grabowske, 1993). The other patient had received a Computerised Tomography (CT) lumbar scan which can provide pictorial and

quantitative information on the distribution on various tissue components for any part of the body (McArdle et al., 1991).

All cases seen in August, except for the physiotherapist with low-back pain, were not considered severe. The Occupational Health Physician had prescribed physiotherapy as the mode of treatment, and believed that this, along with a period of time off work, would be sufficient to relieve symptoms. Physiotherapy, both alone and in conjunction with G.P. consultation, was also the most common type of treatment administered to those suffering musculoskeletal disorders in the cross-sectional questionnaire sample (4.1). This would indicate that physiotherapy is the most favoured mode of treatment for musculoskeletal disorders, even when an exact clinical diagnosis is not found and symptoms are idiopathic, as for example is often the case for low-back pain.

In the more severe case studies, initial treatment had proven unsuccessful and two patients were awaiting surgery in an attempt to alleviate symptoms. Patient 7 was not suitable for surgery as there were imminent disc protrusions at many different levels. Of the two patients that underwent discectomy, one recovered and returned to work symptom free, whilst the other operation failed to alleviate the sciatic symptoms. Whilst research continues to improve this type of surgery, the outcome is not always successful, and attempting to prevent the onset of the condition must prove to be a better option.

4.3.5 Conclusions

- Ten new musculoskeletal cases were presented at the Occupational Health Department within one month giving an annual rate of approximately 120 new cases per year.
- The main anatomical area affected was the low-back with sufferers also reporting sciatic pain.
- The neck and shoulder region was the second most affected anatomical area.
- All but one individual cited lifting patients or equipment as the cause of their problems.

- Of the seven case studies, four people were retired from nursing and one was forced to change to a specialty requiring less patient handling.

Surgery is a last resort and often unsuccessful. The focus should be on a prevention the problem rather than a cure. An ergonomic risk assessment of tasks shall provide a greater understanding of the exact tasks likely to be responsible for injuries.

4.4 An Ergonomic Evaluation of Hospital Based Nursing and Physiotherapy Tasks

4.4.1 Introduction

The musculoskeletal problems experienced by healthcare professionals have been outlined in various reports (Pheasant and Stubbs, 1992; Larese and Fiorito, 1994; Hildebrandt, 1995; Bork et al., 1996). Such epidemiological studies are useful in quantifying musculoskeletal problems and enable comparisons of occupations to be made. However, many researchers do not evaluate the validity of epidemiological work by performing an objective ergonomic assessment in which identification of tasks causing the greatest work stress can be achieved (Garg et al., 1992). An ergonomic evaluation can facilitate the implementation of control measures to reduce the risks associated with performance of the work. The ergonomic approach applied in this research aims to identify the tasks with the highest potential risk of causing musculoskeletal problems. Changes to the working environment and performance of activities can be re-evaluated so that the physical and mental capacities of the individuals will not be out-weighed by the demands of the job.

Ergonomic evaluations have been used to assess the tasks performed for an ergonomic intervention to be established (Garg and Owen, 1992). Assessments should not concentrate purely on the tasks being performed but also on the environment in which the work is being undertaken. Comfort of the patients must also be considered as guidelines will not be implemented if increased patient discomfort is incurred.

The risk assessment aims to identify those nursing and physiotherapy tasks with the highest risk score. The risk assessment pro-forma includes six sub-sections so that the exact component responsible for the resultant high score of high risk tasks can be established. The final aim is to identify whether external factors (for example grade, sex, age) have any significant relationship with the task scores.

4.4.2 Methodology

Development of the risk assessment pro-forma (Appendix 5)

The risk assessment pro-forma was developed based upon guidelines provided by the Health and Safety Executive (Guidance on Manual Handling Operations Regulations 1992 (1998)). Pilot observational work was performed on a range of personnel in different departments at Southport and Formby District General Hospital to ensure all normal actions could be recorded. The results of the epidemiological study were also used in the development of the risk assessment. For example, the questionnaire indicated a relatively high proportion of physiotherapists with problems in the wrists and fingers, so a section indicating finger and wrist force was included in the risk assessment pro-forma.

The risk assessment pro-forma included six sub-sections. These detailed task, posture, load, environmental conditions, the psychological state of the individual and forces acting on the wrists and fingers were included. A large number of observed factors reduce the precision of observations (Kilbom, 1994) but including small sub-sections, rather than one whole reduced this problem. A cumulative scoring system was devised, the total score indicating the overall risk of performing specific activity. Certain tasks/postures were assigned a score depending on the risk, for example, trunk flexion of 45° scores 2, compared to flexion of 90° which scores 4.

It was possible to identify which of the sub-sections were responsible for the overall high task score. The first sub-section detailed 'task' (walking, standing, lifting and so on) with the highest attainable score being 6.0. The second sub-section described the posture adopted by the subject (twisting, lateral bending and so on) and the highest attainable score was 9.0. The next sub-section was concerned with forces acting on the fingers and wrists, with the total possible score being 3.0. The highest attainable score for the sub-section 'load' was 5.0. The final two sub-sections considered the environmental conditions and the psychological state of the individual, with the highest scores being 3.0 and 2.0, respectively.

A short description of the task was included at the time of recording so that a composite score was associated with specific activities. Most importantly, the observation check-list was a quick and non-intrusive method of collecting the data.

Two observers were used during pilot work and they recorded the instantaneous risk assessment discretely but at the same time. When inter-subject variability had been eliminated, data collection began. Eliminating inter-subject variability ensured minimal intra-subject variability so assessments were reliable.

Data collection

The epidemiological work indicated low and high risk specialties in nursing and physiotherapy work and a combination of each were used in the risk assessment. The nine specialties included in the study were as follows and the hours of observations in each are shown in the brackets; casualty (28), outpatients (50), haematology (38), care of the elderly (50), general medicine (31), intensive care (20), orthopaedics (27), surgical (7) and spinal injuries (24). The assessor 'shadowed' one member of staff for a one-hour period during the course of the individual's working day and an instantaneous assessment was carried out every 10 minutes. By remaining with the member of staff continuously for the one hour period, the assessor was also be able to assess the psychological characteristics of the individual which had been shown to be important in the questionnaire analysis. Overall, data were collected for 46 hours and constituted 276 risk assessments. Assessment was performed on both physiotherapists and nurses, at different times of the day, on both sexes and on different grades to ensure a cross-section of information was obtained. Altogether, 197 nurse assessments and 97 physiotherapy assessments were performed. The mean age of nurses was 40.5 ($\pm$ 9.99) and physiotherapists 31 ($\pm$ 9.92). By collecting large amounts of data on numerous individuals, any individual differences in the way personnel perform tasks was smoothed out. A mean score for performing each specific task was therefore obtained.

4.4.2.1 Analysis of data

The information was analysed using Minitab (version 9.2). Analysis of variance was used to examine differences in tasks and subjects. When the residuals were saved from the above analysis, the residuals failed to show a normal distribution using Anderson-Darling test of normality as implemented in Minitab (MINITAB, 1995). A Kruskal-Wallis non-parametric test was used to indicate which tasks were producing the highest risk scores. This process was repeated to establish which of the 6 sub-sectional scores were responsible for the increased overall score of the high risk tasks and to indicate whether other factors such as age, nursing/physiotherapy grade and specialty and time of day had any significant effect on the overall task scores.

4.4.3 Results

High risk tasks The Kruskal-Wallis analysis showed there was a significant difference between the risk scores of the different tasks ($p < 0.05$) and high and low risk tasks were identified. This information is illustrated in Figure 8.

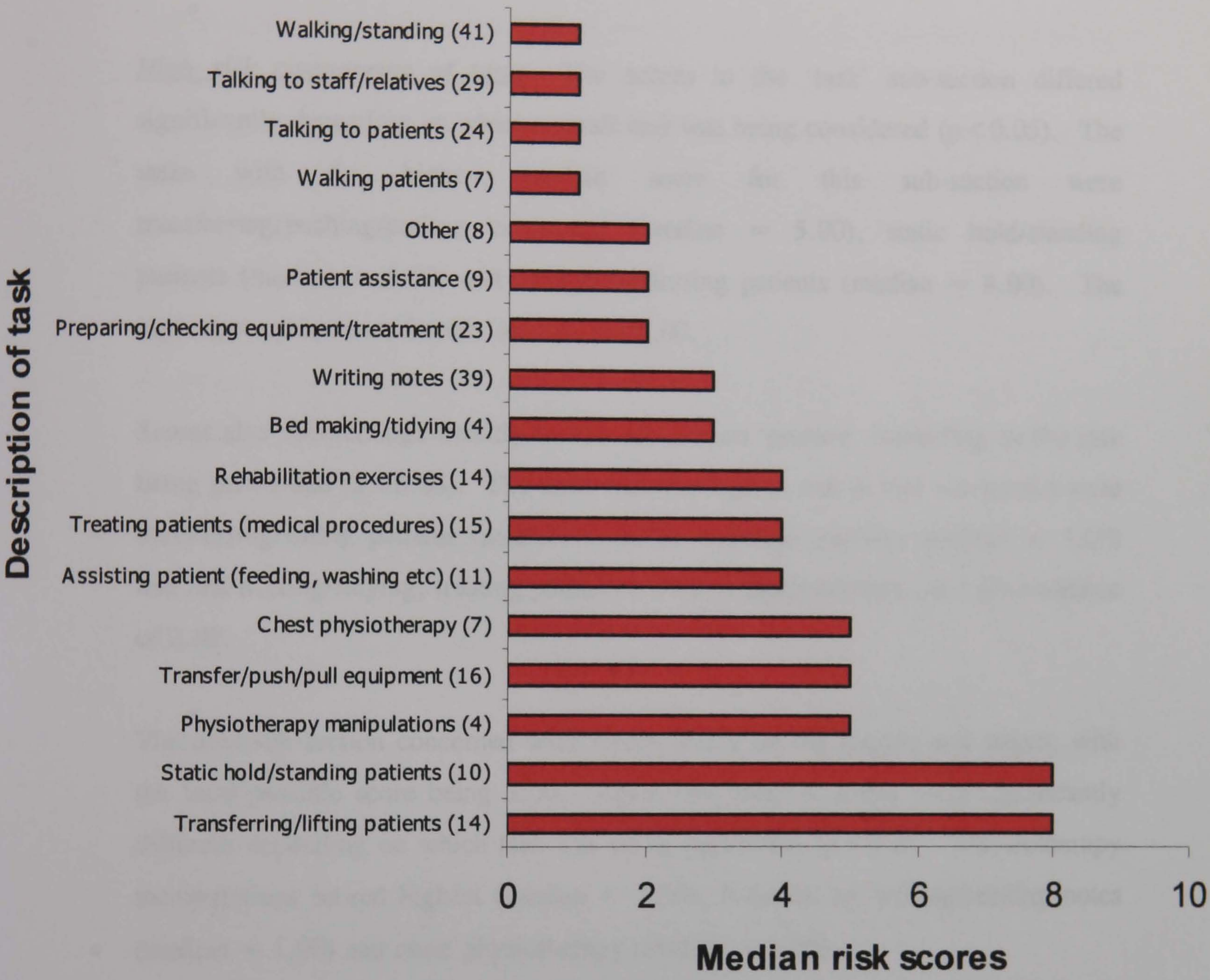

Figure 8. Median risk scores (number of observations in parentheses) for each task

The tasks identified as having the highest risk were those concerned with transferring and lifting patients and those involving a static hold component or standing patients in a static position as part of the rehabilitation process.

High risk components of tasks The scores in the 'task' sub-section differed significantly depending on which overall task was being considered ($p<0.05$). The tasks with the highest median score for this sub-section were transferring/pushing/pulling equipment (median = 5.00), static hold/standing patients (median = 5.00) and lifting/transferring patients (median = 4.00). The highest possible score for this section was 6.00.

Scores also differed significantly for the sub-section 'posture' depending on the task being performed ($p<0.05$). The tasks with the highest risk in this sub-section were transferring/lifting patients (median = 3.50). assisting patients (median = 3.00) and bed-making/tidying, treating patients and chest physiotherapy, all with a median of 2.00.

The next sub-section concerned with forces acting on the fingers and wrists, with the total possible score being 3.00. Again, the median scores were significantly different depending on which task was being performed ($p<0.05$). Physiotherapy manipulations scored highest (median = 1.50), followed by writing/reading notes (median = 1.00) and chest physiotherapy (median = 1.00).

When considering 'load', tasks involving a static hold, or assisting patients to maintain a standing position had a median score of 5.00. Transferring/lifting patients had a median score of 1.00. All other tasks had a median score of 0.00, these differences being significant ($p<0.05$).

The final two sub-sections considered the effects of the environment and the psychological state of the individual on the score of the task. Neither of these subsections gave significant results ($p>0.05$).

Risk score differences related to other factors A Kruskal-Wallis test was performed on the risk total scores to identify the effects of other factors. The median scores were not significantly related to sex or left/right handedness ($p>0.05$). The median scores were also not affected by the nursing grade but were significantly different when the grade of the physiotherapists was considered ($p<0.05$). This can be seen in Figure 9 with the risk being greatest for Senior 2 physiotherapists and least for physiotherapy assistants.

When the time of day was considered, the median scores were significantly lower for tasks performed between 19:00 hours and 22:00 hours than those tasks performed between 08:00 hours and 19:00 hours ($p<0.05$). This comparison is illustrated in Figure 10.

The score differed significantly when the different subject age groups were considered, with the younger age groups having an increased risk ($p<0.05$). This information is given in Table 16.

Table 16. Median task scores and the number of observations for each age group.

Age groups (years)	Median scores	Number of observations
20 - 29	3.00	93
30 - 39	3.00	65
40 - 49	2.00	62
50 - 59	2.00	55

The risk score was also significantly affected by the specialty in which the subject was working ($p<0.05$). The specialty with the highest risk was 'spinal injuries', followed by 'care of the elderly' and 'surgical'. The median values for all specialties are shown in Figure 11. When the two occupations were compared, the median risk scores were significantly different ($p<0.05$), physiotherapists being at a greater risk than the nursing staff.

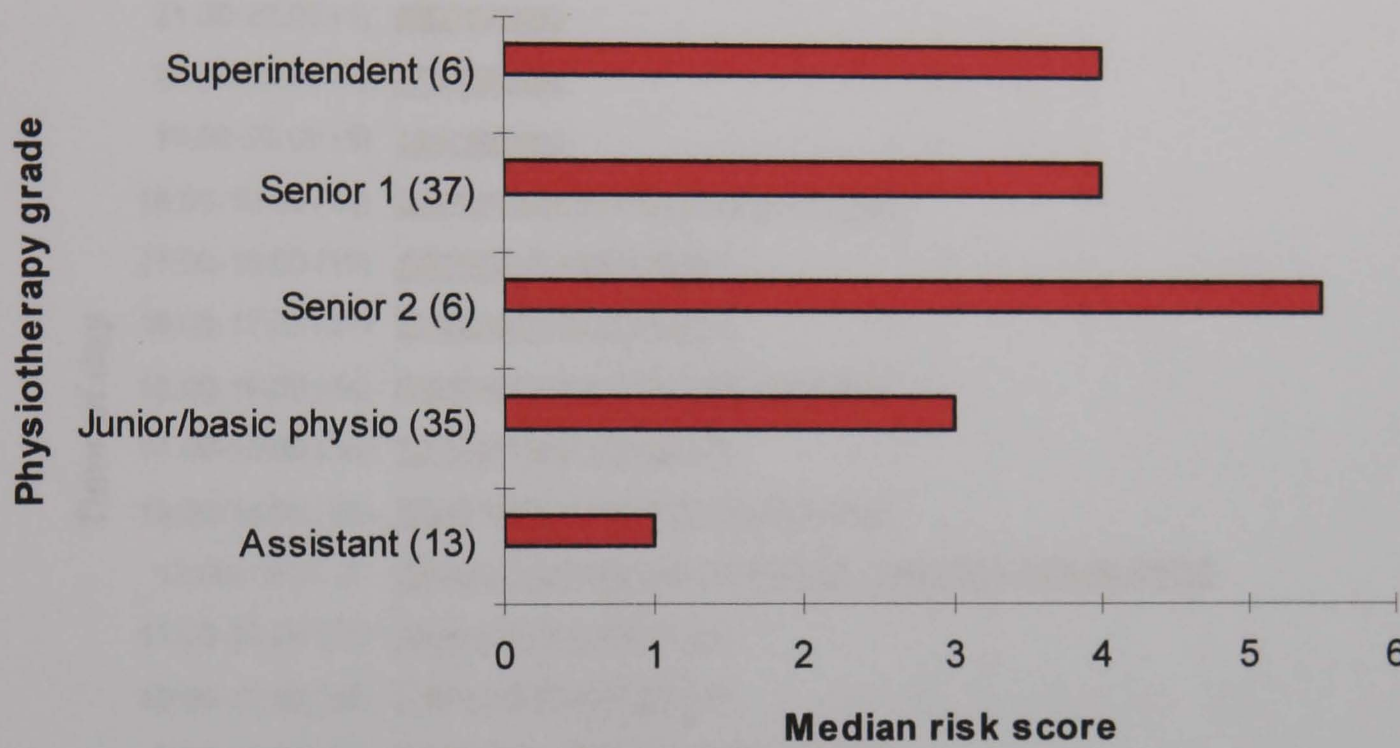

Figure 9. Median values (number of observations in parentheses) for the different physiotherapy grades

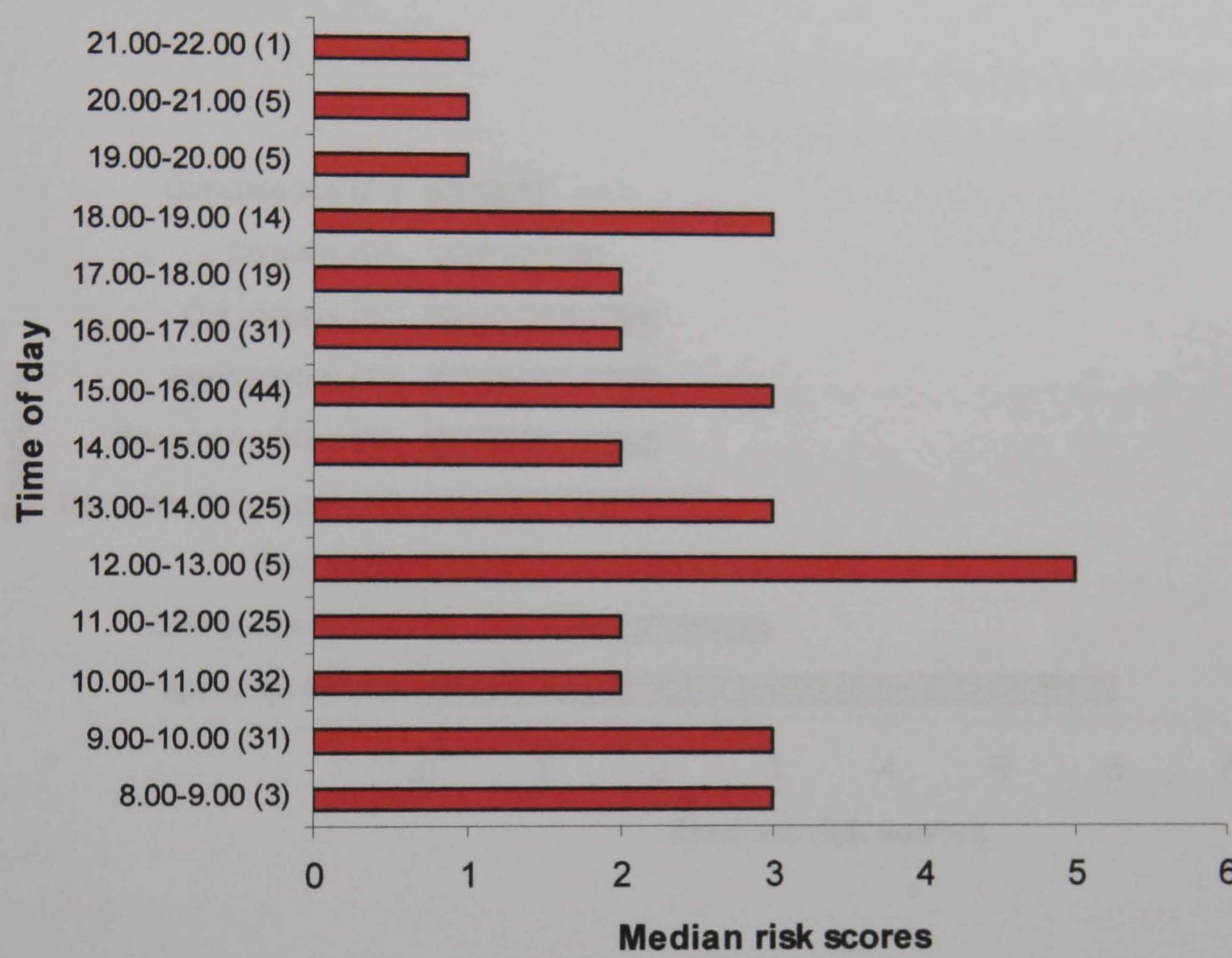

Figure 10. Median scores (number of observations in parentheses) relating to the time of day

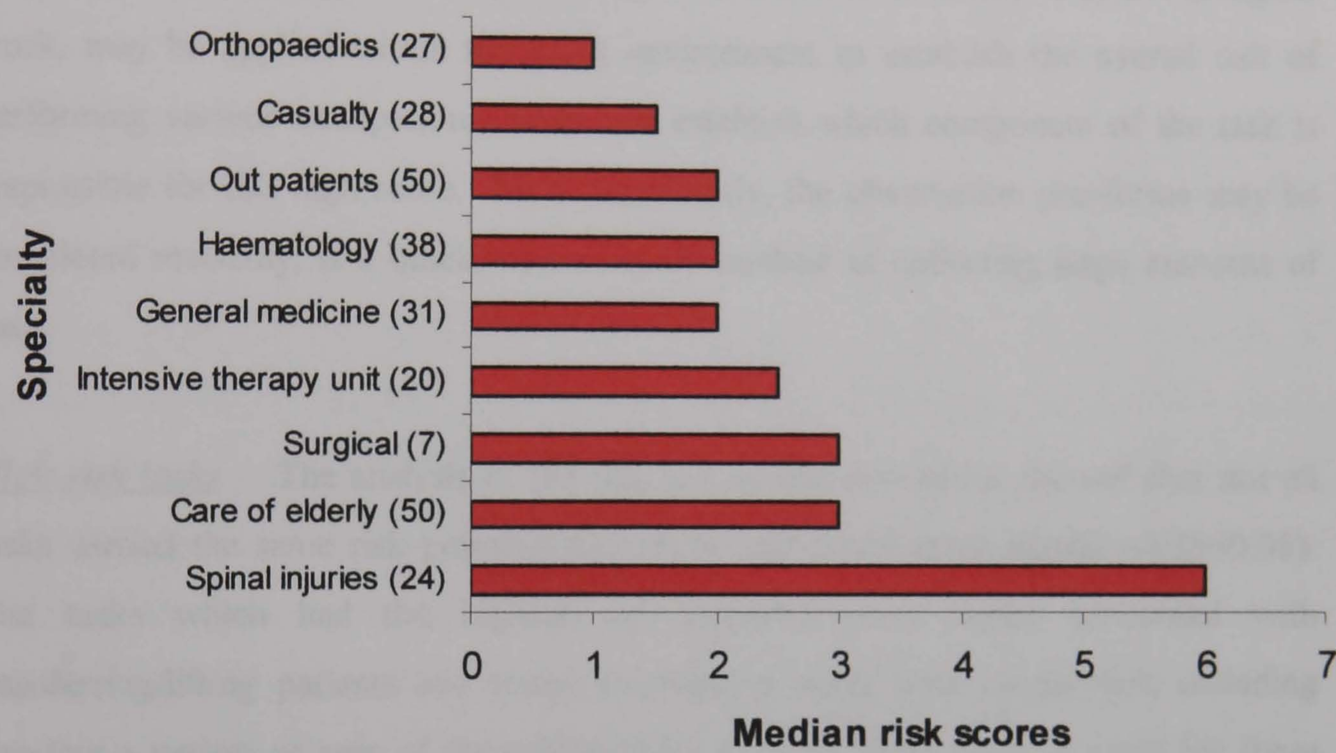

Figure 11. Median task scores (number of observations in parentheses) for each specialty

4.4.4 Discussion

It is apparent that nurses and physiotherapists are highly susceptible to musculoskeletal disorders, particularly back pain, and perceive them to be work-related in origin, with prevalence rates higher than other occupations (Hildebrandt, 1995; Bork et al., 1996). It is also apparent that these healthcare professionals believe patient handling tasks to be instrumental in the onset of symptoms. This present study has shown that the objective risk assessment procedure, the development of which was based on Health and Safety Executive guidelines and in response to results of extensive epidemiological work, may be applied within the work environment to establish the overall risk of performing various occupational tasks and establish which component of the task is responsible for this high score. Most importantly, the observation pro-forma may be completed manually, is a quick, non-intrusive method of collecting large amounts of data.

High risk tasks The analysis of the risk assessment procedure showed that not all tasks carried the same risk potential and these differences were significant ($p<0.05$). The tasks which had the highest risk potential were those concerned with transferring/lifting patients and those involving a static hold component, including standing a patient as part of the rehabilitation process. The medium score for these tasks was 8.00 and the task ranked third (physiotherapy manipulations) had a considerably lower medium of 5.00.

Research considering back pain in nursing has strongly focused on patient lifting and transferring patients as the most likely causal factors. Jensen (1990) showed that personnel performing the greatest number of patient handling tasks had the highest prevalence rates. Other studies show similar findings, including those which ask nursing staff to give subjective ratings of perceived stress (Owen and Garg, 1989). Weight limits for lifting are imposed, but it may not be a single incident that precipitates back problems. There is no guarantee that the cumulative effect of repetitive lifting of objects below this weight will not precipitate damage (Anderson, 1980).

In response to this wealth of data incriminating manual handling for the continued rise in back problems within the nursing profession, numerous assistive devices have been introduced into the workplace. Hofmann et al. (1994) advocated the use of such devices, showing increased low-back pain in Czech Republic and Germany where lifting aids were unsatisfactory compared to the more advanced technology available in France and Sweden. Despite continual indication of the benefits of such devices, aids are not always utilised and manual handling still occurs. Paediatric wards have no hoist because it is considered unnecessary for lifting children (Pheasant et al., 1991), and Harber et al. (1985) stated that, despite being readily available on all wards, the Hoyer lift was only used 7 times in 3000 manual operations.

Results of this risk assessment appear to support the argument of lifting/transferring being a high risk component in the profession. Indeed, the importance of lifting/transferring is applicable to both nursing and physiotherapy staff as the results were analysed together. When the six sub-components of the overall task were analysed, there were some significant differences. Manual lifting/transferring of patients was shown to score highly in the sections 'task' (second only to push/pull/transfer equipment and static holding) and 'posture' (where manual lifting/transferring was the highest risk task). Nursing and physiotherapy staff are often subjected to obstruction when performing lifts. The epidemiological survey in this thesis (4.1) showed that 40% of respondents deemed the work environment to be unsuitable, with 61% of these perceiving the main problem to be a poorly designed work area or space constraints. Harber et al. (1988) showed that 30% of all actions had medical attachments present to hinder patient movement. It is not surprising therefore, that staff frequently have to adopt non-optimum and possibly detrimental, postures to enable transfers to be made with minimum discomfort and danger to the patients.

The sub-section 'load' was not shown to be the most detrimental component of lifting/transferring patients. The score for lifting/transferring patients was the second highest of all tasks but was considerably lower (median = 1.00) than the score for static holding/standing patients (median = 5.00). The loads lifted/transferred by staff were reduced by the use of assistive devices, and also because most manual handling tasks were performed by two or sometimes more members of staff. Often manual handling tasks were delayed if this support was not to hand until the required extra staff were available. Obviously waiting for extra staff would probably not be appropriate in an emergency situation when immediate action is called for and waiting for additional staff is not practical (Stubbs et al., 1983a). Additionally, whilst lifting/transferring patients did not show the greatest medium score for this sub-section, it was significantly higher than other tasks. As already mentioned, it may not be a single lift/transfer that precipitates the onset of pain, but repeatedly performing lifts over a period of time (Anderson, 1980). Failure of vertebrae occurs at much lower loads during repetitive loading, up to 50% lower if 5,000 cycles were performed in a short period of time (Adams, 1996).

'Static holding/standing of patients' was shown to have the same risk as transferring/lifting patients. A static hold was characterised as the maintenance of a posture for five seconds or more where some load was being applied. For example, holding a patient in a sitting position whilst a colleague proceeded to 'bed-bath' the individual. Assisting patients to maintain a standing position was a task usually performed by the physiotherapist to facilitate weight-bearing and circulation and again usually proceeded for a number of seconds. They were therefore stationary tasks. Such static actions have been shown to occur almost as commonly as dynamic actions (Harber et al., 1987b; Blue, 1996). Arad and Ryan (1986) concluded that during an average 40-hour working week, subjects spent 9.5 hours in a bending position. Figure 12 shows a nurse dressing leg wounds with maintained forward trunk flexion.

Figure 12. Nurse re-dressing wounds in maintained trunk flexion

The association between back pain and cumulative stress from such actions was demonstrated by Kumar (1990) with job assessments showing static load to be greater in back pain sufferers. Excessive static load on postural muscles may be more fatiguing than muscular contractions involving movement. Isometric contractions of approximately 15-20% of maximum contraction can lead to impairment of circulation resulting in tissue ischaemia and delayed clearance of metabolites (Chatterjee, 1987). Isometric contractions in flexed postures become particularly necessary because of physical constraints (for example lack of room about the bed) or because equipment (for example the bed) is not at an appropriate height (Harber et al., 1988).

The large amount of evidence detailing lifting and manual handling to be major risk factors for musculoskeletal disorders means the importance of static holding is often neglected, but this study has shown the risk to be equally great as lifting/manual handling. The sub-components of the overall task shown to be responsible for this high score were 'task' and 'load'. Static holding/standing of patients was likely to score highly in the 'task' section because this action was usually performed alone and without the aid of any assistive devices, despite the load being considerable in some situations, and because it was classed in this study as repetitive (maintained), being held for a number of seconds.

Static holding/standing patients scored considerably higher than any other activity for the sub-section 'load'. The high score of this task was mainly because patients were held by one member of staff, who was often in an unstable posture. Also patients could not always be held close to the body, either because lifting a human being is unlike lifting a uniform mass which behaves as expected, or because of environmental constraints. The nature of the patient's disability also compounded the problem and had to be considered when carrying out any procedures.

Lifting/transferring patients and static holding/standing patients would potentially be detrimental to the back and also the neck and shoulders if loads and awkward postures were included. The section of the pro-forma detailing the force acting on the wrists and hands was included because the epidemiological survey and past research (Bork et al., 1996) identified this region as a problem area for physiotherapists. The scores in this section of the pro-forma differed significantly depending on which task was considered. The tasks with the highest scores were physiotherapy manipulations (median = 1.50), writing notes (median = 1.00) and chest physiotherapy (median = 1.00). This finding would therefore appear to support the epidemiological results that indicated physiotherapists had a significantly higher number of problems in this anatomical area and reinforces the dangers of applying data obtained from a nursing population to other healthcare professionals. Continued periods of note writing would also appear to be potentially detrimental. Again this task may be more prominent with the physiotherapy staff who have to write up case notes at the end of each session or at the end of the day and may compound any problems initiated from the involvement of repeated manipulations.

Task risk scores related to other factors The impact of various external factors on the task risk scores was investigated. The risk was not significantly related to gender or left/right handedness. Gender, however, only included a small percentage of male subjects and all of these were physiotherapy staff, due to the lack of males in the chosen specialties. The task score was also not related to the grade of nursing personnel, but was significantly different when the grade of the physiotherapists was considered. The risk was lowest for the assistant and basic physiotherapist, and greatest for Senior 2, Senior 1 and Superintendent grades, with Senior 2 grade having the highest risk. It is suggested that the lower grades work with the Senior 2 and Senior 1 physiotherapists and that their role is a more assistive one, with the Senior 2 and Senior 1 taking more responsibility in the treatment. It is also conceivable that Senior 1 and Superintendent physiotherapists become more involved in the administration of operations and their 'hands on' treatment becomes reduced. This would leave the Senior 2 physiotherapists as having the largest physical work load. Additional work would be required to support or reject this proposition.

The potential risk of performing occupational tasks decreased significantly after 19:00 hours. Prior to this time, the potential risk remained at a constant level throughout the working day (08:00 hours to 19:00 hours). Buckle et al. (1980) showed that 40% of injuries occurred within the first hour of work starting and 65% between 06:00 hours and 12:00 hours. Ryden et al. (1989) suggested that a time of day effect influencing back injuries in nursing may exist, with the highest proportion occurring at the beginning of a shift when staff are not 'warmed up' and at the end of a shift when personnel are in a hurry to leave or fatigue has set in.

It was expected that the times of day with the highest risk would be in the morning and in the early evening when patients are being assisted out of and back into bed, with these being the periods involving a high proportion of patient handling tasks. The data show that there are potentially detrimental tasks with a high risk score occurring through-out the day. The highest score was observed between 12:00 hours and 13:00 hours (median = 5). No explanation can be given for this time being considerably higher than any other time of the day, except that it was approximately the time at which patients were taken to the toilet or assisted on to the commode prior to lunch time. This peak prior to lunch is unlikely to represent staff rushing in their duties so that they can eat their own lunch because staff breaks are staggered throughout the shift and they do not necessarily have their break around this time. Scores after 19:00 hours were considerably lower and this time coincides with when most patients had eaten their evening meal and were back in bed. Once back in bed the patients required little assistance from the nursing staff, especially if relatives were visiting, and this therefore represented a quieter time for the staff. Physiotherapy staff finished work at approximately 17:00 hours except for those on call who were there throughout the night.

When the ages of the nursing and physiotherapy staff were considered together, those between the ages of 20 and 39 were at a significantly higher risk than those who were older. It is conceivable that young staff perform more 'hands-on' work than the older staff with older staff having worked their way up into positions of task delegation. However, if this was true, it would be expected that staff at higher grades (usually older staff) would be performing activities of less potential risk. The data did not support this suggestion.

Adams (1996) believed that back injuries at the beginning of joining the profession may be attributed to the time the intervertebral discs need to 'catch up' with the strengthening muscle and bone. Therefore if young nurses and physiotherapists are at greater risk physiologically and perform tasks with a high risk, this group would be expected to have a significantly increased prevalence rate of musculoskeletal disorders. This possibility shall be discussed in more detail in a later section.

Finally, the task scores were related to the specialty in which they were performed to establish whether certain specialties required the performance of higher risk tasks. The differences between the specialties were significant ($p<0.05$), with the spinal injuries unit being associated with higher risk tasks. Second ranked were care of the elderly and surgical specialties. The specialties deemed to have the lowest risk were orthopaedics and casualty. Vasiliadou et al. (1995) and Owen (1986) reported the highest number of back injuries occurred in specialties requiring physically demanding work. The high risk score for the spinal injuries unit is not surprising if this situation is true, with spinal patients requiring a great deal of physical assistance from staff and the rehabilitation exercised performed by the physiotherapists being sometimes quite strenuous. Care of the elderly would also be considered physically demanding as again the patients can require significant physical assistance. These results would suggest that staff working in certain specialties are at a greater risk of suffering musculoskeletal symptoms than other specialties. The results concerned with the specialty in which personnel work need to be compared with the epidemiological results to ascertain whether this increased potential risk manifests as increased prevalence rates in these specialties. Harber et. al. (1985) believed that there would be no such difference because all aspects of nursing had a high risk component and that nurses would 'select' themselves out of specialties which they found particularly detrimental.

4.4.5 Conclusions

- Tasks with the highest potential risk were those concerned with transferring/lifting patients and those involving a static hold component.
- Manual lifting/handling of patients scored highest on the sub-section 'posture'.
- Static holding/standing patients scored highest in the sub-section 'load' mainly because these activities tended to be performed alone and without the aid of assistive devices.
- The grade of the physiotherapist, the age of the individual and the specialty in which they worked were external factors significantly related to the risk scores.

4.5 Interim Summary of Findings (Epidemiological Studies and Risk Assessment)

Epidemiological work is useful in providing an overview of the musculoskeletal disorder problem faced by the healthcare professionals involved. It does not offer any solutions to the problems indicated. A solution can only be achieved via an objective method of assessing the risk of performing specific occupational tasks. A single measurement method is not sufficient to gauge the variety of settings, tasks and personnel which exist within occupations (Wells et al., 1997). Adopting two different but complementary approaches to the same problem should produce greater success in identifying some of the main underlying causes than adopting a single method of investigation alone.

Patient handling is often cited as the main causal factor preceding a period of low-back pain in both nurses (Jensen, 1990) and physiotherapists (Bork et al., 1996). Indeed, all but one subject included in the prospective study of individuals visiting an Occupational Health Department (n=17) cited lifting as the cause of their musculoskeletal problems. Results of the questionnaire indicated that, of those staff that could attribute their musculoskeletal disorder to a specific incident, 66.7% cited the cause as patient handling/lifting. Of those staff that attributed their symptoms to continued exposure to a stressor, 51.3% of respondents cited this same reason. The epidemiological work indicated lifting/not lifting and the number of lifts performed in the course of an average shift had no predictive significance when entered into the logistic regression analysis for both low-back pain specifically and for musculoskeletal disorders in general.

The risk assessment, supported the argument for the detrimental nature of lifting/handling, indicating this type of task to be a high risk activity. Therefore, patient handling was shown to be a high risk task, but is not totally responsible for the high prevalence of musculoskeletal disorders observed. It is conceivable that all personnel have to participate in lifting/handling of patients and equipment and are exposed to this 'detrimental' aspect of the job. The possibility of the regression analysis drawing a connection between lifting/handling and the absence/presence of a musculoskeletal disorder would thus be reduced. It is also possible that the attention manual handling has received resulted in individuals who suffered musculoskeletal disorders automatically attributing their symptoms to this cause.

Static holding/standing of patients was shown to have risk equally as high as the risk for lifting/handling patients. Kumar (1990) used job assessments to demonstrate that back pain sufferers performed tasks which constituted a greater cumulative static load than non-sufferers. The cumulative stress of such actions may not be so obviously debilitating as pain following a patient lift and this potential risk could therefore be overlooked when subjects are asked to state perceived causes. The potential for static, isometric contractions to have adverse consequences is supported by the epidemiological study of physiotherapists in this thesis (4.1), with physiotherapists whose work regularly required the adoption of maintained stooped positions having a 23% higher risk of suffering musculoskeletal symptoms. This question had not been included in the questionnaire for the nurses so the importance of this factor in nurses could not be assessed. Garg et al. (1992) proposed that many nursing tasks required bent over postures and resultant fatigue of back muscles. It is concluded that static postures constitute a high risk activity for healthcare professionals, with the performance of manual handling tasks immediately after a period of such isometric contraction being particularly dangerous.

The percentage of time spent on the feet was a significant predictor for back pain in the nursing staff. The standing posture may increase the natural process of spinal shrinkage, the effects of which are usually offset by intermittent periods of sitting. Exaggerated spinal shrinkage and resultant bulging on the annulus and nerve root pressure could result in pain and the situation would be conpounded if individuals increased the compressive forces acting on the spine by undertaking further physical activity or the adoption postures that load the spine.

The effects of each risk assessment sub-section on the overall score were considered. When 'load' was considered, the score in this section for patient lifting/handling was considerably lower than the score in this section for static hold/standing patients.

Loads were reduced by the use of assistive devices or by assistance from other members of staff. This situation is not always applicable and it may be that, in emergency situations when it is not possible to wait for extra staff, the highest risk of injury in likely (Stubbs et al., 1983a). Manual lifting scored highest in the sub-section 'posture' potentially because the ideal lifting techniques taught in the classroom are not always possible due to obstructions. Harber et al. (1988) stated that 30% of all actions had a medical attachment present to hinder correct patient movement. Of those individuals responding to the questionnaire, 40% deemed the work environment to be unsuitable, with 61% of these perceiving the main problem to be a poorly designed working area or space constraints. The adoption of non-optimum handling postures could be a serious consideration in the risk of musculoskeletal disorders.

Perceived work pressure was shown to be a strong and significant predictor for both musculoskeletal disorders and low-back pain, essentially in the nursing population. This may be due to a number of factors as discussed in 4.1. A section to record the psychological state of the subject was included in the risk assessment in direct response to this finding. In practice this was difficult to assess, because the section considered whether the subject was 'stressed' and 'hurried' with yes/no answers and all staff were under some degree of stress and performed their activities quickly.

The age of symptomatic and asymptomatic respondents was shown to be significantly different by the epidemiological work. Personnel aged between 30 and 59 and particularly between 50 and 59 showed a higher percentage of musculoskeletal disorders. The initial reaction to these data would be to conclude that the older staff had increased prevalence due to the probability of increased time in the occupation. However, the number of years in the occupation showed no predictive power when entered into the logistic regression model, so the physiological ageing process was thought to be more important in symptom onset than years in the job.

Conversely, the risk assessment showed the staff aged between 20 and 39 actually performed activities with a higher risk. This finding could be attributed to staff of older ages being in higher grades and potentially more involved with administration and less with 'hands on' treatment. However, a significant difference in the prevalence of symptoms of individuals at different grades was not found in the epidemiological study or for nursing staff in the risk assessment. It would appear that younger staff are more at risk but older staff experience more musculoskeletal problems. This would support the conclusion that the increased prevalence with age was due to physiological ageing process and the overall wear and tear of the body throughout work and private life. Further study in this area would be beneficial to solve what appears to be an anomaly in the data.

The danger of assuming that musculoskeletal problems only affect older personnel was illustrated in the prospective study of an Occupational Health Department. Of the 7 case studies, representing the worst cases reported to the occupational health department within the given time period, all were aged below 50 with 2 nurses aged below 30 years. The three nurses that were forced to leave profession because of their musculoskeletal symptoms were 26, 28 and 41 years of age.

The ergonomic risk assessment demonstrated that the overall task score differed significantly between the different physiotherapy grades, with Senior 2 grade having the greatest risk, followed by Senior 1 and Superintendent. This effect of professional grade was not found for the risk assessment of nurses, and the epidemiological study failed to find the prevalence of symptoms was influenced by grade. The higher risk of the higher grades compared to assistant and basic physiotherapists may reflect the length of time in the profession and the cumulative effects of work stress over many years. However, the epidemiological investigation failed to show that the length of time working in the profession was a significant risk factor for either physiotherapists or nursing staff and if this premise was true the highest grade would be expected to have the highest risk and this was not the case. This may therefore suggest that the Senior 2 and higher grades have the highest potential for injury but this potential does not manifest itself in the form of physical symptoms because the staff are accustomed to performing their activities or that a 'healthy worker effect' has occurred and staff susceptible to injury have already left the profession. This finding may suggest that assistant and basic physiotherapists play a supportive role to other staff, Senior 2 have the main responsibility for treatment, and Senior 1 and Superintendent physiotherapists become more involved in administration and less in 'hands on' treatment.

Job specialty was shown to have predictive value for musculoskeletal disorders in both professions and low-back pain in physiotherapists. It was also shown to influence significantly the overall task scores in the risk assessment ($p<0.05$). The specialty responsible for generating the highest task risk scores was spinal injuries, which was perhaps expected considering the highly dependent nature of the patients. Vasiliadou et al. (1995) and Owen (1986) had both previously shown the risk of back injuries was greatest in specialties requiring such physically demanding work. The task scores for each specialty cannot easily be related to the high and low risk specialties identified in the epidemiological investigation because the risk assessment groups together nurses and physiotherapists and the epidemiological study identified different specialties having a high/low risk, depending on which profession was being considered. Separating the risk assessment data into nursing and physiotherapy groups would result in low numbers in each specialty and would therefore give non-reliable results.

It must also be noted that the questionnaire considered annual prevalence. Staff tend to move specialties during the course of their employment and the effects of previous work can not be ignored. Therefore the specialty a nurse/physiotherapist currently works in may not in fact be the specialty in which they were employed when symptoms were first noticed. Mercer (1979) showed nurses to have a 'short stay' profile, with 37% of nurses studied being in the current post for less than 1 year.

Finally, the epidemiological and risk assessment actually consider slightly different aspects despite being complementary methodologies. The risk assessment indicated which specialties had the highest *potential* risk of suffering musculoskeletal symptoms. The epidemiological investigation indicated which specialties had the largest relative percentage of sufferers. It does not necessarily follow that working in a high risk specialty will necessarily result in a higher musculoskeletal prevalence. As previously stated with physiotherapy grade, the staff working in the higher risk specialties represent those staff who have the physical capabilities to complete the required tasks without any adverse affects on health, and those more susceptible staff have already left to work in other specialties or other professions.

The preceding studies have attempted to indicate some factors associated with the onset of different musculoskeletal disorders. Hospital management can take on board some of the recommendations from such studies, for example the implementation of assistive devices to limit the amount of manual handling performed by personnel. Other recommendations may be more difficult to put into practice. The problems of space constraints are difficult to rectify without major structural changes to work-space design or reducing the number of beds within each ward.

The lower back was the anatomical area most affected in nurses and physiotherapists in the epidemiological studies of this thesis. One factor associated with back pain was the percentage of time staff spent on their feet during the course of an average shift. If a short period of sitting could be shown to be beneficial in reducing back pain amongst nurses and physiotherapists, ensuring a seated break occurred during the work shift would be a relatively simple measure for hospitals to implement. In the following study, the aim was to assess the importance of a seated break compared to a standing break on spinal shrinkage, used as an index of loading, one factor associated with potential back pain.

5.0 Spinal Shrinkage During Simulated Tasks of Nurses and Porters

5.1 Spinal Shrinkage During a Seated Break and Standing Break During Simulated Nursing Tasks

5.1.1 Introduction

Human stature varies throughout the course of a day, being greatest on rising and least prior to going to bed. This is because compressive loads on the spine during the day cause fluid to be expelled from the nucleus pulposus and leads to bulging of the annulus and deformation of the vertebral end-plates (Van Dieën and Toussaint, 1993). This situation results in loss of stature. Bulging of the annulus impinges on the nerve roots and increases the probability of pain (Eklund and Corlett, 1984). The process of fluid expulsion is reversed once the load has been removed from the spine and normal stature is regained as a consequence (Helander and Quance, 1990). Prolonged shrinkage is one possible factor associated with back pain as the disc loses its capability to respond to further compressive loading (Eklund and Corlett, 1984).

Spinal shrinkage can be used as a measure of spinal compression because the rate of change in stature is directly related to the load and exposure time (Leivseth and Drerup, 1997). Shrinkage is measured using precision stadiometry. This equipment has been shown to give precise, reliable measures once the subjects have undergone a period of familiarisation (Eklund, 1988; Troup et al., 1985; Eklund and Corlett, 1984; Leatt et al., 1985).

The effect on spinal shrinkage of sitting as opposed to standing has not been conclusively established. Some authors have assumed that spinal shrinkage is greater during sitting than standing (Eklund and Corlett, 1984; Magnusson et al., 1994) and other authors have claimed the converse to be true (Althoff et al., 1992; Leivseth and Drerup, 1997). Logistic regression analysis of the questionnaire data of this thesis (4.1) indicated that the likelihood of suffering back pain increased among the nursing personnel when the percentage of time they spent on their feet was increased. Nursing is an active occupation, with elements of lifting, pushing, pulling and bending. Such actions increase the compressive load on the spine and facilitate spinal shrinkage.

The aim of this study was to assess the effect on spinal shrinkage of a 20-min 'sit down' break compared to a 20-min 'standing break' during a 4-hour trial of simulated nursing activities. It was predicted that spinal shrinkage would be less during the 'seated' break than during the 'standing' break.

5.1.2 Methodology

Development of procedure Work profiles were obtained from 8 nurses working at a District General Hospital. Each nurse was 'shadowed' for 2 hours and the actions performed by the nurse was recorded every 5 seconds. These activities were standing, sitting, walking, pushing, pulling, lifting, bending and crouching. These activities were identified from the risk assessment study and covered all possible activities performed by the nurses. For each nurse shadowed, the total duration of each activity was established. Heart rate was recorded every 15 seconds using a short range telemetry system (Polar, Kempele, Finland).

The nurses were of various grades, worked in different specialties and data were collected at different times of the day to ensure a cross-section of information was recorded. One work profile was rejected from the study because it was considerably different from other profiles and was determined to be non-representative of a normal working period. This profile was for a manager of the neo-natal department and at the time of study no babies were being treated on the ward. The occupational demands for this manager were uncharacteristically low. The average duration of each activity was calculated from the 7 profiles for the 2 hours. This enabled the percentage time each activity was performed to be established

Two different laboratory procedures were developed from this data. In each of the 2 trials, subjects worked for 2 hours, had a break of 20 min and worked for a further 100 minutes. This constituted 4 hours in total for each test as follows:

120-min work → 20-min break → 100-min work → finish

Both trials were identical except subjects sat in the 20-min break in trial 1 and stood during the break in trial 2.

Laboratory Procedure

Pilot work A mean heart rate was obtained from the nurses' data by averaging the mean heart rates of the 7 nurses' profiles. The self-paced test protocol was performed by one subject to ensure that the heart rate for the laboratory procedure was not greatly different to the mean heart rate from the data for the nurses.

Subjects Ten female subjects were recruited to participate in the study. The mean age was 25 (±3.94) years, their mean height was 166 (±9.24) cm and their mean body mass was 63.5 (±6.2) kg. Each subject attended the laboratory on three separate occasions and completed a consent form prior to testing (Appendix 6).

Familiarisation On the first occasion, subjects were familiarised with a precision stadiometer which was used during the testing procedure to measure changes in stature (spinal shrinkage) (Althoff et al., 1992). A cross was drawn on the spinous process of the first thoracic vertebrae (T1). By looking through a camera, mounted behind the subject, the mark could be viewed. The camera was connected to a linear transducer. Relative stature was recorded by moving the camera so that the cross-hairs in the viewer lined up with the mark on the neck (Burton et al., 1994). The equipment and procedure were developed at Münster University and is illustrated in Figure 13. When the subjects were competent at using the stadiometer, they were asked to move away from and back onto the stadiometer numerous times in quick succession. If the cross on the subject's neck was exactly on the cross-hairs of the camera each time, the subject was in the same position each time and familiarisation was complete. This ensured that, during testing, any changes in stature were due to spinal shrinkage and not because the subjects were adopting different postures.

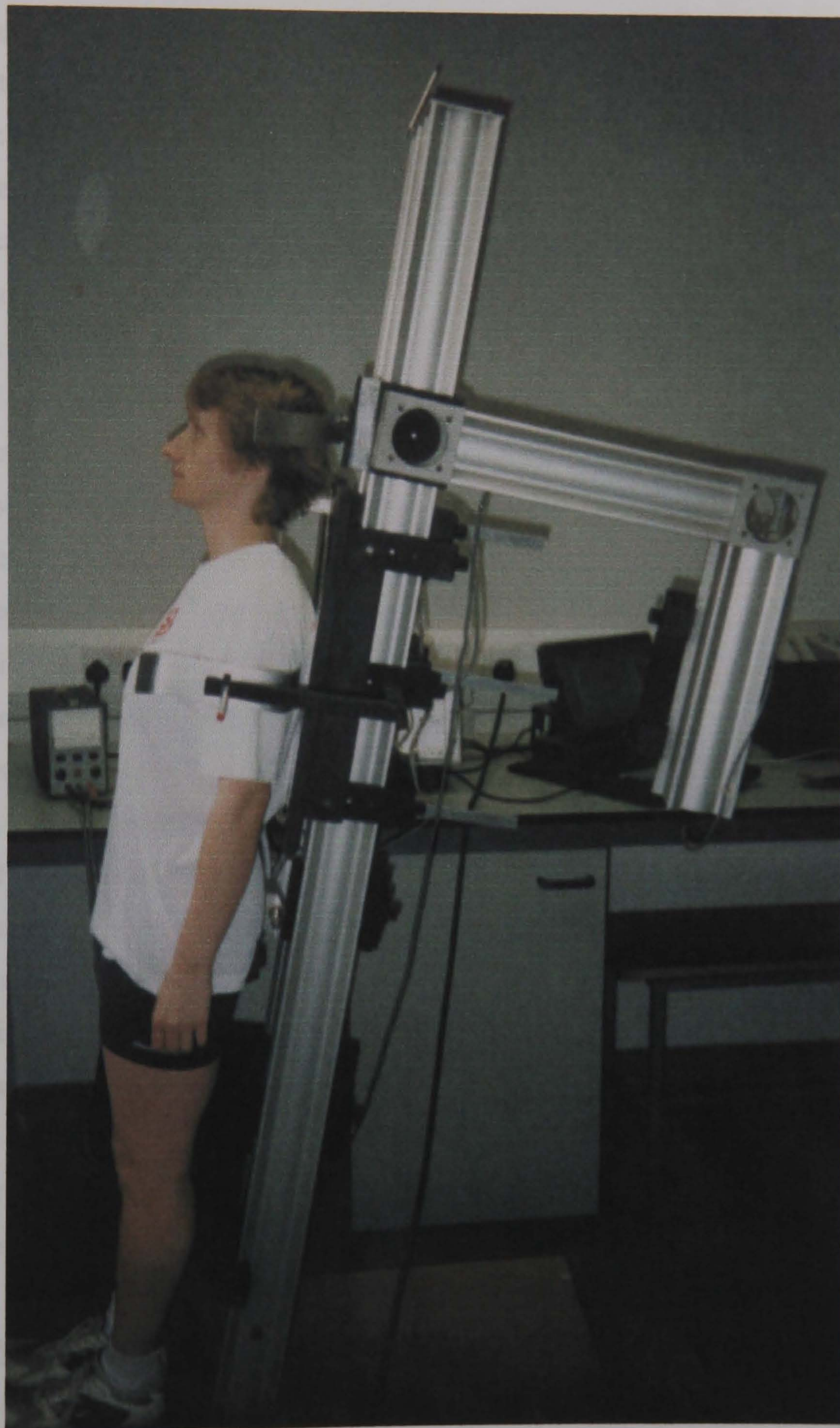

Figure 13. Precision stadiometer to measure spinal shrinkage

Test sessions On the two sessions of testing, subjects were required to attend the laboratory having participated in no physical activity 24 hours prior to testing. Subjects were required to lie supine with knees and hips flexed and ankles supported (Fowler's position) for 20 min to allow for a period of controlled spinal unloading. Subjects performed both trials at the same time of day to reduce any effects of diurnal variation. The order of trials was randomly assigned to the subjects. The research design adopted meant that the subjects effectively acted as their own control.

Subjects were required to undertake short bouts of each activity. During standing, they were asked to stand still or perform one of two activities with their arms. The first activity was to lay a sheet out repeatedly over a table, smooth the sheet down and then fold the sheet back up. This was to simulate a nurse making a bed and other tasks involving attending to a patient in a bed whilst the nurse was stationary. The second task involved repeatedly stacking books from a table at waist height to a shelf approximately shoulder height. This task simulated a nurse removing and replacing drugs, files or bed linen from shelving, attaching or changing a drip, tidying the patients' lockers or other over-head work. There was no actual lifting component to the testing as the nurses shadowed never lifted. Lifting devices were used when actual lifts were required. During care of the patient in the bed, the usual procedure was to work in pairs and 'roll' the patient so that no single nurse was bearing a heavy load at any time. In this study, a low flat box weighing 20 kg was either 'rolled' away from, or to the side of, the subject and held for a number of seconds. This manoeuvre was similar to a nurse rolling a patient in bed to allow medical procedures or bathing, for example. A data collection sheet is given in Appendix 7.

Variables measured Spinal shrinkage was recorded at set intervals throughout each trial. Pre-test data points were obtained to elicit the individual's natural shrinkage. This was extrapolated to determine the predicted shrinkage over the four hours. The difference between the observed and expected shrinkage was the final shrinkage value. Heart rate was recorded every 15 seconds in each test using a short range radio telemetry system (Polar, Kempele, Finland). Subjects were asked to give a rating of perceived exertion (RPE) on a 6 to 20 Borg scale (Borg, 1970) (see Appendix 8) at the beginning of the break and at the end of testing. They were also asked to rank anatomical areas from 'most discomfort' to 'least discomfort' and give an overall measure of discomfort (Corlett and Bishop, 1976) (see Appendix 9) at the beginning and end of the break and at the end of testing.

5.1.2.1. Analysis of data

Differences in mean spinal shrinkage, heart rate, rating of perceived exertion and overall discomfort between the two trials were analysed using paired t-tests in Minitab (version 5).

5.1.3. Results

The mean, standard deviation and level of significance for heart rates, RPE, discomfort and spinal shrinkage for trials 1 and 2 are given in Table 17. Significant results are high-lighted. Mean heart rates for the first 2 hours and the last 100-min did not differ significantly between the 2 trials. The mean heart rate during the break in the sitting trial was significantly less than the mean heart rate during the break in the standing trial. Perceived postural discomfort was significantly greater after the standing break than the seated break. Spinal shrinkage was also significantly greater at the end of the standing trial than at the end of the seated trial.

Table 17. Recorded variables and the level of probability (significant results are in bold).

	Standing break	Sitting break	P value
Heart rate for the first 2 hours (beats/min)	88 (±11)	87 (±9)	0.80
Discomfort at end of first 2 hours	2 (±0.943)	2.2 (±0.919)	0.34
RPE at end of first two hours	9.6 (±2.119)	9.3 (±2.003)	0.39
Heart rate during the break (beats/min)	87 (±11)	77 (±8)	**0.003**
Discomfort at the end of the break	2.3 (±1.252)	1.3 (±0.483)	**0.009**
Heart rate for the last 100 min (beats/min)	89 (±9)	88 (±8)	0.60
Discomfort at end of testing	2.8 (± 1.13)	2.4 (±1.17)	0.27
RPE at end of testing	10.9 (±1.79)	10.9 (±1.73)	1.00
Spinal shrinkage (mm)	3.80 (± 2.26)	2.77 (±1.61)	**0.021**

5.1.4. Discussion

Increased mechanisation and use of computers greatly reduced the occurrence of physically demanding jobs in the western world. However, the prevalence of musculoskeletal disorders, and in particular back problems remains high (Van Dieën and Oude Vrielink, 1998). Biering-Sørensen (1983) reported that 52-60% of the general population group surveyed gave work as the main cause of their back pain. The logistic regression analysis of the questionnaire data of this thesis (4.1) suggested a relationship between back problems in the nursing population surveyed and the percentage of time nursing personnel spent on their feet in the course of an average shift. There was no relationship between the time spent on the feet and musculoskeletal disorders in general, suggesting that prolonged standing/walking had a potentially detrimental effect on the back only.

The aim of this present study was to assess the effect of a 20-min seated break as opposed to a 20-min standing break on spinal shrinkage of subjects performing a 4-

hour period of simulated nursing tasks. This is based on the assumption that the process of spinal recovery and stature gain is rapid and that a period of sitting provides for a period of decreased spinal loading compared with standing (Leivseth and Drerup, 1997). Consultation with hospital based nurses had indicated that although a 20-min break was scheduled during each shift, demands on the wards often meant that this break was sometimes not taken. Nurses were often on their feet for the entire length of the shift. The length of time spent standing is of particular importance in the nursing profession where about 90% of the nurses are female. Discs of females are smaller and have a smaller cross-sectional area than in males. A small disc is under higher stress than a larger disc and thus, fluid loss and viscoelastic deformation will be greater (Althoff et al., 1992).

When the shrinkage for the two trials was compared, it was found that subjects had less shrinkage over the 4 hours of testing when they sat for the 20-min break as opposed to when they stood. The work performed in each of the two trials was identical but, as the work was self-paced, it was important that this difference in the amount of shrinkage could not be attributed to differences in work-load. The average heart rates of the first 2 hours were compared and there was no significant difference found. Heart rates for this time period for sitting and standing breaks were 87 (±9) and 88 (±11) beats/min, respectively. This was also true when the average heart rates for the last 100-min of the work cycle were compared (representing the remaining time once the 20-min break had been taken). Heart rates for this period of time were 89 (±9) and 88 (±7) beats/min for standing and sitting, respectively. This observation indicates that there was no difference between the work-loads of the two trials and so the difference in shrinkage can be attributed to the effects of the posture during the break.

The beneficial effects of sitting on shrinkage are not conclusive. Magnusson et al. (1990) observed a decreased stature in a sitting position. In this study by Magnusson et al. (1990) the subjects lay down prior to testing and the shrinkage observed whilst sitting was probably due to the shrinkage naturally observed when subjects move from a supine into a sitting posture (Leivseth and Drerup, 1997).

Stature loss has been measured when subjects sat for 1.5 hours in three different chairs. These were a stool, office chair with a lumbar support, and an easy chair with a full-size backrest, inclined at 110 and with a 4-cm deep lumbar support. Shrinkage was greatest in the stool, followed by the office chair but stature increased when subjects sat in the easy chair (Eklund and Corlett, 1984). A trial incorporating standing was not included in the research design so a comparison between sitting and standing could not be made. It is also worth noting that only three subjects were used in this study.

Spinal shrinkage in subjects sitting in a variety of different chairs was studied by Althoff et al. (1992) with a correction made for heel compression (Foreman and Linge, 1989). The greatest increase in stature was reported when sitting with an inclined back rest and arms supported. However, sitting always resulted in an increase in stature, regardless of the chair used or the posture adopted. This was also true during unsupported erect sitting. It was concluded that sitting reduced spinal stress compared to standing.

Comparisons in spinal shrinkage between relaxed sitting, seated work and standing work over 6.5 hours indicated that relaxed sitting for a 2-hour period showed a significant gain in stature. Working for 2 hours in a sitting posture had only minor influences on stature, with height loss being significantly less than that observed during standing work. The difference in shrinkage between the group undertaking standing work and the group performing work sitting down was confined to the lumbar region of the spine (Leivseth and Drerup, 1997). Some caution must be exercised in interpreting these results. Subjects did not act as their own control because it was a field based study with the working subjects representing two different occupations and other factors such as loads moved may play a role. Nevertheless, it would appear to suggest that the load on the lumbar spine was significantly greater during standing work than seated work and indeed a period of relaxed sitting caused significant stature gains.

Nursing is recognised as a physically demanding job, with periods of lifting, pushing/pulling, bending and twisting. The demanding nature of the profession is of particular importance when it is considered that the majority of nursing personnel are female. Foreman and Troup (1987) measured changes in stature of 12 nurses during an 8-hour working shift and a 12-hour day off. Overall loss of stature during the working day was significantly greater than the loss during the day off. The duration for which the spine was off-loaded was inversely related to loss of stature, indicating that the spine had time to recover when the load was removed. Leskinen et al. (1988) recorded stature changes during continual manual work. They concluded that decreases in stature reflect the cumulative work load as there is no possibility for regain of stature if there are no rest periods. Stålhammar et al. (1992) suggested that recovery occurs quickly once a period of unloading is initiated. A few minutes of rest lying down after heavy activities was suggested to be beneficial for the spine.

The results of this present study suggest that a period of sitting as opposed to standing has a beneficial effect on spinal shrinkage over a 4-hour period of work. This is not to say that stature increased during the seated break but that the shrinkage process was slowed when compared to the shrinkage occurring during standing. A seated break may therefore have the potential to reduce back problems linked with spinal shrinkage by reducing spinal loading.

During this present study, postural discomfort (Corlett and Bishop, 1976) and rating of perceived exertion (Borg, 1970) were measured. Postural discomfort and RPE did not differ significantly between the two trials after the first 2 hours of testing, when subjects had performed exactly the same work on each of the two occasions. There was also no significant difference between the two trials for either of these measures (RPE and postural discomfort) at the end of the 4-hour session. There was, however, a significant difference in postural discomfort after the 20-min break, with subjects reporting lower values of discomfort after sitting than after standing. Whilst this measure indicated total body discomfort and not simply discomfort of the back, it would appear to support the shrinkage measurements that sitting reduced the perceived as well as recorded load on the body. Using the same measure of postural discomfort, Troup et al. (1985) reported that subjects 'reporting discomfort... will be subjected to an increased rate of spinal shrinkage'. The differences in discomfort reported by the subjects after the break in this present study give added weight to the recorded differences in spinal shrinkage.

The subjects' heart rates were also recorded during the break. The average heart rates for subjects during the standing break and sitting break were significantly different; 87 (±11) and 77 (±8) beats/min, respectively. The higher heart rate when standing may be because of decreased venous return due to pooling in the extremities when standing, heart rate increasing to compensate for a reduction in stroke volume. Muscles used in the maintenance of the standing posture may also be responsible for eliciting the higher heart rate during the standing break with less muscle activity being required during sitting. This extra muscular activity may be exerting a greater load on the spine than when is present when the subjects sit.

In a real life situation is it not possible for nurses working in demanding situations to take frequent short breaks to allow for a period of spinal recovery. Whilst lying down yields the greatest rate of recovery, this manoeuvre is probably not practical in a work situation either. This present study suggests that a period of sitting significantly allows some recovery when compared to standing and is a potential way to reduce the back pain problem amongst nursing personnel. Prolonged standing may also result in fatigue. Nurses in a state of fatigue may be more likely to adopt incorrect postures during lifting which could increase the likelihood of injury (Estryn-Behar et al., 1990).

Finally, the lower back was not the only anatomical area to be affected by the simulated work. Subjects were asked to indicate on a diagram the anatomical areas in which they experienced discomfort. The responses varied according to the subject but areas affected included the shoulders and neck, the upper and mid-back and both upper and lower legs. Whole body postural discomfort was significantly lower after the seated break than the standing break. Extensive periods of standing may have detrimental effects on other anatomical areas.

5.1.5 Conclusions

- A seated break of 20 min induced less spinal shrinkage than a standing break of the same duration during 4 hours of simulated nursing activities.
- A period of sitting allows for unloading the spine and either reversal or termination of the shrinkage process.
- Subject complained of significantly greater postural discomfort after the standing break than following the seated break.
- Ensuring that nurses have a 20-min break and maintain seated during this time has the potential to reduce the prevalence of back problems in hospital nursing staff.

5.2 Spinal Shrinkage During Simulated Tasks of Hospital Porters

5.2.1 Introduction

The previous study (5.1) indicated that a 20-min seated break slowed down the rate of spinal shrinkage compared to a 20-min standing break during simulated nursing tasks. A period of sitting allows for unloading the spine and may have the potential to reduce the likelihood of nurses suffering back pain. Establishing the optimal position of the break may be beneficial in reducing back pain further. Porters were recruited for this study because literature concerning their musculoskeletal status is lacking, despite their job requiring elements of physically demanding work. Secondly, porters were used because analysis of break times showed that porters had longer total break time during an average day than nurses or physiotherapists. Nurses breaks were too short to be manipulated.

The study firstly aimed to establish whether back pain was a problem experienced by hospital porters. Secondly, the magnitude of spinal shrinkage of porters working under the existing hospital work-rest schedule was measured. A modified work-rest schedule was then developed to ascertain whether spinal shrinkage could be lessened and the potential for the occurrence of back pain reduced.

5.2.2 Methodology

a) Epidemiology of back pain in hospital porters

A short questionnaire was devised to assess the back problems experienced by hospital porters. The questionnaire consisted of nine questions, some of which had multiple sub-sections. The questions were concerned with establishing the perceived cause of occupational back pain, the symptoms experienced, how often back pain occurred and sickness absence profiles. A copy of the questionnaire can be found in Appendix 10.

Questionnaires were distributed in October 1998 to the deputy head porter of Southport and Formby District General Hospital. This individual was responsible for ensuring that every porter within the hospital received a questionnaire. Altogether, nineteen questionnaires were distributed. Completed questionnaires were either returned to the deputy head porter en masse or were returned independently. The questionnaire was completely confidential.

b) Spinal shrinkage

Procedure development Eight hospital based porters were recruited from Southport and Formby District General Hospital to obtain work profiles. The mean age was 40 (±8.7) years. Each porter was 'shadowed' by an observer for a 2-hour period in which time the activities performed by the porter and the amount of time each action took was recorded. The actions included walking, standing, sitting and pushing or pulling whilst walking. The percentage of time each action was performed within the 2-hour period was then obtained.

The work-rest schedule of the hospital porters was ascertained. Porters worked an eight hour shift with one 10-min break in the morning and afternoon and a 30-min break for lunch. A 4-hour period of testing was used to represent this work-rest schedule, with the three breaks constituting 25 min. The first 4-hour test protocol was as follows (trial 1):

53.75-min work → 5-min break → 53.75-min work → 15-min break → 53.75-min work → 5-min break → 53.75-min work → finish.

An alternate four-hour work-rest schedule was proposed and constituted the second test session (trial 2):

71.66-min work → 12.50-min break → 71.66-min work → 12.50-min break → 71.66-min work → finish.

The relative percentage of time in which the subjects were walking, standing, pushing and so on during the 4-hour period of testing was calculated from the hospital based information on porters. The percentage of time that each action was performed was identical for each of the two test sessions. Rest breaks were differently distributed but the total time spent at rest was constant.

Laboratory Procedure

Subjects Ten male students were recruited to participate in the study. The mean age was 23 (±2.9) years, their mean height was 180 (±5.4) cms and their mean body mass was 81.3 (±12.71) kg. Each subject was required to attend the laboratory on three separate occasions and completed a consent form prior to testing (see Appendix 11). A precision stadiometer was used to measure spinal shrinkage. On the first occasion subjects underwent training to familiarise themselves with this equipment. The equipment and procedure for measuring spinal shrinkage was identical to that stated in the previous section of this thesis (5.1).

Test sessions On each of the two subsequent test sessions, subjects were required to attend the laboratory having participated in no physical activity for 24 hours prior to testing. Subjects were asked to rest with trunk supine and legs raised with knees and hips flexed and ankles supported (Fowler's position) for 20 min prior to each session of testing. Each subject performed the existing work-rest schedule and the modified work-rest schedule, on two separate occasions; the hypothesis was that two longer breaks as opposed to two short and one longer break reduces spinal shrinkage, by allowing more time for spinal recovery. Subjects remained seated during the breaks. The order of testing was randomly assigned to the subjects. The research design adopted meant that the subjects acted as their own control. Each subject was also tested at the same time of the day to ensure natural diurnal variation was controlled for. At the end of each test, subjects were asked to give a rating of perceived exertion (RPE) on a 6 to 20 Borg scale (Borg, 1970). During testing, heart rate was recorded using a short range radio telemetry system (Polar, Kempele, Finland). (See Appendix 12 for the data collection sheets for the 2 trials).

5.2.2.1 Analysis of Data

The questionnaire was analysed using the statistical software SPSS (version 6.01). Differences between the two trials for spinal shrinkage, RPE and heart rate were analysed using paired t-tests in Minitab (version 5).

5.2.3 Results

a) Epidemiology of back pain in hospital porters

A response rate of 89.5% (n = 17) was obtained for the porters' questionnaire. Only one porter was female. Just over half of the group (53%) reported that they had back pain at some time in their working lives of a perceived work related cause. Only one porter reported that he had taken time off work due to the symptoms. Three porters reported that they could remember a single incident that initiated the first period of back pain. Two attributed their pain to lifting a patient and the third attributed it to moving equipment. Five porters reported that their symptoms were caused by stress over a period of time. This included lifting/moving patients and equipment and three porters also stated pushing/pulling trolleys.

b) Spinal shrinkage

There was no significant difference between the spinal shrinkage of the subjects in trial 1 and trial 2 ($p>0.05$). There was also no difference in the rating of perceived exertion and mean heart rates for the two trials ($p>0.05$). Results are given in Table 18.

Table 18. Results for shrinkage, perceived exertion and heart rates in response to simulated porters' tasks.

	Trial 1	Trial 2	P value
Spinal shrinkage (mm)	2.1 (±3.16)	2.9 (±2.92	0.47
Rating of perceived exertion	7.6 (±1.4)	7.8 (±1.4)	0.34
Mean heart rate (beats/min)	79 (±6)	81 (±6)	0.35

5.2.4 Discussion

The results of the previous study reported that a seated break was important to reduce the overall amount of spinal shrinkage nurses suffered in the course of 4 hours of simulated work activities. This study aimed to develop this idea by attempting to ascertain whether shorter, but frequent seated breaks produced less spinal shrinkage than one long break. As in the previous study a 4-hour test protocol was used due to the difficulties of obtaining subjects willing to participate in the study for 8 hours which would represent a full working shift. It was not possible to examine nurses in this study because nurses only have a 30-min break during the course of the 8 hours of work. In a 4-hour simulated trial this would allow for a break of only 15 min which was insufficient time to allow for manipulation of the break length. It was decided that porters would be used because they were allotted a 50-min break during an average work shift and a break of 25 min during testing allowed for some manipulation. Before commencing with the spinal shrinkage work a short questionnaire was administered to all the porters working at Southport and Formby District General Hospital. This questionnaire indicated that back problems of a perceived work-related origin were evident in the population so using porters for this part of the work was believed to be valid. They also represent a group of healthcare employees who are rarely studied in terms of musculoskeletal disorders or back problems despite their work being of a physically demanding nature.

No significant differences were found in this study in the shrinkage of subjects between the observed rest schedule and the experimental work-rest regimen. Trial 2 had been expected to elicit a reduced mean shrinkage, with two longer breaks (12.50 min) facilitating more recovery than one long break (15 min) and two very short breaks (5 min). Shrinkage and recovery occur at an exponential rate (Konz, 1998). This exponential recovery would suggest that frequent short breaks are most beneficial as they give the greatest relative recovery. However, very small breaks may not allow sufficient time to change from discal compression to expansion.

Helander and Quance (1990) considered the effects of the duration and frequency of rest intervals on spinal shrinkage in keyboard operators. Forty minutes of rest breaks were dispersed throughout 4 hours of work; 8 breaks of 5 min, 4 breaks of 10 min, 2 breaks of 20 min or a single break of 40 min. During the breaks the subjects were required to stand or walk around. The 5-min and 10-min breaks were too little time to allow a change from shrinkage to recovery, but the 20-min and 40-min breaks allowed for height gain. It was concluded that 2 breaks of 20 min yielded the optimum because a single 40-min break demanded a long work period and subjects became restless and uncomfortable. These subjective data are important as individuals' ratings of perceived exertion have been shown to be associated linearly with spinal shrinkage (Troup et al., 1985). This study by Helander and Quance (1990) considered sedentary workers, with spinal shrinkage occurring during time seated and recovery occurring whilst standing. The current study is concerned with active work and seated rest.

The present findings suggest that breaks longer than 10-min are required to initiate a period of recovery from spinal shrinkage. Recovery was not expected after the 5- min breaks in trial 1. If recovery does not occur until after approximately 10 min, then both trial 1 and trial 2 had equal time of rest that could initiate recovery (the last 5 min of the 15-min break in trial 1 and the last 2.50 min of the 2 breaks of 12.50-min in trial 2). The similarity in recovery time may have accounted for the lack of difference in spinal shrinkage between the two trials.

It was suggested that the 5-min breaks were too short to assist recovery and that two longer breaks would be more beneficial to reduce total spinal shrinkage. This result was not confirmed with spinal shrinkage not affected by the positioning and length of rest breaks. Some sitting was incorporated into the work period in both trials (as is the case when porters are awaiting their next task) and the seated posture may have facilitated recovery within both trials. Where there are no periods of sitting during the work time, the periods of recovery during the designated breaks may become more important and consequently, differences between the trials might have been expected. Whether recovery occurred during the breaks or during the sitting periods during work could not be resolved.

The rating of perceived exertion ranged from 6 to 10 on Borg's 6 to 20 scale. Mean heart rate values were 79 (±6) and 81 (±6) beats/min for trial 1 and trial 2, respectively. The results for both of these variable show that the work load was 'light'. It is likely that more physically demanding work would induce a greater amount of spinal shrinkage (Tyrrell, et al., 1985) and the length of rest breaks may have been more important.

5.2.5 Conclusions

- The questionnaire indicated a high prevalence of back problems in the small group of porters surveyed.
- Altering the length and positioning of rest breaks did not affect spinal shrinkage.
- Back pain experienced by the porters can not be reduced by employing the altered work-rest schedule.

6.0 Overview of Findings

6.1 Fulfilment of Aims

1. The prevalence of musculoskeletal disorders among hospital based nurses and physiotherapists has been established. Annual prevalence of musculoskeletal disorders of various locations for nurses and physiotherapists combined was 49%. The point prevalence was 20.7%. The most commonly affected area was the low-back/buttocks/pelvis/hips/ upper legs area.

2. Clinical diagnoses and prognoses of nursing and physiotherapist patients attending an Occupational Health Clinic have been obtained. The most commonly affected anatomical area of those consulting the Occupational Health Clinic was the lower back area. A clinical diagnosis was given for some patients. Others were said to have 'low-back pain' indicating the idiopathic nature of some symptoms, even after a medical examination. Four of the 7 case studies were retired from the profession indicating the severity of some musculoskeletal disorders.

3. Perceived causes of these musculoskeletal disorders have been obtained. Most nurses and physiotherapists believed their musculoskeletal symptoms were caused by patient lifting/manual handling. Logistic regression analysis failed to show that this variable was significantly associated with musculoskeletal disorders or low-back pain. Other factors did show a significant associated and will be discussed further in section 6.2.2 below. Direction of causality for these associated factors is not conclusive because very few of the measured variables changed over the 20-month period of the longitudinal study.

4. The tasks with the greatest potential to cause musculoskeletal disorders have been established. These are transferring/lifting patients and static holding activities/standing of patients.

5. The effects of 4-hour simulated nursing tasks on spinal shrinkage have been established. Spinal shrinkage was less when the subjects had a 20-min seated break during the 4 hours than when they stood for the 20-min break.

6. The effects of a modified work-rest schedule on spinal shrinkage and the compressive loads on the spine during simulated porters tasks have been given. There was no significant difference in the amount of spinal shrinkage between the existing work-rest schedule and the modified work-rest schedule.

6.2 Synthesis of Findings

6.2.1 Review of work; All the aims of this thesis have been fulfilled by the epidemiological, field based and experimental work in the preceding chapters. The annual prevalence of musculoskeletal disorders of various locations for nurses and physiotherapists combined was 49%. The point prevalence was 20.7%. A clinical diagnosis and prognosis of all nurses and physiotherapy personnel attending an occupational health clinic has been obtained. This allows for the identification of tasks/activities responsible for the onset of musculoskeletal symptoms. Perceived causes have been ascertained using the cross-sectional questionnaire data. Prospective data concerning perceived causes were collected using the longitudinal questionnaire and the accident report information from the occupational health physician.

The ergonomic risk investigation provided information regarding which nursing and physiotherapy tasks were most stressful. Tasks with the highest potential risk for causing musculoskeletal disorders were those concerned with lifting/transferring patients and those involving a static hold component, including standing a patient as part of the rehabilitation process.

Precision stadiometry was used to determine the effects of simulated nursing tasks on spinal shrinkage. It was concluded that a 20-min seated break during work would have a beneficial effect on shrinkage as opposed to a 20-min standing break. Mean shrinkage values for the standing trial and seated trial were 3.80 mm and 2.77 mm, respectively. This difference was significant and was confirmed by ratings of perceived exertion data. The same methodology was employed to investigate the effects of an altered work-rest schedule on spinal shrinkage for a simulation of porters' tasks. The altered work-rest schedule did not have any significant effect on spinal shrinkage when compared to the existing work-rest schedule of the hospital-based porters.

The results of the work will be interpreted in this chapter with regard to the musculoskeletal problem of healthcare professionals.

6.2.2 General discussion; Nurses and physiotherapists reported a high prevalence rate of musculoskeletal disorders. It has previously been reported that nurses have a high risk of suffering back problems. This thesis elucidates that the back, although the most commonly affected anatomical area, is not the only area affected in nurses. It also shows that physiotherapists, a group of healthcare professionals personnel seldom studied, also exhibit a high prevalence of musculoskeletal disorders. The problem of musculoskeletal disorders among nurses and physiotherapists must be addressed by staff, hospital managers and researchers alike. The cross-sectional questionnaire stated that musculoskeletal disorders accounted for 19% of all sickness absences.

Figure 14 is a schematic model detailing the factors this thesis found to be associated with an increased risk of suffering or reporting a musculoskeletal disorder amongst nurses and physiotherapists. The premise that musculoskeletal disorders have a multi-factorial aetiology has been confirmed. Occupational, organisational, personal and psychosocial factors appear to be important and should be considered in combination.

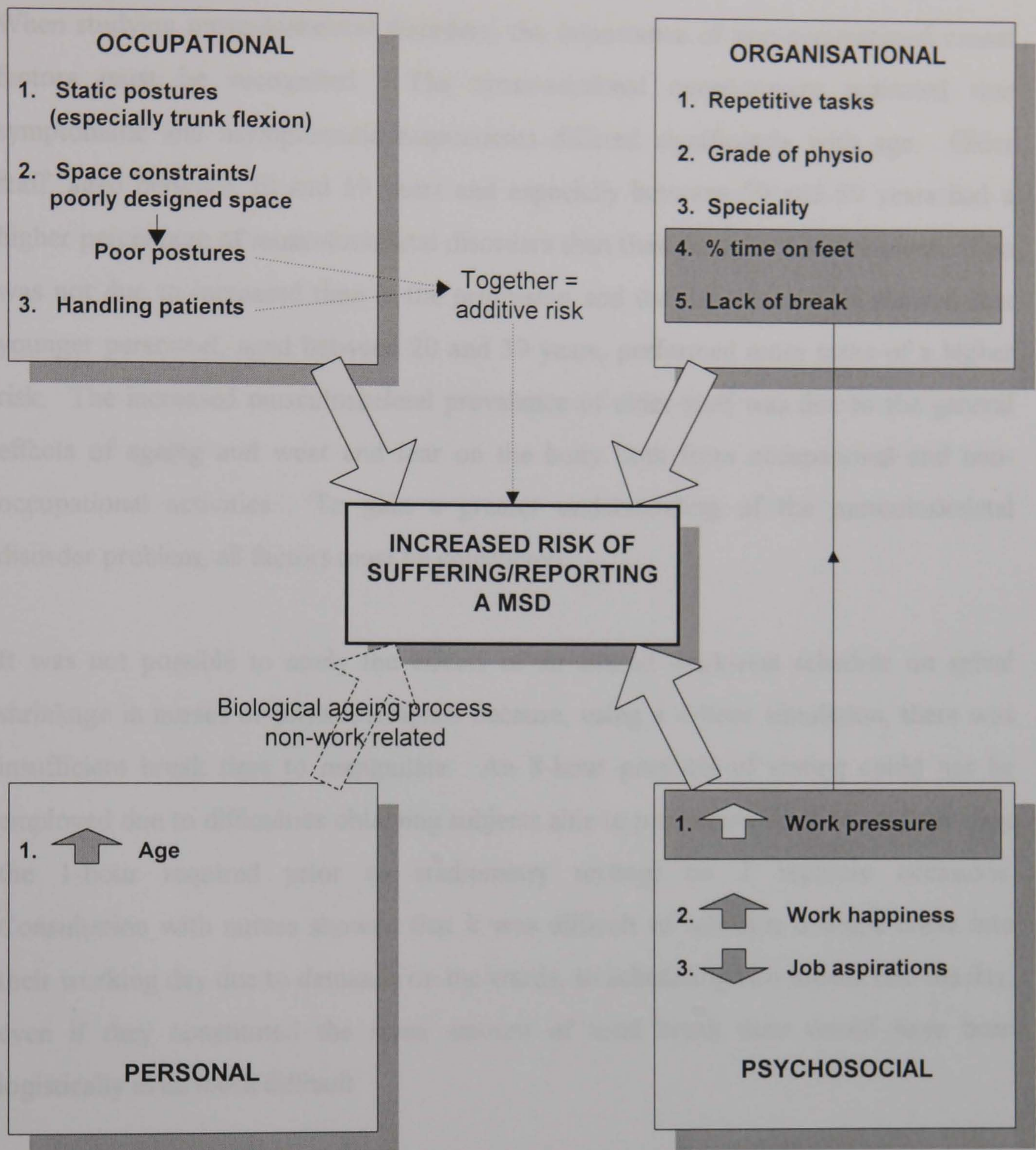

Figure: 14 Schematic model detailing factors associated with an increased risk of suffering or reporting a musculoskeletal disorder

When studying musculoskeletal disorders, the importance of non-occupational causal factors must be recognised. The cross-sectional questionnaire indicated that symptomatic and asymptomatic respondents differed significantly with age. Older staff, aged between 30 and 59 years and especially between 50 and 59 years had a higher percentage of musculoskeletal disorders than their younger counter-parts. This was not due to increased time in the profession and the risk assessment showed that younger personnel, aged between 20 and 39 years, performed more tasks of a higher risk. The increased musculoskeletal prevalence of older staff was due to the general effects of ageing and wear and tear on the body both from occupational and non-occupational activities. To gain a greater understanding of the musculoskeletal disorder problem, all factors must be considered.

It was not possible to study the effects of an altered work-rest schedule on spinal shrinkage in nurses or physiotherapists because, using a 4-hour simulation, there was insufficient break time to manipulate. An 8-hour protocol of testing could not be employed due to difficulties obtaining subjects able to participate for 9 hours (including the 1-hour required prior to stadiometry testing) on 2 separate occasions. Consultation with nurses showed that it was difficult to schedule a single break into their working day due to demands on the wards, so scheduling two breaks into the day, even if they constituted the same amount of total break time would have been logistically even more difficult.

A review of literature indicated that the musculoskeletal disorder problem faced by hospital-based porters was largely unknown, despite their jobs requiring aspects of pushing, pulling, lifting and extensive periods of walking. The short questionnaire distributed to one hospital showed that back pain was prevalent among this group of porters. The porters' back pain was perceived by them to be of a work-related origin. The positioning and length of rest breaks did not affect spinal shrinkage in subjects performing a simulation of porters' tasks. The back problems experienced by the porters were not attributed to the positioning of the rest breaks in this study.

This thesis has highlighted the factors associated with musculoskeletal disorders and low-back pain in nurses and physiotherapists and to a lesser degree hospital porters. It has also indicated the multi-disciplinary nature of musculoskeletal disorders and low-back pain. It is valuable to initially assess the impact of individual factors on musculoskeletal symptoms but to give an understanding of the whole problem, factors must not be considered in isolation.

It is important that research can be understood by those for whom it was intended. It would be possible to collate these findings in order to make recommendations to healthcare managers. Findings from this thesis are being studied by one hospital within the Merseyside area.

7.0 Recommendations for Future Work

7.1 Recommendations for Future Work

In this thesis information detailing the musculoskeletal problem experienced by healthcare professionals and some of the possible causes have been reported. Not all the questions that arose during this work could be answered within the scope of this thesis and the following points are recommendations for future work. The main limitations of this study was that it was only concerned with a selected group of healthcare professionals (nurses, physiotherapists and porters). Gaps in the literature exist concerning healthcare professionals other than nurses. This study has included physiotherapists and to a lesser degree porters and studies concerning these and other employees would be valuable.

This work has identified areas where the potential for further study exists.

1) The major area of work arising from this thesis is the validation of the proposed ergonomic model. The following work could be completed to achieve this:-

a) There is a need to investigate the direction of causality between musculoskeletal disorders and the associated risk factors. It would be beneficial to follow asymptomatic individuals just joining the nursing or physiotherapy profession over numerous years. Each few months a detailed questionnaire could be used to assess whether a musculoskeletal disorder had developed and the physical, psychosocial, environmental and organisational factors of that time. This would ensure that the first episode of a musculoskeletal disorder could be recorded and distant recall was not relied on.

b) It would be important to assess the effects of maintained static postures on the musculoskeletal system. Comparing electromyographic (EMG) recordings of performing identical work in the upright position and a position of lateral trunk flexion would indicate differences in muscle activity. Spinal shrinkage measurements to assess compressive loads on the spine could be used in conjunction with EMG.

c) The identification of exactly which specialties have the highest risk and the reasons why need closer examination. The research design of any investigation in this area must consider that personnel are likely to have worked in numerous different specialties during the course of their working lives. Monitoring musculoskeletal disorders of new staff working in different specialties would be beneficial.

d) The benefits of having a seated break during the course of a nurses' working day needs further investigation. It would be valuable to test nurses during the course of an actual working shift, as opposed to students performing simulated nursing tasks within a laboratory. The effects on spinal shrinkage could then be assessed over the full 8-hour shift and actual rather than simulated activities investigated.

2) The working area of nurses and physiotherapists should be redesigned and the impact of these changes assessed. Comparative work on postures adopted and EMG readings of the back for before and after the intervention could be performed.

3) A review of literature failed to show any studies relating to musculoskeletal disorders in hospital-based porters within the United Kingdom. The small questionnaire distributed to all porters in one hospital within Merseyside showed that the prevalence for back problems was high and may need more investigation in a larger sample.

4) Investigations of the back pain problem in surgeons was out-side the scope of this thesis. Surgeons represent a group of individuals who spend long periods of time standing whilst performing lengthy operations. Spinal shrinkage may be associated with extended periods of time on the feet. Investigating the effects on spinal shrinkage whilst performing operations standing would establish whether or not this was a problem. An alternative way of performing surgery (combining a mixture of standing and sitting) could be beneficial in reducing compressive loading on the spine and its consequences for back and musculoskeletal problems.

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Appendix One

Nurses' Questionnaire

(Cross-Sectional Study)

This investigation of **musculoskeletal disorders amongst healthcare professionals** has been initiated by the European Commission.

Health and safety at work are of prime importance; we need to know if reoccurring musculoskeletal problems exist which may be attributed to the work you do and/or the environment in which you are employed.

In order for this information to be of use, we also need some information about your lifestyle. These questions are valuable and designed to be as non-intrusive as possible; please give them your full attention.

Your responses to this questionnaire are strictly confidential and will not be disclosed to any third party.

PLEASE READ THE QUESTIONS THOROUGHLY AND PROVIDE ADDITIONAL INFORMATION WHERE REQUESTED.

THANK YOU FOR TAKING THE TIME TO COMPLETE THIS IMPORTANT DOCUMENT.

QUESTIONNAIRE CODE ☐

Please tick boxes where appropriate or write the required information in the space provided.

SECTION 1. GENERAL INFORMATION

1. **Are you FEMALE ☐ or MALE? ☐**
2. **Please state your JOB TITLE / GRADE**
   ....
   ....
3. **For how long (years) have you worked as a nurse?**
   ....
4. **In which speciality do you work at the moment?**..
5. **How long (years) have you worked in this speciality?**........................**years**
6. **Do you feel you are at the pinnacle of your career? NO ☐ YES ☐**
   If no, what would be the highest grade of nursing you would like to achieve and feel capable of achieving?..
   ....
7. **During the past year how many days off work due to sickness of any type have you taken?** ....**days**

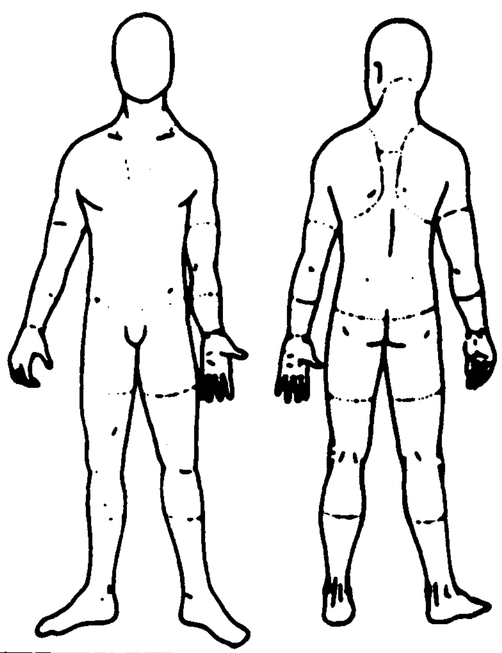
SECTION 2. MUSCULOSKELETAL DISORDERS

Musculoskeletal disorders (MSD) may be defined as injuries or diseases of the musculoskeletal system which may be attributed to work.

The following questions relate to MSDs which may occur at <u>any site</u> of the body, these include tendinitis (shoulder, hand, wrist, Achilles), epicondylitis (e.g. tennis elbow), low back pain. They may be characterised by symptoms of **pain, numbness or inflammation**.

8. Have you experienced any pain or discomfort <u>within the past year</u> that you believe to be related to your work?
   NO ☐ go to section 3
   YES ☐ continue with next question

9. Refer to the body diagram below and mark on the anatomical site of the disorder. **<u>If you have experienced more than one musculoskeletal disorder, use the form 2A at the back of the questionnaire to register details of a separate MSD.</u>**



Front	Back

10. Please indicate the symptoms/discomfort you experience in relation to the MSD indicated on the diagram:

Pain	☐	Burning	☐
Numbness/Tingling	☐	Swelling	☐
Pain/numbness/tingling	☐	Stiffness	☐
Ache	☐	Other (describe)............................	

....

11. Are you <u>currently</u> experiencing symptoms? NO ☐ YES ☐

12. When did you first notice the problem? (month/year)............................

13. How long does the problem usually last?

Less than 1 hour	☐	> 1 week - 1 month	☐
1 hr - 24 hrs	☐	> 1 month - 6 months	☐
>24 hrs - 1 week	☐	More than 6 months	☐

14. How many separate times have you had the problem?

Constant	☐	Once a month	☐
Daily	☐	Every 2-3 months	☐
Once a week	☐	More than 6 months	☐

15. Can you recall an <u>incident</u> after which symptoms were FIRST evident?
    NO ☐ YES ☐ If YES (give details of the incident)..............
    ....
    ....
    ....

    15a What time of day did this incident occur?

Morning	☐	Evening	☐
Afternoon	☐	Night	☐

    15b If your MSD can NOT be attributed to a single incident, can you attribute it to <u>continued exposure</u> to particular occupational activities (give details of activities and time spent each day performing them)
    ....
    ....
    ....

16. Are your symptoms made worse by the performance of specific occupational activities? NO ☐ YES ☐ If YES, please indicate which activities aggravate symptoms (specific postures, movements etc.)..
....
....
....

17. Has the presence of symptoms forced you to change job (ie. Speciality)?
NO ☐ YES ☐

18. Has the presence of symptoms forced you to <u>change the way you perform</u> occupational activities? NO ☐ YES ☐
If YES, please indicate which activities are affected and how you now cope with performing them ....
....
....
....

19. Have you consulted a medical practitioner with regard to this disorder?
NO ☐ YES ☐ If YES, please list ALL those you have consulted (e.g. General Practitioner, Osteopath, Consultant Physician, Occupational Health physician)..
....
....

20. Have you been given a clinical diagnosis with regard to your musculoskeletal disorder? NO ☐ YES ☐ If YES, please state the diagnosis..
....
....

21. Have you had sickness absence from work specifically resulting from your MSD symptoms only? NO ☐ YES ☐ If YES, how many days <u>during the last year</u> have you been absent from work due to these symptoms? ....days

22. Have you received treatment for your MSD? NO ☐ YES ☐
If YES, what treatment have you been given (e.g. physiotherapy, rest, surgery, analgesics). Please specify how long you have been receiving treatment..
....
....
....

22a How effective has the above treatment been:
- Symptoms much worse ☐
- Symptoms worse ☐
- Symptoms unchanged ☐
- Symptoms less severe ☐
- Symptoms disappeared ☐

23 Please rate the intensity of discomfort you feel with regard to this MSD during the <u>course of a days work</u>:
- No discomfort ☐
- Slight discomfort ☐
- Moderate discomfort ☐
- Unbearable discomfort ☐

24. Please rate the intensity of discomfort you feel when symptoms are at <u>their very worst</u>:
- No discomfort ☐
- Slight discomfort ☐
- Moderate discomfort ☐
- Unbearable discomfort ☐

25. When are symptoms at their most severe (e.g. in the morning, at night, after work)?..
....
....

Would you be willing to discuss your MSD in greater detail with an independent researcher?
If you would like to do so, either telephone Dr Diana Leighton (0151 231 2157) or write your name and contact number here so that a short interview may be arranged:

....

....

SECTION 3. YOUR WORK AND WORK ENVIRONMENT

26. Are you involved in the lifting and handling of patients?
NO ☐ go to question 28.
YES ☐

27. Approximately how many manual patient transfers per shift do you perform? (Without the use of assistive devices: hoists/sliding boards etc.) ....lifts per shift

28. Do you regularly use assistive devices when you need to transfer patients? NO ☐ YES ☐ If NO, please state reason(s)..

....

....

29. What proportion of your time is spent on your feet/standing during a shift?...............%

30. Are there any activities which you <u>repeatedly</u> perform within a short period of time? NO ☐ YES ☐ If YES, please give details of activities..

....

....

....

31. Is your work environment suitable for the occupational activities you need to perform? NO ☐ YES ☐ If NO please state how activities are affected (e.g. space constraints, equipment design)

....

....

....

....

32. Do your occupational activities include overhead tasks i.e. reaching above head height? NO ☐ YES ☐ If YES, please indicate the purpose of these activities...

....

....

....

33. Questions about your <u>life at work</u>. Read each statement carefully and decide which answer best suits you.
"In the past few weeks, how much of the time at work have you felt the following?"

	Never	Occasionally	Some of the time	Much of the time	Most of the time	All of the time
1. Tense	☐	☐	☐	☐	☐	☐
2. Cheerful	☐	☐	☐	☐	☐	☐
3. Uneasy	☐	☐	☐	☐	☐	☐
4. Enthusiastic	☐	☐	☐	☐	☐	☐
5. Worried	☐	☐	☐	☐	☐	☐
6. Optimistic	☐	☐	☐	☐	☐	☐
7. Calm	☐	☐	☐	☐	☐	☐
8. Gloomy	☐	☐	☐	☐	☐	☐
9. Contented	☐	☐	☐	☐	☐	☐
10. Depressed	☐	☐	☐	☐	☐	☐
11. Relaxed	☐	☐	☐	☐	☐	☐
12. Miserable	☐	☐	☐	☐	☐	☐

34. Please indicate how strongly you agree/disagree with the all the statements given below. Tick the box beneath the most appropriate response(s)(tick one box per statement).

Statement	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
I can do my job well	☐	☐	☐	☐	☐
I sometimes think I am not very competent at my job	☐	☐	☐	☐	☐
I can deal with just about any problem in my job	☐	☐	☐	☐	☐
I find my job quite difficult	☐	☐	☐	☐	☐
I feel I am better than most people at tackling job difficulties	☐	☐	☐	☐	☐
In my job I often have trouble coping	☐	☐	☐	☐	☐
In my job I like to set myself challenging targets	☐	☐	☐	☐	☐
I am not very interested in my job	☐	☐	☐	☐	☐
I enjoy doing new things in my job	☐	☐	☐	☐	☐
I prefer to avoid difficult activities in my job	☐	☐	☐	☐	☐
In my job, I make a special effort to keep trying when things seem difficult	☐	☐	☐	☐	☐
I am not very concerned how things turn out in my job	☐	☐	☐	☐	☐
	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree

35. How satisfied do you feel about your job as a whole?

- Extremely dissatisfied ☐
- Very dissatisfied ☐
- Moderately dissatisfied ☐
- Not sure ☐
- Moderately satisfied ☐
- Very satisfied ☐
- Extremely satisfied ☐

36. Please read each question and tick the box which best represents your reply.

Question	Rarely	Sometimes	Often	Most of the time
Do you have too much work to do?	☐	☐	☐	☐
Do you feel that you have a lot of responsibility for the work of others?	☐	☐	☐	☐
Do you work very hard - either physically or mentally?	☐	☐	☐	☐
Are you under pressure to keep up with new ways of doing things?	☐	☐	☐	☐
Do you have to decide things where mistakes could be quite costly?	☐	☐	☐	☐
Do you work too many hours?	☐	☐	☐	☐
Do you have too little help or equipment to get the job done well?	☐	☐	☐	☐
Do you have important responsibilities?	☐	☐	☐	☐
	Rarely	Sometimes	Often	Most of the time

SECTION 4. ABOUT YOURSELF & YOUR LIFESTYLE

37. Please give you AGE .... HEIGHT ....
and WEIGHT ....

38. Do you smoke cigarettes? YES ☐ NO ☐

39. Approximately how many units of alcohol do you drink in a typical week?................................units
1 unit = 1 glass of wine 1 unit = a single measure of spirits
= ½ pint beer, lager, cider = a small glass of sherry

40. Do you regularly participate in physical activity of 20 minutes duration or longer? YES ☐ NO ☐

41. How do you rate your current level of fitness compared to other nurses of your age?
good/better ☐ average/same ☐ poor/worse ☐

42. Have you ever been diagnosed with a metabolic disease e.g. diabetes mellitus, hypothyroidism, megaloblastic anaemia?
NO ☐ YES ☐ please give details...
....
....
....

43. Please state approximately the distance between your home and work.
.... miles

44. Do you suffer from rheumatoid arthritis? NO ☐ YES ☐

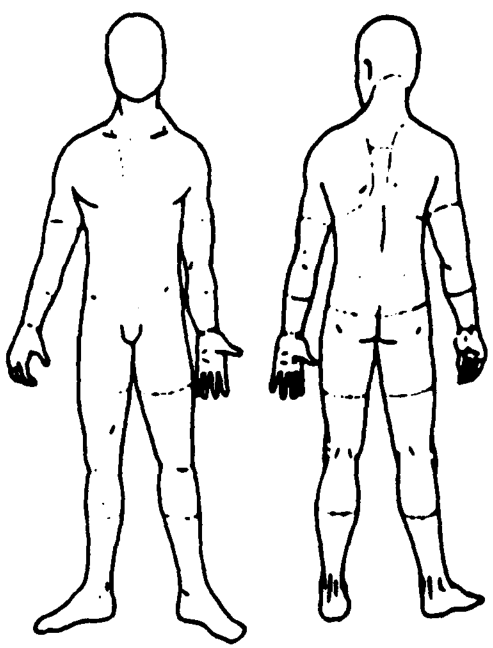
45. Questions about your life outside your job. Read each statement carefully and decide which answer best suits you.
"In the past few weeks, how much of the time outside of work have you felt the following?"

	Never	Occasionally	Some of the time	Much of the time	Most of the time	All of the time
1. Tense	☐	☐	☐	☐	☐	☐
2. Cheerful	☐	☐	☐	☐	☐	☐
3. Uneasy	☐	☐	☐	☐	☐	☐
4. Enthusiastic	☐	☐	☐	☐	☐	☐
5. Worried	☐	☐	☐	☐	☐	☐
6. Optimistic	☐	☐	☐	☐	☐	☐
7. Calm	☐	☐	☐	☐	☐	☐
8. Gloomy	☐	☐	☐	☐	☐	☐
9. Contented	☐	☐	☐	☐	☐	☐
10. Depressed	☐	☐	☐	☐	☐	☐
11. Relaxed	☐	☐	☐	☐	☐	☐
12. Miserable	☐	☐	☐	☐	☐	☐

FORM 2A TO REPORT ADDITIONAL MUSCULOSKELETAL DISORDERS

ONLY fill in this section if you have an **additional MSD** not already stated in the rest of the questionnarire.

1. On the body diagram below mark on the anatomical site of the disorder.



2. Please indicate the symptoms/discomfort you experience:

Pain	☐	Burning	☐
Numbness/Tingling	☐	Swelling	☐
Pain/numbness/tingling	☐	Stiffness	☐
Ache	☐	Other (describe)	

....

3. Are you <u>currently</u> experiencing symptoms? NO ☐ YES ☐

4. When did you first notice the problem (month/year)...................................

5. How long does the problem usually last?

Less than 1 hour	☐	> 1 week - 1 month	☐
1 hr - 24 hrs	☐	> 1 month - 6 months	☐
>24 hrs - 1 week	☐	More than 6 months	☐

6. How many separate times have you had the problem?

Constant	☐	Once a month	☐
Daily	☐	Every 2-3 months	☐
Once a week	☐	More than 6 months	☐

7. Can you recall an <u>incident</u> after which symptoms were FIRST evident?
NO ☐ YES ☐ If YES (give details of the incident) ....
....
....

7a What time of day did this incident occur?

Morning	☐	Evening	☐
Afternoon	☐	Night	☐

7b If you can NOT attribute your MSD to a single incident, can you attribute it to <u>continued exposure</u> to particular occupational activities(give details of activity and time spent each day performing these activities)....
....
....
....

8. Are your symptoms made worse by the performance of specific occupational activities? NO ☐ YES ☐ If YES, please indicate which activities aggravate symptoms (specific postures, movements etc.)..........................
....
....
....

9. Has the presence of symptoms forced you to change your job (ie speciality)? NO ☐ YES ☐

PLEASE TURN OVER

FORM 2A TO REPORT ADDITIONAL MUSCULOSKELETAL DISORDERS

10. Has the presence of symptoms forced you to <u>change the way you perform</u> occupational activities? NO ☐ YES ☐ If YES, please indicate which activities are affected and how you now cope with performing them ....
....
....
....

11. Have you consulted a medical practitioner with regard to this disorder? NO ☐ YES ☐ If YES, please list ALL those you have consulted (e.g. General Practitioner, Osteopath, Consultant Physician).......................
....
....

12. Have you been given a clinical diagnosis with regard to your musculoskeletal disorder? NO ☐ YES ☐ If YES, please state the diagnosis...
....
....

13. Due to your MSD symptoms, have you taken sickness absence from work? NO ☐ YES ☐ If YES, how many days <u>during the last year</u> have you been absent from work due to symptoms?

............................days

14. Have you received treatment for your MSD? NO ☐ YES ☐
If YES, what treatment have you been given (e.g. physiotherapy, rest, surgery, analgesics). Please specify how long you have been receiving treatment...
....
....
....

14a How effective has the above treatment been:
- Symptoms much worse ☐
- Symptoms worse ☐
- Symptoms unchanged ☐
- Symptoms less severe ☐
- Symptoms disappeared ☐

15. Please rate the intensity of discomfort you feel with regard to this MSD during the <u>course of a days work</u>:
- No discomfort ☐
- Slight discomfort ☐
- Moderate discomfort ☐
- Unbearable discomfort ☐

16. Please rate the intensity of discomfort you feel when symptoms are at <u>their very worst</u>:
- No discomfort ☐
- Slight discomfort ☐
- Moderate discomfort ☐
- Unbearable discomfort ☐

17. When are symptoms at their most severe (e.g. in the morning, at night, after work?..
....
....

Dr. D. Leighton and Ms C. Beynon would sincerely like to thank you for taking the time to complete this questionnaire.

Appendix Two

Physiotherapists' Questionnaire

(Cross-Sectional Study)

This investigation of **musculoskeletal disorders amongst healthcare professionals** has been initiated by the European Commission.

Health and safety at work are of prime importance; we need to know if reoccurring musculoskeletal problems exist which may be attributed to the work you do and/or the environment in which you are employed.

In order for this information to be of use, we also need some information about your lifestyle. These questions are valuable and designed to be as non-intrusive as possible; please give them your full attention.

Your responses to this questionnaire are strictly confidential and will not be disclosed to any third party.

PLEASE READ THE QUESTIONS THOROUGHLY AND PROVIDE ADDITIONAL INFORMATION WHERE REQUESTED.

THANK YOU FOR TAKING THE TIME TO COMPLETE THIS IMPORTANT DOCUMENT.

QUESTIONNAIRE CODE ☐

Please tick boxes where appropriate or write the required information in the space provided.

SECTION 1. GENERAL INFORMATION

1. **Are you FEMALE ☐ or MALE? ☐**
2. **Please state your JOB TITLE / GRADE**
   ....
   ....
3. **For how long (years) have you worked as a physiotherapist?**
   ....
4. **In which speciality do you work at the moment?**.....................................
5. **How long (years) have you worked in this speciality?**........................**years**
6. **Do you feel you are at the pinnacle of your career? NO ☐ YES ☐**
   If no, what would be the highest grade of nursing you would like to achieve and feel capable of achieving?...
   ....
7. **During the past year how many days off work due to sickness of any type have you taken?** ....**days**

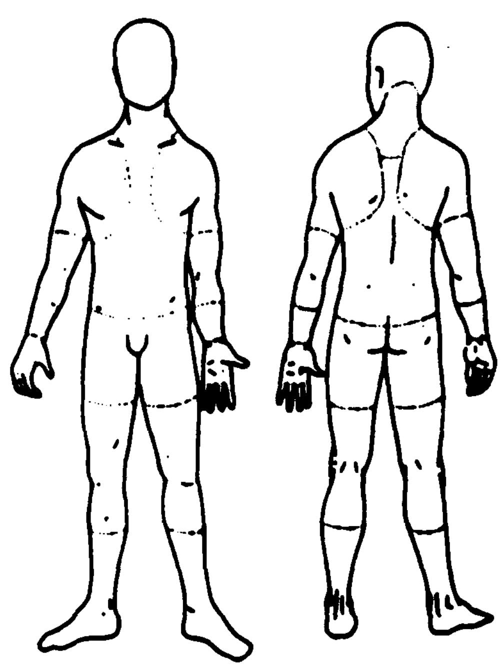
SECTION 2. MUSCULOSKELETAL DISORDERS

Musculoskeletal disorders (MSD) may be defined as injuries or diseases of the musculoskeletal system which may be attributed to work.

The following questions relate to MSDs which may occur at <u>any site</u> of the body, these include tendinitis (shoulder, hand, wrist, Achilles), epicondylitis (e.g. tennis elbow), low back pain. They may be characterised by symptoms of pain, numbness or inflammation.

8. Have you experienced any pain or discomfort <u>within the past year</u> that you believe to be related to your work?
   NO ☐ go to section 3
   YES ☐ continue with next question

9. Refer to the body diagram below and mark on the anatomical site of the disorder. <u>If you have experienced more than one musculoskeletal disorder, use the form 2A at the back of the questionnaire to register details of a separate MSD.</u>



Front	Back

10. Please indicate the symptoms/discomfort you experience in relation to the MSD indicated on the diagram:

Pain	☐	Burning	☐
Numbness/Tingling	☐	Swelling	☐
Pain/numbness/tingling	☐	Stiffness	☐
Ache	☐	Other (describe)........................	

....

11. Are you <u>currently</u> experiencing symptoms? NO ☐ YES ☐

12 When did you first notice the problem? (month/year)..........................

13. How long does the problem usually last?

Less than 1 hour	☐	> 1 week - 1 month	☐
1 hr - 24 hrs	☐	> 1 month - 6 months	☐
>24 hrs - 1 week	☐	More than 6 months	☐

14. How many separate times have you had the problem?

Constant	☐	Once a month	☐
Daily	☐	Every 2-3 months	☐
Once a week	☐	More than 6 months	☐

15. Can you recall an <u>incident</u> after which symptoms were FIRST evident?
NO ☐ YES ☐ If YES (give details of the incident)................

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

15a What time of day did this incident occur?

Morning	☐	Evening	☐
Afternoon	☐	Night	☐

15b If your MSD can NOT be attributed to a single incident, can you attribute it to <u>continued exposure</u> to particular occupational activities (give details of activities and time spent each day performing them)

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

16. Are your symptoms made worse by the performance of specific occupational activities? NO ☐ YES ☐ If YES, please indicate which activities aggravate symptoms (specific postures, movements etc.)..
....
....
....

17. Has the presence of symptoms forced you to change job (ie. Speciality)?
NO ☐ YES ☐

18. Has the presence of symptoms forced you to <u>change the way you perform</u> occupational activities? NO ☐ YES ☐
If YES, please indicate which activities are affected and how you now cope with performing them ....
....
....
....

19. Have you consulted a medical practitioner with regard to this disorder?
NO ☐ YES ☐ If YES, please list ALL those you have consulted (e.g. General Practitioner, Osteopath, Consultant Physician, Occupational Health physician)...
....
....

20. Have you been given a clinical diagnosis with regard to your musculoskeletal disorder? NO ☐ YES ☐ If YES, please state the diagnosis...
....
....

21. Have you had sickness absence from work specifically resulting from your MSD symptoms only? NO ☐ YES ☐ If YES, how many days <u>during the last year</u> have you been absent from work due to these symptoms? ....days

22. Have you received treatment for your MSD? NO ☐ YES ☐
If YES, what treatment have you been given (e.g. physiotherapy, rest, surgery, analgesics). Please specify how long you have been receiving treatment...
....
....
....

22a How effective has the above treatment been:

Symptoms much worse ☐
Symptoms worse ☐
Symptoms unchanged ☐
Symptoms less severe ☐
Symptoms disappeared ☐

23 Please rate the intensity of discomfort you feel with regard to this MSD during the <u>course of a days work</u>:

No discomfort ☐
Slight discomfort ☐
Moderate discomfort ☐
Unbearable discomfort ☐

24. Please rate the intensity of discomfort you feel when symptoms are at <u>their very worst</u>:

No discomfort ☐
Slight discomfort ☐
Moderate discomfort ☐
Unbearable discomfort ☐

25. When are symptoms at their most severe (e.g. in the morning, at night, after work)?...
....
....

Would you b… to discuss your MSD in greater detail with an independent researcher?
If you would like to do so, either telephone Dr Diana Leighton (0151 231 2157) or write your name and contact number here so that a short interview may be arranged:

....

....

SECTION 3. YOUR WORK AND WORK ENVIRONMENT

26. How many patient lifts/manual transfers do you perform <u>without</u> the use of any assistive devices per shift? ....

27 How many patient lifts/manual transfers do you perform <u>with</u> the aid of assistive devices per shift?............................

28. If you do not **always** use assistive devices for patient lifting/manual handling, what are your reasons?..
....
....

29. Do you regularly adopt stooped/bent over positions NO ☐ YES ☐
If yes, for what purpose?..
....
....

30. What proportion of your time is spent on your feet/standing during a shift?................%

31. Are there any activities which you <u>repeatedly</u> perform within a short period of time? NO ☐ YES ☐ If YES, please give details of activities..
....
....
....

32. Is your work environment suitable for the occupational activities you need to perform? NO ☐ YES ☐ If NO please state how activities are affected (e.g. space constraints, equipment design)
....
....
....
....

33. Do your occupational activities include overhead tasks i.e. reaching above head height? NO ☐ YES ☐ If YES, please indicate the purpose of these activities..
....
....
....

34. Questions about your <u>life at work</u>. Read each statement carefully and decide which answer best suits you.
"In the past few weeks, how much of the time at work have you felt the following?"

	Never	Occasionally	Some of the time	Much of the time	Most of the time	All of the time
1. Tense	☐	☐	☐	☐	☐	☐
2. Cheerful	☐	☐	☐	☐	☐	☐
3. Uneasy	☐	☐	☐	☐	☐	☐
4. Enthusiastic	☐	☐	☐	☐	☐	☐
5. Worried	☐	☐	☐	☐	☐	☐
6. Optimistic	☐	☐	☐	☐	☐	☐
7. Calm	☐	☐	☐	☐	☐	☐
8. Gloomy	☐	☐	☐	☐	☐	☐
9. Contented	☐	☐	☐	☐	☐	☐
10. Depressed	☐	☐	☐	☐	☐	☐
11. Relaxed	☐	☐	☐	☐	☐	☐
12. Miserable	☐	☐	☐	☐	☐	☐

34. Please indicate how strongly you agree/disagree with the all the statements given below. Tick the box beneath the most appropriate response(s)(tick one box per statement).

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
I can do my job well	☐	☐	☐	☐	☐
I sometimes think I am not very competent at my job	☐	☐	☐	☐	☐
I can deal with just about any problem in my job	☐	☐	☐	☐	☐
I find my job quite difficult	☐	☐	☐	☐	☐
I feel I am better than most people at tackling job difficulties	☐	☐	☐	☐	☐
In my job I often have trouble coping	☐	☐	☐	☐	☐
In my job I like to set myself challenging targets	☐	☐	☐	☐	☐
I am not very interested in my job	☐	☐	☐	☐	☐
I enjoy doing new things in my job	☐	☐	☐	☐	☐
I prefer to avoid difficult activities in my job	☐	☐	☐	☐	☐
In my job, I make a special effort to keep trying when things seem difficult	☐	☐	☐	☐	☐
I am not very concerned how things turn out in my job	☐	☐	☐	☐	☐
	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree

35. How satisfied do you feel about your job as a whole?

- Extremely dissatisfied ☐
- Very dissatisfied ☐
- Moderately dissatisfied ☐
- Not sure ☐
- Moderately satisfied ☐
- Very satisfied ☐
- Extremely satisfied ☐

36. Please read each question and tick the box which best represents your reply.

	Rarely	Sometimes	Often	Most of the time
Do you have too much work to do?	☐	☐	☐	☐
Do you feel that you have a lot of responsibility for the work of others?	☐	☐	☐	☐
Do you work very hard - either physically or mentally?	☐	☐	☐	☐
Are you under pressure to keep up with new ways of doing things?	☐	☐	☐	☐
Do you have to decide things where mistakes could be quite costly?	☐	☐	☐	☐
Do you work too many hours?	☐	☐	☐	☐
Do you have too little help or equipment to get the job done well?	☐	☐	☐	☐
Do you have important responsibilities?	☐	☐	☐	☐
	Rarely	Sometimes	Often	Most of the time

SECTION 4. ABOUT YOURSELF & YOUR LIFESTYLE

37. Please give your AGE .... HEIGHT ....
and WEIGHT ....

38. Do you smoke cigarettes? YES ☐ NO ☐

39. Approximately how many units of alcohol do you drink in a typical week?................................units
1 unit = 1 glass of wine 1 unit = a single measure of spirits
= ½ pint beer, lager, cider = a small glass of sherry

40. Do you regularly participate in physical activity of 20 minutes duration or longer? YES ☐ NO ☐

41. How do you rate your current level of fitness compared to other nurses of your age?
good/better ☐ average/same ☐ poor/worse ☐

42. Have you ever been diagnosed with a metabolic disease e.g. diabetes mellitus, hypothyroidism, megaloblastic anaemia?
NO ☐ YES ☐ please give details..
....
....
....

43. Please state approximately the distance between your home and work.
.... miles

44. Do you suffer from rheumatoid arthritis? NO ☐ YES ☐

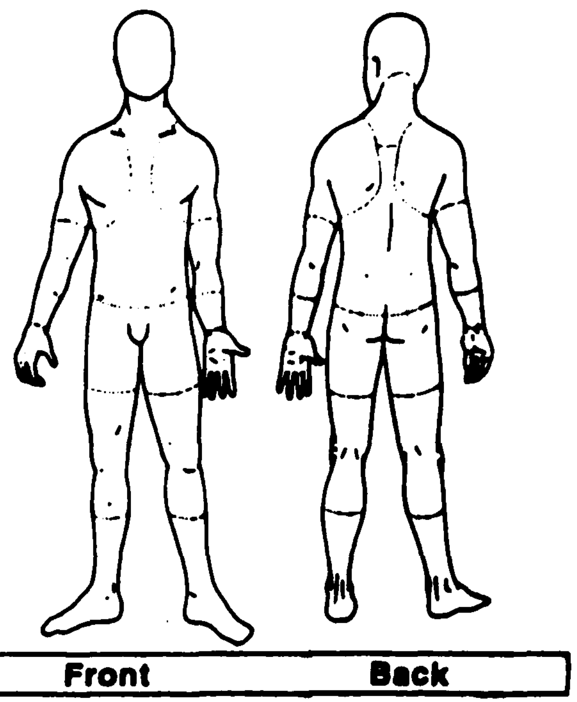
45. **Questions about your life <u>outside</u> your job. Read each statement carefully and decide which answer best suits you.**
"In the past few weeks, how much of the time outside of work have you felt the following?"

	Never	Occasionally	Some of the time	Much of the time	Most of the time	All of the time
1. Tense	☐	☐	☐	☐	☐	☐
2. Cheerful	☐	☐	☐	☐	☐	☐
3. Uneasy	☐	☐	☐	☐	☐	☐
4. Enthusiastic	☐	☐	☐	☐	☐	☐
5. Worried	☐	☐	☐	☐	☐	☐
6. Optimistic	☐	☐	☐	☐	☐	☐
7. Calm	☐	☐	☐	☐	☐	☐
8. Gloomy	☐	☐	☐	☐	☐	☐
9. Contented	☐	☐	☐	☐	☐	☐
10. Depressed	☐	☐	☐	☐	☐	☐
11. Relaxed	☐	☐	☐	☐	☐	☐
12. Miserable	☐	☐	☐	☐	☐	☐

FORM 2A TO REPORT ADDITIONAL MUSCULOSKELETAL DISORDERS

ONLY fill in this section if you have an **additional MSD** not already stated in the rest of the questionnarire.

1. On the body diagram below mark on the anatomical site of the disorder.



2. Please indicate the symptoms/discomfort you experience:

Pain	☐	Burning	☐
Numbness/Tingling	☐	Swelling	☐
Pain/numbness/tingling	☐	Stiffness	☐
Ache	☐	Other (describe)	

....

3. Are you <u>currently</u> experiencing symptoms? NO ☐ YES ☐

4. When did you first notice the problem (month/year)...................................

5. How long does the problem usually last?

Less than 1 hour	☐	> 1 week - 1 month	☐
1 hr - 24 hrs	☐	> 1 month - 6 months	☐
>24 hrs - 1 week	☐	More than 6 months	☐

6. How many separate times have you had the problem?

Constant	☐	Once a month	☐
Daily	☐	Every 2-3 months	☐
Once a week	☐	More than 6 months	☐

7. Can you recall an <u>incident</u> after which symptoms were FIRST evident?
NO ☐ YES ☐ If YES (give details of the incident) ....
....
....

7a What time of day did this incident occur?

Morning	☐	Evening	☐
Afternoon	☐	Night	☐

7b If you can NOT attribute your MSD to a single incident, can you attribute it to <u>continued exposure</u> to particular occupational activities(give details of activity and time spent each day performing these activities)....
....
....
....

8. Are your symptoms made worse by the performance of specific occupational activities? NO ☐ YES ☐ If YES, please indicate which activities aggravate symptoms (specific postures, movements etc.)..............................
....
....
....

9. Has the presence of symptoms forced you to change your job (ie speciality)? NO ☐ YES ☐

PLEASE TURN OVER

FORM 2A TO REPORT ADDITIONAL MUSCULOSKELETAL DISORDERS

10. Has the presence of symptoms forced you to <u>change the way you perform</u> occupational activities? NO ☐ YES ☐ If YES, please indicate which activities are affected and how you now cope with performing them ....
....
....
....

11. Have you consulted a medical practitioner with regard to this disorder? NO ☐ YES ☐ If YES, please list ALL those you have consulted (e.g. General Practitioner, Osteopath, Consultant Physician).......................
....
....

12. Have you been given a clinical diagnosis with regard to your musculoskeletal disorder? NO ☐ YES ☐ If YES, please state the diagnosis...
....
....

13. Due to your MSD symptoms, have you taken sickness absence from work? NO ☐ YES ☐ If YES, how many days <u>during the last year</u> have you been absent from work due to symptoms?

............................days

14. Have you received treatment for your MSD? NO ☐ YES ☐
If YES, what treatment have you been given (e.g. physiotherapy, rest, surgery, analgesics). Please specify how long you have been receiving treatment...
....
....
....

14a How effective has the above treatment been:

- Symptoms much worse ☐
- Symptoms worse ☐
- Symptoms unchanged ☐
- Symptoms less severe ☐
- Symptoms disappeared ☐

15. Please rate the intensity of discomfort you feel with regard to this MSD during the <u>course of a days work</u>:

- No discomfort ☐
- Slight discomfort ☐
- Moderate discomfort ☐
- Unbearable discomfort ☐

16. Please rate the intensity of discomfort you feel when symptoms are at <u>their very worst</u>:

- No discomfort ☐
- Slight discomfort ☐
- Moderate discomfort ☐
- Unbearable discomfort ☐

17. When are symptoms at their most severe (e.g. in the morning, at night, after work?...
....
....

Dr. D. Leighton and Ms C. Beynon would sincerely like to thank you for taking the time to complete this questionnaire.

Appendix Three

Physiotherapists' Questionnaire

(Longitudinal Study)

Thank you for taking the time to fill out our last questionnaire relating to work related musculoskeletal disorders.

To obtain more in depth data we wish to follow some physiotherapists over a period of 20 months to assess any change/development in their musculoskeletal status. Questionnaires will be sent to you every 4 months.

We would greatly appreciate your continued support.

Your responses to this questionnaire are strictly confidential and will not be disclosed to any third party.

PLEASE READ THE QUESTIONS THOROUGHLY AND PROVIDE ADDITIONAL INFORMATION WHERE REQUESTED.

THANK YOU FOR TAKING THE TIME TO COMPLETE THIS IMPORTANT DOCUMENT.

QUESTIONNAIRE CODE ☐

Please tick boxes where appropriate or write the required information in the space provided.

SECTION 1. GENERAL INFORMATION

1. **Since the last questionnaire, have you changed** GRADE?
   NO ☐ YES ☐ **If yes, what is your current grade?**
   ....

2. **Since the last questionnaire, have you changed speciality?**
   NO ☐ YES ☐ **If yes, what specialtiy are you currently working in?** ....
   ....

3. **Since the last questionnaire, how many days off work due to sickness of any type have you taken?** ....days

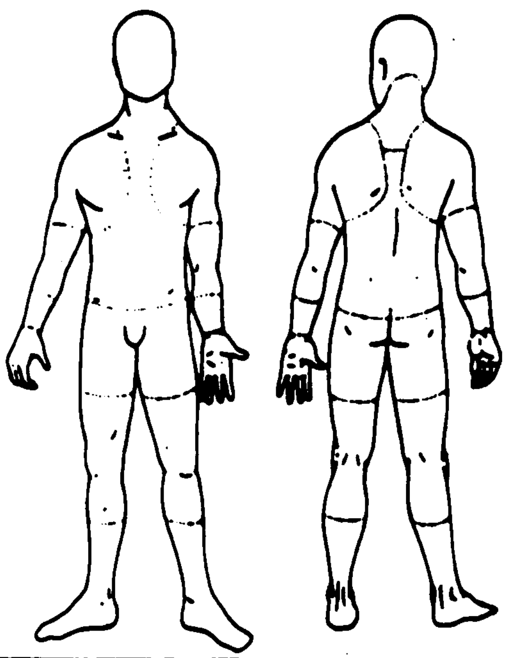
SECTION 2. MUSCULOSKELETAL DISORDERS

Musculoskeletal disorders (MSD) may be defined as injuries or diseases of the musculoskeletal system which may be attributed to work.

The following questions relate to MSDs which may occur at <u>any site</u> of the body, these include tendinitis (shoulder, hand, wrist, Achilles), epicondylitis (e.g. tennis elbow), low back pain. They may be characterised by symptoms of **pain**, **numbness** or **inflammation**.

4. Have you experienced pain or discomfort **<u>since the last questionnaire</u>** that you believe to be related to work? **(this pain may be due to a new musculoskeletal disorder, or an old recurring problem)**
   NO ☐ go to section 3
   YES ☐ continue with next question

5. Refer to the body diagram below and **mark on** the anatomical site of the disorder. **<u>If you have experienced more than one musculoskeletal disorder, use the form 2A at the back of the questionnaire to register details of a separate MSD.</u>**



Front **Back**

6. Please indicate the symptoms/discomfort you experience in relation to the MSD indicated on the diagram:
   Pain ☐ Burning ☐
   Numbness/Tingling ☐ Swelling ☐
   Pain/numbness/tingling ☐ Stiffness ☐
   Ache ☐ Other (describe)..............................
   ....

7. When did you first notice the problem? (month/year)..........................

8. How long does the problem usually last?
   Less than 1 hour ☐ > 1 week - 1 month ☐
   1 hr - 24 hrs ☐ > 1 month - 6 months ☐
   >24 hrs - 1 week ☐ More than 6 months ☐

9. How many separate times have you had the problem?
   Constant ☐ Once a month ☐
   Daily ☐ Every 2-3 months ☐
   Once a week ☐ More than 6 months ☐

10. Can you recall an <u>incident</u> after which symptoms were FIRST evident?
   NO ☐ YES ☐ If YES (give details of the incident)................
   ....
   ....
   ....

   10a What time of day did this incident occur?
   Morning ☐ Evening ☐
   Afternoon ☐ Night ☐

   10b If your MSD can NOT be attributed to a single incident, can you attribute it to <u>continued exposure</u> to particular occupational activities (give details of activities and time spent **each day** performing them)
   ....
   ....
   ....

11 Are your symptoms made worse by the performance of specific occupational activities? NO ☐ YES ☐ If YES, please indicate which activities aggravate symptoms (specific postures, movements etc.)..
....
....
....

12. Has the presence of symptoms forced you to **change job** (ie. Speciality)?
NO ☐ YES ☐

13. Has the presence of symptoms forced you to **change the way you perform** occupational activities? NO ☐ YES ☐
If YES, please indicate which activities are affected and how you now cope with performing them ....
....
....
....

14. **Since the last questionnaire**, have you consulted a medical practioner with regards to this disorder? NO ☐ YES ☐ If YES, please list ALL those you have consulted (eg G.P. , Osteopath, Consultant Physician, Occupational Health Physician)......................................
....
....

15. Have you been given a clinical diagnosis with regard to your musculoskeletal disorder? NO ☐ YES ☐ If YES, please state the diagnosis..
....
....

16. Have you had sickness absence from work specifically resulting from your **MSD symptoms only?** NO ☐ YES ☐ If YES, how many days **since the last questionnaire** have you been absent because of these symptoms? ....days

17. **Since the last questionnaire** have you received treatment for your MSD? NO ☐ YES ☐ If YES, what treatment have you been given (e.g. physiotherapy, rest, surgery, analgesics) Please specify how long in in total you have been receiving treatment..
....
....
....

17a How effective has the above treatment been:

- Symptoms much worse ☐
- Symptoms worse ☐
- Symptoms unchanged ☐
- Symptoms less severe ☐
- Symptoms disappeared ☐

18. Please rate the intensity of **discomfort** you feel with regard to this MSD during the **course of a days work**:

- No discomfort ☐
- Slight discomfort ☐
- Moderate discomfort ☐
- Unbearable discomfort ☐

19. Please rate the intensity of **discomfort** you feel when symptoms are at **their very worst**:

- No discomfort ☐
- Slight discomfort ☐
- Moderate discomfort ☐
- Unbearable discomfort ☐

20. When are symptoms at their most severe (e.g. in the morning, at night, after work)?..
....
....

Would you be willing to discuss your MSD in greater detail with an independent researcher?
If you would like to do so, either telephone Dr Diana Leighton (0151 231 2157) or write your name and contact number here so that a short interview may be arranged:
....
....

SECTION 3. YOUR WORK AND WORK ENVIRONMENT

21. How many patient lifts/manual tansfers do you perform <u>without</u> the use of **any assistive devices** per shift?.................................

22. How many patient lifts/manual transferes do you perform <u>with</u> the aid of **assistive devices** per shift?..................................

23. If you do not **always** use assistive devices for patient lifting/manual handling, what are reasons?..
....
....

24. Do you regularly adopt stooped/bent over positions ? NO ☐ YES ☐
If YES, for what purpose? ....
....
....

25. What proportion of your time is spent on your feet/standing during a shift?...............%

26. Are there any activities which you <u>repeatedly</u> perform within a short period of time? NO ☐ YES ☐ If YES, please give details of activities..
....
....

27. Is your work environment suitable for the occupational activities you need to perform? NO ☐ YES ☐ If NO please state how activities are affected (e.g. space constraints, equipment design)
....
....
....
....

28. Do your occupational activities include overhead tasks i.e. reaching above head height? NO ☐ YES ☐ If YES, please indicate the purpose of these activities...
....
....
....

29. Questions about your <u>life at work</u>. Read each statement carefully and decide which answer best suits you.
"In the past few weeks, how much of the time at work have you felt the following?"

	Never	Occasionally	Some of the time	Much of the time	Most of the time	All of the time
1. Tense	☐	☐	☐	☐	☐	☐
2. Cheerful	☐	☐	☐	☐	☐	☐
3. Uneasy	☐	☐	☐	☐	☐	☐
4. Enthusiastic	☐	☐	☐	☐	☐	☐
5. Worried	☐	☐	☐	☐	☐	☐
6. Optimistic	☐	☐	☐	☐	☐	☐
7. Calm	☐	☐	☐	☐	☐	☐
8. Gloomy	☐	☐	☐	☐	☐	☐
9. Contented	☐	☐	☐	☐	☐	☐
10. Depressed	☐	☐	☐	☐	☐	☐
11. Relaxed	☐	☐	☐	☐	☐	☐
12. Miserable	☐	☐	☐	☐	☐	☐

30. Please indicate how strongly you agree/disagree with the all the statements given below. Tick the box beneath the most appropriate response(s)(tick one box per statement).

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
I can do my job well	☐	☐	☐	☐	☐
I sometimes think I am not very competent at my job	☐	☐	☐	☐	☐
I can deal with just about any problem in my job	☐	☐	☐	☐	☐
I find my job quite difficult	☐	☐	☐	☐	☐
I feel I am better than most people at tackling job difficulties	☐	☐	☐	☐	☐
In my job I often have trouble coping	☐	☐	☐	☐	☐
In my job I like to set myself challenging targets	☐	☐	☐	☐	☐
I am not very interested in my job	☐	☐	☐	☐	☐
I enjoy doing new things in my job	☐	☐	☐	☐	☐
I prefer to avoid difficult activities in my job	☐	☐	☐	☐	☐
In my job, I make a special effort to keep trying when things seem difficult	☐	☐	☐	☐	☐
I am not very concerned how things turn out in my job	☐	☐	☐	☐	☐
	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree

31. How satisfied do you feel about your job as a whole?

- Extremely dissatisfied ☐
- Very dissatisfied ☐
- Moderately dissatisfied ☐
- Not sure ☐
- Moderately satisfied ☐
- Very satisfied ☐
- Extremely satisfied ☐

32. Please read each question and tick the box which best represents your reply.

	Rarely	Sometimes	Often	Most of the time
Do you have too much work to do?	☐	☐	☐	☐
Do you feel that you have a lot of responsibility for the work of others?	☐	☐	☐	☐
Do you work very hard - either physically or mentally?	☐	☐	☐	☐
Are you under pressure to keep up with new ways of doing things?	☐	☐	☐	☐
Do you have to decide things where mistakes could be quite costly?	☐	☐	☐	☐
Do you work too many hours?	☐	☐	☐	☐
Do you have too little help or equipment to get the job done well?	☐	☐	☐	☐
Do you have important responsibilities?	☐	☐	☐	☐
	Rarely	Sometimes	Often	Most of the time

SECTION 4. ABOUT YOURSELF & YOUR LIFESTYLE

33. Please give your WEIGHT ....

34. Do you smoke cigarettes? YES ☐ NO ☐

35. Approximately how many units of alcohol do you drink in a typical week?................................units
1 unit = 1 glass of wine 1 unit = a single measure of spirits
= ½ pint beer, lager, cider = a small glass of sherry

36. Do you regularly participate in physical activity of 20 minutes duration or longer? YES ☐ NO ☐

37. How do you rate your current level of fitness compared to other physiotherapists of your age?
good/better ☐ average/same ☐ poor/worse ☐

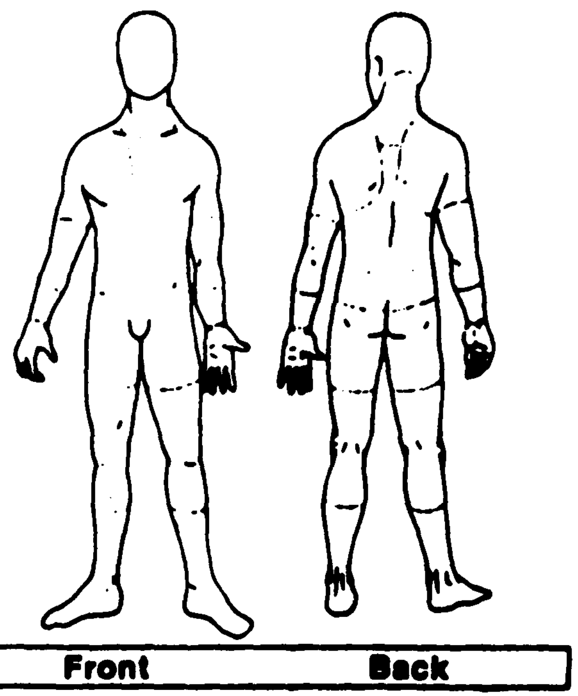
38. **Questions about your life <u>outside</u>, your job. Read each statement carefully and decide which answer best suits you.**
"In the past few weeks, how much of the time outside of work have you felt the following?"

	Never	Occasionally	Some of the time	Much of the time	Most of the time	All of the time
1. Tense	☐	☐	☐	☐	☐	☐
2. Cheerful	☐	☐	☐	☐	☐	☐
3. Uneasy	☐	☐	☐	☐	☐	☐
4. Enthusiastic	☐	☐	☐	☐	☐	☐
5. Worried	☐	☐	☐	☐	☐	☐
6. Optimistic	☐	☐	☐	☐	☐	☐
7. Calm	☐	☐	☐	☐	☐	☐
8. Gloomy	☐	☐	☐	☐	☐	☐
9. Contented	☐	☐	☐	☐	☐	☐
10. Depressed	☐	☐	☐	☐	☐	☐
11. Relaxed	☐	☐	☐	☐	☐	☐
12. Miserable	☐	☐	☐	☐	☐	☐

FORM 2A TO REPORT ADDITIONAL MUSCULOSKELETAL DISORDERS

ONLY fill in this section if you have experienced musculoskeletal symptoms **since the last questionnaire that you have not already stated in this questionnaire This pain may be from a NEW OR OLD musculoskeletal disorder.**

1. On the body diagram below mark on the anatomical site of the disorder.



2. Please indicate the symptoms/discomfort you experience:

Pain	☐	Burning	☐
Numbness/Tingling	☐	Swelling	☐
Pain/numbness/tingling	☐	Stiffness	☐
Ache	☐	Other (describe)	

....

3. Are you <u>currently</u> experiencing symptoms? NO ☐ YES ☐

4. When did you first notice the problem (month/year).................................

5. How long does the problem usually last?

Less than 1 hour	☐	> 1 week - 1 month	☐
1 hr - 24 hrs	☐	> 1 month - 6 months	☐
>24 hrs - 1 week	☐	More than 6 months	☐

6. How many separate times have you had the problem?

Constant	☐	Once a month	☐
Daily	☐	Every 2-3 months	☐
Once a week	☐	More than 6 months	☐

7. Can you recall an <u>incident</u> after which symptoms were FIRST evident?
NO ☐ YES ☐ If YES (give details of the incident) ....
....
....

7a What time of day did this incident occur?

Morning	☐	**Evening**	☐
Afternoon	☐	**Night**	☐

7b If you can NOT attribute your MSD to a single incident, can you attribute it to <u>continued exposure</u> to particular occupational activities(give details of activity and time spent each day performing these activities)....
....
....
....

8. Are your symptoms made worse by the performance of specific occupational activities? NO ☐ YES ☐ If YES, please indicate which activities aggravate symptoms (specific postures, movements etc.).............................
....
....
....

9. Has the presence of symptoms forced you to change your job (ie speciality)? **NO** ☐ **YES** ☐

PLEASE TURN OVER

FORM 2A TO REPORT ADDITIONAL MUSCULOSKELETAL DISORDERS

10. **Has** the presence of **symptoms** forced you to **change the way you perform** **occupational** activities? NO ☐ YES ☐ If YES, please indicate which activities are affected **and how** you now cope with performing them ....
....
....
....

11. **Since the last questionnaire**, have you consulted a medical practitioner with regard to this **disorder**? **NO** ☐ **YES** ☐ If YES, please list ALL that you have **consulted** (eg GP, **Osteopath**, Consultant)..................
....
....

12. Have you been given a clinical diagnosis with regard to your musculoskeletal disorder? NO ☐ YES ☐ If YES, please state the diagnosis..
....
....

13. Due to your MSD **symptoms**, have you taken sickness absence from work? NO ☐YES ☐ If YES, how many days **during the last year** have you been absent from work due to symptoms?

..........................days

14. **Since the last questionnaire**, have you received treatment for your MSD? **NO** ☐ **YES** ☐ If YES, what treatment have you been given (eg physiotherapy, rest, surgery, analgesics)...
....
....
....

14a How effective has the above treatment been:

Symptoms much worse ☐
Symptoms worse ☐
Symptoms unchanged ☐
Symptoms less severe ☐
Symptoms disappeared ☐

15. Please rate the intensity of **discomfort** you feel with regard to this MSD during the **course of a days work**:

No discomfort ☐
Slight discomfort ☐
Moderate discomfort ☐
Unbearable discomfort ☐

16. Please rate the intensity of **discomfort** you feel when symptoms are at **their very worst**:

No discomfort ☐
Slight discomfort ☐
Moderate discomfort ☐
Unbearable discomfort ☐

17. When are symptoms at their most severe (e.g. in the morning, at night, after work?..
....
....

Dr. D. Leighton and Ms C. Beynon would sincerely like to thank you for taking the time to complete this questionnaire.

Appendix Four

Occupational Health Department

Data Collection Sheet

MUSCULOSKELETAL DISORDERS AMONGST HEALTHCARE PROFESSIONALS

INJURY REPORT FORM

GENERAL INFORMATION

1. REFERENCE of subject............... AGE............... SEX...............

2. Is the subject a NURSE............ or PHYSIOTHERAPIST?............

3. What GRADE is the subject?..

4. In which SPECIALITY does the subject work?..

DETAILS OF MUSCULOSKELETAL DISORDER

5. What is the LOCATION of the injury?..
....
....

6. What is the CLINICAL DIAGNOSIS?...
....
....

7. What are the SYMPTOMS?...
....
....

8. How SEVERE is the injury, in terms of how it affects work capability?

EXTREMELY SEVERE............	QUITE SEVERE............	QUITE MILD............	EXTREMELY MILD..........

9. Has the injury resulted in DAYS OFF WORK? YES............ NO............
If YES, state number of days off work so far?............

10. Has the injury affected the subject's ABILITY TO WORK in any other way?......
....
....

11. What TREATMENT has been initiated and what is its outcome so far? ....
....
....
....
....

12. What was the stated CAUSE of the injury? (please be as specific and detailed as possible)..
....
....
....

Appendix Five

Risk Assessment Pro-forma

AGE........................
FEMALE.................. MALE....... ....
NURSE.................... PHYSIO..................
GRADE...
SPECIALITY...

DOMINANT SIDE...................
DATE....................................
TIME.....................................
WARD NO..............................
SUBJECT NO..........................

TASK	WALKING ( ) 1	
	STANDING ( ) 1	
	SITTING ( ) 1	
	PUSHING ( ) 1	
	PULLING ( ) 1	
	KNEEL ( ) 1	
	RUNNING ( ) 1	
	ST. HOLD ( ) 1	
	LIFTING ( )	OBJECT ( ) 1 PATIENT ( ) 1 ALONE ( ) 3 2PEOPLE ( ) 2 MORE ( ) 1
	DEVICES	AMBULIFT ( ) EASY SLIDE ( ) WALKING BELT ( ) ( ) PAT SLIDE ( ) ( )
	DESCRIBE TASK	....
	REPEATED ( ) 1	....
POSTUR	STOOPING ( ) 1	
	TWISTING ( ) 1	
	TRUNK FLEXION ( )	<20 ( ) 1 <45 ( ) 2 <70 ( ) 3 <90 ( ) 4 BW ( ) 3
	LATERAL BENDING ( )	LEFT ( ) 1 RIGHT ( ) 1
	SHOULDERS SAGITTAL ( )	+90 ( ) 1 +135 ( ) 2
	SHOULDERS FRONTAL ( )	+90 ( ) 1 +135 ( ) 2
	NECK	EXTENDED ( ) 0 FLEXED ( ) 1
	ANGLES	20 45 70 90
HANDS	WRISTS	FLEXED ( ) 1 EXTENDED ( ) 0
	FORCE	YES ( ) 1 NO ( ) 0
	FINGERS FORCE	YES ( ) 1 NO ( ) 0
LOAD	EFFORT	EASY ( ) 0 HARD ( ) 1 STABLE( ) 0 UNSTABLE ( ) 1
	WEIGHT	....
	CENT. OF GRAVITY	<20 ( ) 0 35 ( ) 0 50 ( ) 1 70 ( ) 2 +70 ( ) 3
ENVIRO	TEMP	HOT ( ) 1 COLD ( ) 1
	NOISE	YES ( ) 1 NO ( ) 0
	CONSTRAINT OF POSTURE	YES ( ) 1 NO ( ) 0 ....
PERS	STRESSED	YES ( ) 1 NO ( ) 0
	HURRIED	YES ( ) 1 NO ( ) 0

Appendix Six

Subject Consent Form

(Nurses' Spinal Shrinkage Study)

SUBJECT CONSENT FORM

Project Title; **An investigation of musculoskeletal disorders in healthcare professionals**

Project Supervisor; **Professor Tom Reilly**
Dr. Diana Leighton
Professor Alan Nevill

Project Investigator; **Caryl Beynon**

Background

Musculoskeletal disorders are the most commonly reported source of occupational disease within the industrial world. Back pain is the most commonly reported musculoskeletal disorder. Long term loading to the spine may potentiate back pain. The aim of this study is to assess the impact of rest breaks on spinal shrinkage.

Testing Protocol

Subjects will be required to visit the laboratory on three occasions;

1. Equipment familiarisation

Spinal shrinkage is measured using a stadiometer. The initial session will involve the subject becoming familiar with this piece of equipment.

2. First and second testing sessions

Subjects must do no physical activity prior to testing. Each of the two test sessions take approximately five hours. The subject is initially required to lie down for 20 minutes. Over the next four hours, the subject will be asked to walk, sit, stand, crouch, bend and push or pull a wheel chair for various time periods. Measurement of stature will be assessed using the stadiometer at certain times through the four hours of testing. One session will record stature changes with a 20 minute seated break during testing and the second will record stature changes when the subject stands for the 20 minute break. The order will be randomly assigned to the subjects.

Declaration

Name;...

I agree to take part in the above study, the details of which have been explained to me fully. I understand that I can terminate my involvement in the study at any time. I do not suffer from any medical condition that my affect my involvement in the study.

Signed... *Date.................*

Appendix Seven

Data Collection Sheet for

Spinal Shrinkage Work (Nurses)

Nurses Data Collection Sheet

Test (rest/no rest)................................ Date..

Name.. Time..

Age..

Weight..

Height..

Action	Time	Time
walk	5.5	5.5
stand	3.5	9.0
stand (ex1)	2.0	11.0
sit	3.5	14.5
stand (ex1)	2.0	16.5
stand (ex2)	3.0	19.5
walk	1.0	20.5
bend	1.0	21.5
crouch	0.5	22.0
stand (ex1)	2.0	24.0
stand (ex2)	3.0	27.0
walk	4.0	31.0
stand (ex1)	5.0	36.0
push	1.0	37.0
walk	2.0	39.0
lift	0.5	39.5
stand	2.0	41.5 **SD**
stand (ex1)	3.0	44.5
walk	2.0	46.5
stand (ex1)	5.0	51.5
stand (ex2)	5.0	56.5
crouch	0.5	57.0
pull	0.5	57.5
walk	1.0	58.5

Action	Time	Time
lift	0.5	59.0
sit	3.0	2.0
push	1.0	3.0
sit	2.0	5.0
stand (ex1)	2.0	7.0
stand (ex2)	3.0	10.0
bend	1.0	11.0
stand (ex1)	2.0	13.0
stand (ex2)	2.0	15.0
bend	2.0	17.0
stand	2.0	19.0 **SD**
stand (ex1)	3.0	22.0
sit	3.0	25.0
stand (ex1)	2.0	27.0
stand (ex2)	3.0	30.0
pull	0.5	30.5
stand (ex1)	4.0	34.5
stand (ex2)	3.0	37.5
bend	3.0	40.5
stand (ex1)	5.0	45.5
stand (ex2)	2.5	48.0
push	2.5	50.5
crouch	0.5	51.0
bend	1.0	52.0

Action	Time	Time
pull	0.5	52.5
bend	1.0	53.5
push	1.0	54.5
lift	0.5	55.0
walk	2.0	57.0
lift	0.5	57.5
push	0.5	58.0
stand (ex2)	2.0	60.0 **SD**
		discom
BREAK	**R.P.E**	
		discom
walk	5.0	25.0 **SD**
stand (ex1)	3.0	28.0
stand (ex2)	2.0	30.0
bend	2.0	32.0
stand	3.0	35.0
stand (ex1)	3.0	38.0
pull	0.5	38.5
lift	0.5	39.0
sit	4.0	43.0
pull	0.5	43.5
stand (ex1)	5.0	48.5
stand (ex2)	3.0	51.5
bend	1.0	52.5
stand (ex1)	3.0	55.5
stand (ex2)	2.0	57.5
walk	5.0	2.5

Action	Time	Time
pull	0.5	3.0
crouch	0.5	3.5
stand (ex1)	7.0	10.5
stand (ex2)	3.0	13.5
sit	3.0	16.5
walk	5.0	21.5
crouch	0.5	22.0
lift	0.5	22.5
stand (ex1)	4.0	26.5
stand (ex2)	2.0	28.5
walk	5.0	33.5
push	1.0	34.5
lift	0.5	35.0
walk	5.0	40.0
stand (ex1)	3.0	43.0
stand (ex2)	2.0	45.0
bend	2.0	47.0
push	1.0	48.0
walk	4.0	52.0
stand (ex1)	3.0	55.0
lift	0.5	55.5
bend	1.0	56.5
push	1.5	58.0
stand (ex2)	1.5	59.5
lift	0.5	60.0 **SD**
		discom
FINISH	**R.P.E.**	

Total testing time - 4 hours

Total break time - 20 minutes

Measurement of discomfort taken at beginning and end of break and end of testing

Exercise 1 - ‘bed making’

Exercise 2 - ‘book stacking’

Appendix Eight

Borg (1970)

Rating of Perceived Exertion Scale

RATING OF PERCEIVED EXERTION

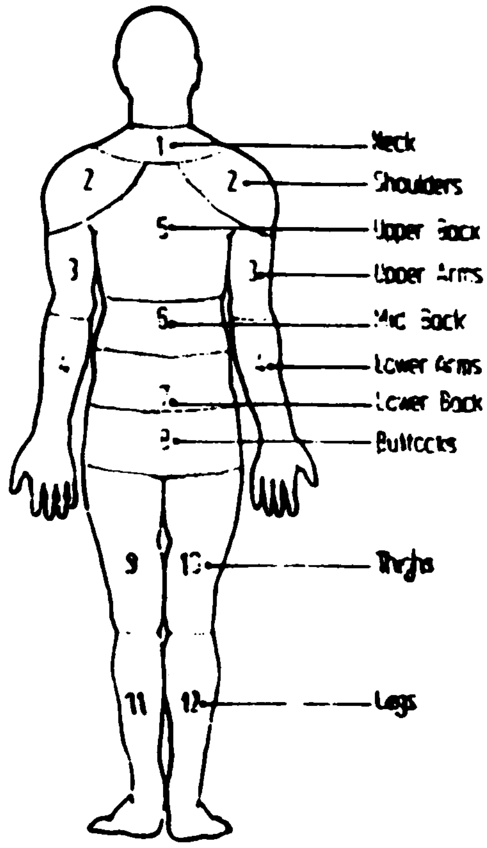
How stressful do you rate this work now?

6	
7	very, very light
8	
9	very light
10	
11	fairly light
12	
13	somewhat hard
14	
15	hard
16	
17	very hard
18	
19	very, very hard
20	

Appendix Nine

Corlett and Bishop (1976)

Assessment of Postural Discomfort



area of greatest discomfort

1..
2..
3..
4..
5..
6..
7..
8..
9..
10..

⇓

area of least discomfort

1 **7**

no discomfort ——————————> max discomfort

Overall discomfort.................................

Appendix Ten

Porters' Back Pain Questionnaire

This investigation into occupational back pain has been initiated by the European Commission.

Health and safety at work is of prime importance; we need to know if back pain is a serious problem within your occupation.

Your responses to this questionnaire are strictly confidential and will not be disclosed to any third party (including other staff within the hospital you work).

Please tick boxes where appropriate or write the required information in the space provided.

1. Are you male or female

2. Have you ever any back pain or discomfort?
   NO you do not need to complete any more questions but please return this form to Caryl Beynon in the envelope provided
   YES continue with next question

3. What do you think brought on this problem with your back?
   Accident Activity at home
   Sporting activity Activity at work
   Other (**please specify**)..

IF YOUR PROBLEM IS NOT CAUSED BY WORK DO NOT COMPLETE ANY MORE QUESTIONS. please return this form to Chris Tebbs

4. Can you recall a **single incident** after which symptoms were FIRST evident?
   NO YES If YES, please give details of the incident
   ....
   ....
   If your back problem can NOT be attributed to a single incident, can it be attributed to **continued exposure** to particular occupational activities? Give details of these activities..
   ....
   ....

5. Are you **currently** experiencing symptoms?
   NO please continue to question 4
   YES please continue to question 4

6. Please indicate symptoms you experience in relation to your back discomfort (you may tick more than one)
   Pain Burning
   Numbness Swelling
   Tingling Stiffness
   Ache Other (describe)..

7. What is the **total length of time** that you have had back trouble during the **last 12 months**?
   0 days more than 30 days but not every day
   1-7 days every day
   8-30 days

8. How often do you get or have you had back pain?
   constant once a month
   daily every 2 - 3 months
   once a week more than 6 months

9. Have you had sickness absence from work specifically resulting from your back problem?
   NO YES If YES, how many days **during the last year** have you been absent form work due to these symptoms?
   ....days

THANK YOU FOR TAKING THE TIME TO COMPLETE THIS IMPORTANT DOCUMENT
Please return to Chris Tebbs

Appendix Eleven

Subject Consent Form

(Porters' Spinal Shrinkage Study)

SUBJECT CONSENT FORM

Project Title; **An investigation of musculoskeletal disorders in healthcare professionals**

Project Supervisor; **Professor Tom Reilly**
Dr. Diana Leighton
Professor Alan Nevill

Project Investigator; **Caryl Beynon**

Background

Musculoskeletal disorders are the most commonly reported source of occupational disease within the industrial world. Back pain is the most commonly reported musculoskeletal disorder. The aim of this study is to develop a modified work-rest schedule that will reduce spinal shrinkage in hospital porters, spinal shrinkage being one factor associated with back pain.

Testing Protocol

Subjects will be required to visit the laboratory on three occasions;

1. Equipment familiarisation

Spinal shrinkage is measured using a stadiometer. The initial session will involve the subject becoming familiar with this piece of equipment.

2. First and second testing sessions

Subjects will be required to attend the laboratory in the morning and must do no physical activity prior to the testing. Each of the two test sessions take approximately four and a half hours. The subject is initially required to lie down for half an hour. Over the next four hours, the subject will be asked to walk, sit, stand and push or pull a wheel chair for various time periods. Measurement of stature will be assessed using the stadiometer at certain times through the four hours of testing. One session will test the existing porters' work-rest schedule and the other the modified work-rest schedule. The order will be randomly assigned to the subjects.

Declaration

Name;...

I agree to take part in the above study, the details of which have been explained to me fully. I understand that I can terminate my involvement in the study at any time. I do not suffer from any medical condition that my affect my involvement in the study.

Signed.. *Date*.................

Appendix Twelve

Data Collection for Spinal Shrinkage (Porters)

Trial 1 and Trial 2

EXPERIENTAL PROCEDURE
SESSION 1

NAME ____________________ DATE ___________

AGE ____________________

HEIGHT (M) _____________

WEIGHT (KG) ____________

Activity	Duration (mins)	Stopwatch (time)	Repeat 1	2	3	4
Push(half with)	7	0-7				
Sit	3	7-10				
Pull (half with)	6	10-16				
Stand	3.15	16-19.15				
Walk	10	19.15-29.15				
Push(half with)	6.45	29.15-36				
Sit	2.30	36-38.30				
Pull (half with)	5	38.30-43.30				
Walk	10.15	43.30-53.45				

- Complete once - 5min break
- Repeat again - 15min break
- Repeat again - 5min break
- Repeat again - Finish

EXPERIENTAL PROCEDURE
SESSION 2

NAME ____________________ **DATE** ___________

AGE ____________________

HEIGHT (M) _____________

WEIGHT (KG) ____________

Activity	Duration (mins)	Stopwatch (time)	Repeat 1	2	3
Push (half with)	10	0-10			
Sit	7.30	10-17.30			
Pull (half with)	7.30	17.30-25			
Stand	4.15	25-29.15			
Walk	15	29.15-44.15			
Push (half with)	8.15	44.15-52.30			
Pull (half with)	7	52.30-59.30			
Walk	12	59.3C-71.40			

- Complete once - 12.5min break
- Repeat again - 12.5min break
- Repeat again - Finish

Appendix Thirteen

Communications Arising from this Thesis