Health and Safety
Executive

Ageing and work-related musculoskeletal disorders

A review of the recent literature

Prepared by the **Health and Safety Laboratory**
for the Health and Safety Executive 2010

RR799
Research Report

Health and Safety Executive

Ageing and work-related musculoskeletal disorders

A review of the recent literature

Olanre Okunribido & Tony Wynn
Health and Safety Laboratory
Harpur Hill
Buxton
Derbyshire
SK17 9JN

This work was commissioned to provide a review of the recent literature concerning ageing and occupational MSD, and to carry out scoping activities to inform the formulation of future policy or guidance and provision of advice. However, as the findings were developed, the scoping element was dropped at the customer's request.

Attitudes towards ageing and work are changing; more employers regard older workers as a valuable asset and are willing to keep current employees on for longer periods past the usual retirement age. Older workers are more susceptible to work-related MSD than younger workers because of decreased functional capacity; the propensity for injury is related more to the difference between the demands of work and the worker's physical work capacity (or work ability) rather than their age. An older workforce has implications for the health and safety responsibilities of employers. These include providing additional support for worker requirements, changing the workplace attitudes towards ageing, providing a positive knowledge base, adjusting the workplace design and accommodations and improving worker/employer relationships (co-operation).

This report and the work it describes were funded by the Health and Safety Executive (HSE). Its contents, including any opinions and/or conclusions expressed, are those of the authors alone and do not necessarily reflect HSE policy.

HSE Books

First published 2010

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EXECUTIVE SUMMARY

Objectives

This work was commissioned to provide a review of the recent literature concerning ageing and occupational musculoskeletal disorders (MSD), and to carry out scoping activities to inform the formulation of future policy or guidance and provision of advice. It had the following five objectives:

- To identify current scientific thinking about the subject.
- To evaluate if individuals are more susceptible to MSD in the workplace as they age.
- To identify the implications of an ageing workforce on the health and safety responsibilities of employers.
- To identify in broad terms those areas in which HSE's existing guidance need material changes to take account of the specific nature of ageing workers
- To identify information that can enable provision of advice to people who enquire about accommodating older workers.

However, as the findings were developed, the scoping element was dropped at the customer's request. Consequently, the project was concluded with three objectives being addressed through the literature review stage, as follows:

- To identify current scientific thinking about the subject.
- To evaluate if individuals are more susceptible to MSD in the workplace as they age.
- To identify the implications of an ageing workforce on the health and safety responsibilities of employers.

Main Findings

Attitudes towards ageing and work are changing. More employers regard older workers as a valuable asset and are willing to keep current employees on for longer periods past the usual retirement age. However, while many do now appreciate the value of older workers, only a few workplaces actually implement measures, to support and increase their retention of older workers.

Age is not an independent risk factor for work-related MSD. Older workers are more susceptible to work-related MSD than younger workers because of decreased functional capacity. The propensity for injury is related more to the difference between the demands of work and the worker's physical work capacity (or work ability) rather than their age.

An older workforce has implications for the health and safety responsibilities of employers. These include providing additional support for worker requirements, changing the workplace attitudes towards ageing, providing a positive knowledge base, adjusting the workplace design and accommodations and improving worker/employer relationships (co-operation).

Recommendations

It is recommended that awareness campaigns are implemented to disseminate the benefits of ageing workers in the workplace and raise awareness of those elements of the workplace that

are not suited to their needs. The expectation is that this will change the attitudes of employers and employees towards ageing and aged workers.

1 INTRODUCTION

1.1 BACKGROUND

The European Union (EU) Agency for Safety and Health (OSHA) describe age as one of the factors that can lead to musculoskeletal disorders (MSD)[1]. The UK government's policy in this area is to increase the number of people aged 50+ in employment by over 1 million, so that 80% of people of working age are employed. If this aim were achieved, the ratio of workers to non-workers would be the same in 2050 as it is now, despite the increasing age of the population.[2]

The Health and Safety Executive's (HSE) policy concerning ageing and work, which is to fit the job to the worker, allow for workplace changes to be made because of an employee's age, and holds the view that age in itself is not a risk factor for work-related MSD. An exception to this are diseases that affect the muscles and bones, such as arthritis, which are generally age related and some occupations may exacerbate these conditions or increase the likelihood of their early onset (Olsson et al. 2004). Evidence supporting HSE's policy, has been provided from recently commissioned Department of Work and Pensions (DWP) research on ageing, *Facts and misconceptions about age, health status and employability* (Benjamin and Wilson, 2005), undertaken by The Health and Safety Laboratory (HSL). The work showed that there are many misconceptions about the effect of age on employability and indicated that employers, workers and even health and safety professionals do not always share HSE's current policy view.

It is important that HSE is aware of the current scientific thinking on the topic of MSD and ageing, so that its policy can be adjusted if necessary. This is becoming increasingly important, as the issue of age, work, and the risk of musculoskeletal disorders is one that is being raised more often. Specifically, HSE needs information to help it assess what impact an increase in the number of employed older workers will have on both duty holders' responsibilities and on HSE's responsibilities for guidance to government and employers.

1.2 RATIONALE AND AIMS

MSD are impairments of the bodily structures, such as muscles, joints, tendons, ligaments and nerves, which are caused or aggravated primarily by the performance of work and by the effects of the immediate environment in which work is carried out (OSHA, 2007). They carry a high cost in terms of lost workdays in addition to medical treatment costs, making them an important issue for employers. For Great Britain, it has been reported that MSDs affect around 1.0 million people a year (Jones *et al.,* 2006) and are amongst the most frequently reported occupational illnesses among older workers (Silverstein, 2008). Peele *et al.* (2005) reported that MSD comprised 34% of all work-related injuries in the US and opined that MSDs in working populations might have a more pronounced effect on older workers than young workers. This was based on observations that physiologically, young adults have superior muscular performance peaking around age 33 and that recovery time for musculoskeletal injuries lengthens with age. Gardner *et al.* (2008) identified MSD as the

[1] *The website address is http://osha.europa.eu/priority_groups/ageingworkers/hazards_html*
[2] *See http://www.dwp.gov.uk/opportunity_age/volume1/summary.asp*

leading work-related health concern in the developed world, accounting for up to 30% of all injuries requiring time away from work.

A review of the evidence regarding ageing and working with specific reference to MSD was considered necessary at this time to ensure that important issues are not overlooked, that future advice provided is evidence based, and to enable forward projection in respect of the implications for compliance by duty-holders and the verbal and written guidance provided by HSE on MSDs and an older workforce.

This work was commissioned to provide a review of the recent literature concerning ageing and occupational MSD, and to carry out scoping activities to inform the formulation of future policy or guidance and provision of advice. It had the following five objectives:

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2 METHODOLOGY

2.1 SEARCH STRATEGY

Three HSL reactive support projects reports concerning ageing and older workers were identified and reviewed.

The following activities were undertaken to identify other relevant published research articles and other sources of information:

- Searches of databases (MEDLINE, OSHROM, Ergonomics Abstracts) were conducted, using key words (Ageing, Age, Older, Worker, Injury, Disorders, Musculoskeletal, Pain, Interventions)
- Web searches using the Google scholar search engine and similar key words. The search activity was done periodically to ensure that relevant current reports were not missed.

2.2 EXCLUSIONS

Reports published before 2003 and those that were not focused on MSD as an occupational problem or did not include aged workers (those aged 50 years or more) were excluded. The scope for the work was deliberately restricted because most of the pre-2003 studies had been captured in previous HSL work.

3 HSL WORK ON AGE AND WORK

This section provides an overview of the key findings from previous related HSL work, namely Shearn (2005), Benjamin and Wilson (2005) and Harris and Higgins (2006). This is meant to provide a context for discussion of the findings from the current updating work (2003-present).

The work by Shearn (2005) reviewed the literature to provide an overview of the implications of the demographic ageing of the UK's labour force and to identify future employment scenarios for older workers. He found that:

- There was a degree of variability in how older workers were defined, in respect of age ranges used to designate older workers, e.g., 45-65 yrs, 60-65 yr, and 50-70 yrs, though in most cases the term was used to refer to individuals in their late 50s to mid 60s.
- Significant demographic change is predicted over forthcoming decades such that, older workers will constitute a greater proportion of the available workforce, and their needs will require supporting, and the health and productivity of older workers given greater attention.
- Older individuals tend to be employed in occupations that vary substantially by gender and reflect traditional trends. In that, males are proportionally over-represented in managerial, professional, skilled trades, machine operative and elementary occupations and women are represented in administrative and elementary occupations with relatively few employed in skilled trades or machine operator occupations.

Shearn (2005) concluded from the review that if they are to facilitate the predicted levels of older worker activity, employers would need to establish better provisions for 'back to work' rehabilitation, offer incentives for older worker training, enable a greater degree of flexible working patterns and introduce improvements to the work environment.

Benjamin and Wilson (2005) reviewed the prevailing literature concerning age, health status and employability of people with three main aims; first, to dispel inaccurate perceptions about older adults, secondly to demonstrate that health and safety cannot be used as an "excuse" to justify the exclusion of older workers, thirdly to raise awareness about older workers' ability to work and the benefits of engaging older workers. They identified nine common beliefs about ageing and older workers:

- Chronological age determines health and age brings illness and disease;
- Getting older is associated with loss of cognitive capacity;
- Older workers have less physical strength and endurance;
- Older workers tend to have poorer sensory abilities such as sight and hearing;
- Older workers take more time off sick;
- Older workers have difficulty adapting to change;
- Older workers find it hard to learn new information making their knowledge and skills outdated;
- Older workers have more accidents in the workplace;
- Older workers are less productive.

Based on analysis of the information and data gathered from a variety of sources, for example statistics from the Office of National Statistics, published journal articles and reports, the key findings from the work were that:

- Chronological age is not the most important determinant of health, and ageing does not inevitably bring illness and disease. Health is influenced by numerous other factors, particularly lifestyle and amount of exercise and nutrition.
- Physical strength and endurance is very specific to individuals', such that some older workers may be stronger and more physically able than their younger colleagues.
- Older workers do not always take more time off work than younger workers. Indeed, older workers tend to take less short term/non-certified sickness absences than younger workers, which is the biggest source of absence and disruption for employers. Older workers by contrast, take more long-term/medically certified sickness absences, due largely to chronic disease.
- Older workers do not always have more accidents in the workplace than younger workers. Accident rates vary in terms of a number of factors such as type of accident and, in general, younger workers are reported to have a higher propensity for accidents in the workplace than older workers.

Benjamin and Wilson (2005) concluded from the findings that:

- Older adults are vastly different from each other due to the interaction of both external and internal factors with the process of ageing.
- No stereotype of older workers is likely to be true for all, or even for most older workers, particularly, the belief that chronological age is the most important determinant of health or of older workers taking more time off work.

Finally the more recent review by Harris and Higgins (2006) was carried out to provide an overview of organisational interventions that can help prevent retirement among older workers and to offer practical advice and information for retention of older workers. They found that:

- Older workers constitute a valuable resource for all organizations, due to their increased reliability compared to younger workers, their greater commitment and dedication to duty, decreased turnover and absenteeism and a diversity of expertise, knowledge and skills sets that they possess.
- There is a reasonable quantity of information relating to the retention of older workers, but little literature detailing specific organisational interventions that have been implemented.

This review showed that there are benefits for organisations by retaining older workers and that to prevent early retirement of the ageing workforce, organisations should aim to promote job satisfaction and maintain the health and productivity of older workers. This could be achieved through job redesign, and flexible working and retirement arrangements.

In summary, the three pieces of previous HSL work have shown that:

- In Britain like many developed nations, the populations including worker populations are ageing and this has generated increased research in order to effectively control age related workplace risks, particularly those associated with occupational ill health.
- Age is not the most important determinant of health, nor does ageing inevitably bring illness and disease. Negative beliefs about ageing, including that older age is a risk factor for injury at work, have however, tended to preclude older workers from workplaces.
- As the proportion of older workers increases, new responsibilities for health and safety of the workforce may be placed on employers.

The sections that follow review current research (from 2003 to present date) concerning ageing workers and development of musculoskeletal disorders.

4 REVIEW OF AGEING AND MSD LITERATURE (2003 – 2009)

This section of the report presents the findings from the literature searches concerning musculoskeletal disorders and ageing/older age as a risk factor.

4.1 DEMOGRAPHIC TRENDS

The literature regarding demographic trends suggests the nature of the labour force in many countries, particularly developed countries, is changing. Older workers (50 years and over) are becoming more prevalent in the workplace (Terranova, 2004; Whiting, 2005; Harris, 2006; Hoonakker *et al.,* 2006; Alpass and Mortimer 2007; Hotopp, 2007). According to Silverstein (2008), increased life expectancy due to improvements in health and a decrease in birth rate over the years is leading to a progressive ageing of society. Whiting (2005) provides evidence that the rate at which companies are employing older workers has increased significantly since 1992, with a marked increase over the last decade and that, workers over the age of 50 are already becoming a defining part of the labour market. Hottopp (2007) reported for the UK that the employment rate of older workers has continued to increase since 1992 and particularly over the last decade.

Data from the UK Office for National Statistics (HSE, 2008) suggests that the mean age of the UK population will rise from 39.6 years to 42.6 by 2031 and 44 by 2050. It is also projected that there will be an increase in the size of the population aged less than 45 years old (+2.7 million), mainly due to the impact of migration, by 2031. However, it is expected that the increase in the number of over 45 year olds during this period will be far greater (+7.8 million) than that of the less than 45 year olds. This is illustrated in Figure 1, which shows a significant increase in older age groups over time. Data from the US Bureau of Labour Statistics (cited in Attwood, 2005), predicted that between 1998 and 2008, the number of civilian workers aged 55 years and over will increase by 49.9% while the number of 25 to 54 year old workers will increase by only 5.5%. Furthermore, data predicted that the number of workers between ages 16 and 24 will decrease by 2.8%. A growing number and proportion of older workers are also predicted for the next 25 years due to the anticipated shortage of younger workers (Figure 2).

One direct implication of these data is that as older workers retire the flow of new workers required to replace them will be insufficient. This could lead to labour and skills shortages, which in turn, could lead to a decrease in output (Silverstein, 2008). Alpass and Mortimer (2007) reported on New Zealand’s worker population age increases in line with global trends, and suggested that this reflected a combination of sub-replacement fertility, continuing longevity, and ageing baby boomers. Based on the expected changes to the population, they predicted that an older labour force is inevitable with 50% of workers older than 42 years of age by 2012 and that those aged 65 and over in the workforce will also increase in number. The authors concluded that such demographic changes have implications for how the nation will address the impact of an ageing workforce in the future. Furthermore, Terranova (2004) analysed the personnel records for a City Council Local Authority, and found that 40% of the workforce was over the age of 46 years, including an even higher proportion in the so-called blue-collar workforce, i.e. trade and operational workers. Similarly, Letvak (2005) found in a population of Registered Nurses that ageing of the workforce has added to an already acute shortage of staff, and that this may present serious issues, in terms of increased workloads and ratings of job dissatisfaction in the workplace.

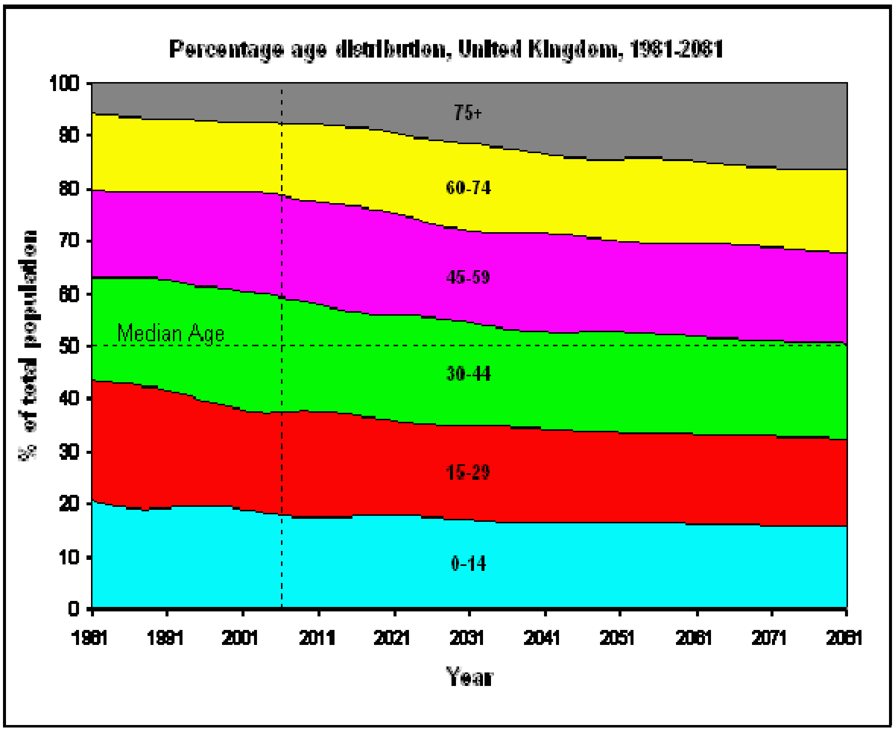

Figure 1: Actual and projected age distribution, 1981 -2081 (Office for National Statistics, 2008)

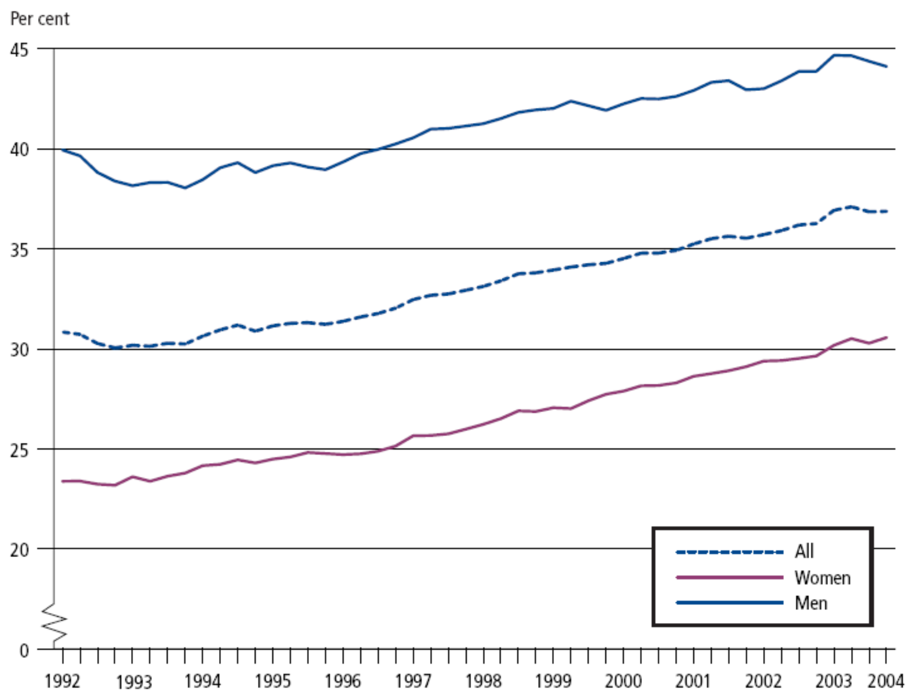

Figure 2: Employment rates for people aged 50 and over by sex; United Kingdom; spring 1992 to spring 2004 (Hotopp, 2005).

Based on these observations, the indications are that the numbers and proportion of older workers is growing steadily, and there is a need for employers to be informed about the implications.

4.2 AGEING AND FUNCTIONAL CAPABILITY

The studies on functional capability indicate age-related changes in functional capabilities of adults and it is generally agreed that as we age we are not able to perform to the same level as when we were young (Savinainen *et al.*, 2004; Atwood, 2005; Kowalsi-Trakofler *et al.*, 2005; Kenny *et al.*, 2008; Welch *et al.,* 2008). In terms of MSD, there are three main musculoskeletal changes reported in the literature; a reduction in joint mobility, decrease in muscular strength and the slowing of reaction and movement times. Leaviss *et al.* (2008) presents data that indicates the physical work capacity of a 65-year old is around half that of an average 25-year old worker. McNair and Flynn (2008), suggested that work performance in most jobs does not decline with age before the late 60s, particularly when the individuals are healthy, motivated and kept up to date. Welch *et al.* (2008) found that increasing age was associated with reduced physical functioning independent of the presence of medical conditions or MSD. Changes in physical abilities that are encountered with ageing, are however, influenced by individual genetics and lifestyle, as well as the environment in which individuals work and live (Buchman *et al.,* 2007; Kenny *et al.*, 2008). Therefore, highly trained older individuals may, in reality, be able to outperform those many years younger than them and the type of job that is done may have either a training or wearing effect on physical capacity.

4.2.1 Physical abilities

Ades and Toth (2005) examined data from the Baltimore Longitudinal Study of Ageing (a long-term descriptive study started in 1978, in which participants were subjected to two full days of medical, physiological and psychological testing every two years) and found nonlinear age-related decreases in aerobic capacity (measured as volumetric capacity VO_{2max}), which in fact, increased progressively with each age group (decade). The decline in peak VO_{2max} was between 3 and 6% for participants between 30 and 40 years of age but greater than 20% per decade, for those aged 70 years or more. For all age groups, the more physically active participants had higher peak VO_{2max} measures than less active individuals, but reduced peak VO_{2max} was observed at all levels of physical activity. Yassierli *et al.* (2007) investigated differences in isometric muscle capacity between 24 older (55-65yrs) and 24 younger (18-25 yrs) individuals who performed sustained shoulder abductions and torso extensions to exhaustion at 30%, 50% and 70% of individual Maximum Voluntary Contraction (MVC). Compared to the younger group, older individuals exhibited lower muscular strength, longer endurance time and slower development of local fatigue. Age effects of fatigue were typically moderated by effort level. Non-linear target relationships between target joint torque and endurance time were observed, with effects of age differing between shoulder abduction and torso extension. Overall, the effects of age on endurance and fatigue were more substantial and more consistent for the shoulder muscle than for the torso muscles and were in all likelihood, related to differences in muscle fibre type composition. For strength recovery rates, no significant age or gender effects were found. In summary, the study suggested that differences in isometric work capacity do exist between older and younger individuals, but that this effect is influenced by effort level and muscle tested. Punakallio, *et al.* (2005) investigated the associations of balance, muscular capacities and age with the risk of slip and falling in walking experiments with fully equipped fire fighters. Results indicate that old (43-56) fire fighters experienced as many slips as young (33-38) fire fighters and over half of each group experienced slips of over 5cm, which are thought to dramatically increase the risk of an unrecoverable fall. However, the older fire fighters tended to have longer slip distances than younger ones, particularly at faster walking speeds.

Letvak (2005) compared the prevalence of physical and mental health problems among a population of older nurses with a norm-based comparison group and found that their group of subjects had higher levels of physical and mental health than the national norm-scores for the comparison group. The author attributed the findings to high levels of job satisfaction among the older workers and concluded that efforts must be made to improve job attributes, which impact health, especially high physical demands. Shin *et al.* (2006) assessed the risks for older people from lifting by examining the trunk kinematics and ground reaction forces during lifting. Ten older (55-63 years) and ten younger (19-29 years) adults performed lifting tasks in six different conditions. A lumbar motion monitor was used to measure the participants' trunk kinematics and a force platform was used to measure the ground reaction forces during the lifting motion. The younger participants had higher trunk kinematics values comparison to their older counterparts, particularly in the transverse plane (axial twisting); the peak trunk velocity and acceleration values were significantly different between the two age groups. The peak transverse velocity was 40% lower and peak transverse acceleration was 30% lower in the older participants compared to the younger group. Age did not show a significant effect on the ground reaction forces or other trunk kinematic variables. The reduced trunk movements displayed by older participants were more obvious during asymmetric lifts. The authors suggested that older participants utilized greater twisting in their lower extremities to achieve the required asymmetric postures, thereby reducing the twisting demands placed on the lower back. Indeed, older people, generally, have weaker trunk extensors compared with leg extensors relative to their young counterparts and as such may prefer to use their legs more than their back because a leg-dominant lifting strategy provides a more stable posture in motion than a back-dominant lifting strategy.

The work by Savinainen *et al.* (2004) measured the musculoskeletal and cardiovascular capacity of ageing employees, in relation to workload, over four follow up investigations during a period of 16 years (1981, 1985, 1992 and 1997), and reported age-related decline in physical capacity during the follow-up period. There were also differences in physical capacity observed between different workload groups, such that employees with low workload had better physical capacity than those with high workload, especially among women. Irrespective of age, the results showed that over the follow-up period, improvements in physical capacity were more common than reductions among employees with low physical workloads but not for employees with high workload. The differences between high and low workload groups in physical capacity were larger among women than among men.

4.2.2 Need for recovery

Kiss *et al.* (2008) examined whether ageing workers had a greater need for recovery in comparison to their younger counterparts in a cross-sectional questionnaire study, with 1100 participants employed in the public sector. The participants were divided into two age groups; older workers (aged 45 years and over) and younger workers (aged less than 45 years old). A score higher than 45 (out of 100) was defined as a high need for recovery, while a score of 45 and lower was defined as a low need for recovery. The older worker group had significantly higher recovery scores compared to the younger workers (Table 1) and there were significantly more participants with a high need for recovery in the older worker group than in the young worker group.

Table 1: Summarised measures of recovery with age (Kiss *et al.*, 2008)

Age (years)	***Recovery measures***			
	Score		***High need for recovery***	
	Mean	***(SD)***	***Number reporting (N)***	***(%)***
<45	33.6	(27.9)	242	(34.0)
>45	40.9	(31.5)	173	(45.2)

Gender, presence of musculoskeletal disorder, work pressure, monotonous work, social support from superiors, full-time work and unsatisfactory social contacts were all significant correlates with the need for recovery. When these variables were taken into account in multivariate analysis, the older workers still showed a significantly higher need for recovery than the younger workers. This suggests that, although the occupational exposures to work strain were similar for both age groups, ageing workers had a significantly higher need for recovery than younger workers.

Gall and Parkhouse (2004) assessed the changes in work ability as a function of age in power line technicians (PLT). The physical tests used were designed to represent the essential task elements of power line maintenance identified from a detailed task analysis. Results indicated that older PLT scored lower in all test variables relative to the younger workers. However, six of the nine test variables did not demonstrate a statistical difference between the mean scores of young (>39 years) and old (50+ years) age groups. The older group did score significantly lower on tests of aerobic capacity, one-handed pull down, and both right and left standard handgrip tests. Despite these differences the older PLT was able to meet and exceed the physical requirements necessary to carry out the essential tasks of a power line technician. Furthermore, there was relatively little decline in musculoskeletal capacity between the young and old PLT, which would suggest that the heavy manual work associated with this occupation could be maintaining the physical capacity (aerobic and musculoskeletal) of the older worker. One possible confounder in the analysis of these results is that participants who expressed concerns of aggravating or acquiring MSD injury prior to or during the test were removed from that study and their data was not used during the analysis. Therefore only data collected from participants without significant MSD problems were used. This reduced the impact of musculoskeletal injuries when assessing the difference between young and old age groups.

These observations indicate that musculoskeletal functional capacities decline progressively with age, but several factors other than chronological age, such as level of physical activity and the demands of the work, contribute to determine an individual’s decrease in capabilities.

4.3 PREVALENCE/INCIDENCE OF MSD

Various types of MSD have been identified amongst older worker groups varying from simple aches and pains, discomfort and tingling sensations in the different regions of the body to overuse injuries and conditions (Palliser, *et al.,* 2005; Pransky *et al.,* 2005; Kaila-Kangas *et al.,* 2006; Hotopp, 2007; Zuhosky *et al.,* 2007; Landau *et al.,* 2008).

Generally, studies report higher values for older workers than younger workers, and higher values for those who leave work due to disease compared to those who continue in work till retirement (Whiting, 2005; Hartman *et al.*, 2003; Holmstrom and Engholm, 2003; Peek-Asa *et al.*, 2004; Hotopp, 2007; Taimela *et al.*, 2007; Silverstein, 2008). Between the ages of 51 and 62 years, the prevalence of musculoskeletal disorders may increase as much as 15% among workers, with more pronounced increases occurring in physically demanding occupations (Ilmarinen, 2002), especially where such occupations do not maintain or improve strength (Savinainen *et al.,* 2004). It has also been suggested that biological changes related to the ageing process, for example, degenerative changes to muscles, tendons, ligaments and joints contribute to the pathogenesis of musculoskeletal disorders (Cassou, *et al.,* 2002). Furthermore, studies indicate that aged workers suffer more serious but less frequent workplace injuries than younger workers and that MSD are often the result of a failure to match the work-based requirements of a task to the functional capacity of workers (Silverstein, 2008). A chronic overload for the elderly worker caused by a disruption of the balance between physical workload and physical work capacity can exacerbate the development of MSD (de Zwart *et al.,* 1999). Thus, older workers in physically demanding occupations are more likely to report musculoskeletal injury complaints (back, neck, upper/lower extremities) than their younger counterparts.

Taimela *et al.* (2007) studied the association between self-reported health problems and sickness absence from work. 1341 participants undertaking construction, service and maintenance work within a large Finnish corporation completed a questionnaire containing items regarding lifestyle, anthropometrics, sleep disturbances, work-related stress and fatigue, depression, pain, disability due to musculoskeletal problems and a prediction of future workability. The average age of participants was 44 years old (range 19–61 years) and 61% of respondents were blue-collar workers. The results showed that overall, 31% of respondents reported health problems, accounting for 61% of the total number of days on sick leave. The proportions with no sickness absence were lower in young employees than among those at least 40 years of age and those who reported one health problem had on average almost twice the number of sickness absence days than those who did not report any health problems. The prevalence of health problems was found to increase with age, and occupation (blue-collar workers had increased sickness absence in comparison to white-collar employees). However, when self-reported health problems and occupational grade were accounted for, age was not associated with the total number of absence days and older workers were less likely to stay out of work than their younger counterparts.

Palliser *et al.* (2005) examined a random sample of New Zealand dentists (N = 413) in order to identify the severity of musculoskeletal discomfort associated with the profession. In this study, the annual prevalence of such symptoms (lower back or neck) was 63%, with 49% experiencing symptoms in the shoulders. In the previous year, 53% (218) of the dentists had experienced symptoms in up to four body areas. The results indicated that older dentists were no more likely to suffer musculoskeletal discomfort than younger dentists (the average age of the sample was 43 years, with 29% of the sample aged between 31 and 40). Welch *et al.* (2008) investigated the prevalence of medical and musculoskeletal conditions among working roofers with 1000 subjects distributed in four age sub-groups 40-44, 45-49, 50-54 and 55-59 years. The results showed that there was a significant burden of MSD among the roofers, such that 69% of respondents had experienced at least one medical or musculoskeletal condition in the previous year with 54% reporting at least one MSD. Lower back/sciatica problems were the single most commonly reported health problem, affecting over a quarter of all respondents and lung disease led the list of medical conditions. The proportion of subjects with MSD was roughly equal across all age groups and, of those with MSD as their most serious condition, 79% reported that their MSD was work-related. Almost half of participants whose most serious condition was an MSD were estimated to be younger than 45 years when the problem began. Pransky *et al.*, (2005b) found that older workers reported fewer residual symptoms of injury than younger workers. In general, those over 55 appeared to be more content than those in the under 55 cohort, reporting not just higher satisfaction with the workers compensation insurer, but also with their pre-injury employment, the medical care they received for their injury and the provider's return to work recommendations. Younger workers had significantly lower pre-injury job satisfaction, experienced less positive responses from employers, were less satisfied with the response of the workers' compensation insurer post injury, and had more problems on returning to work, perhaps a consequence of less well-established relationship in the workplace. Peek-Asa *et al.* (2004) studied the incidence of acute low back pain among a cohort (n = 2152 reported injuries) of manual handlers. Age, gender, length of employment and lifting intensity were included as covariates. Results suggest an inverse association between age and acute lower back injury, in that workers aged between 45 - 54 years had the lowest injury incidence density rate (4.4 per 100 full-time equivalent work hours (FTE), i.e. 2000 hours per year), compared with workers aged < 44 years, the rate ratio was 0.78. Workers aged > 54 years had a comparative rate ratio of 0.84 relative to the < 44 years age group. However, this relationship disappears when lifting intensity and length of employment are considered where data suggests that those over 55 had the same number of injuries as those under 55; however the consequences of injury were greater in terms of lost work time for older workers.

However, Guo *et al.* (2004) found that age had a significant association with MSD such that prevalence tended to increase with age in a nationwide survey of 22,475 members of the general working population of Taiwan, though those in the youngest group (aged <18 years) did not have the lowest prevalence for most conditions. In fact, workers aged between 45 and 64 years had the highest prevalence in both genders. This group of workers reported 37% prevalence of MSD among their participants, for which the lower back and waist were the most frequently affected areas of the body, followed by the shoulder. The most common pattern was that the prevalence decreased from the first age group to the second age group (18 – 24 years), then increased with age till the 45-54 year old group or the 55-64 year old group, after which they decreased again. This pattern was observed for neck, elbow, knee and ankle in workers of both genders. Eriksen (2003) examined the prevalence of musculoskeletal pain in Norwegian nurses' aides and how this varied by demographic factors, number of working hours per week, and service sector. Participants were 6,485 respondents currently employed as nurses' aides and represented by the Norwegian Union of Health and Social Workers. The results indicated the prevalence of musculoskeletal pain in Norwegian nurses' aides was very high, not only for lower back but also for pain in several other regions of the body. The prevalence of any musculoskeletal pain (in previous 14 days) was 88% (95% confidence interval (CI) 88-90%), of intense musculoskeletal pain was 51% (CI 50-52%) and of widespread pain was 27% (CI 25-28%). While prevalence of pain in the extremities increased continuously with increasing age, prevalence of neck pain and back pain was normally distributed, with the lowest prevalence rates seen for the youngest and the oldest age groups. Holmstrom and Engholm (2003) reported age-related prevalence of MSD for nine body locations among their surveyed group of workers (construction workers, foremen and white-collar office workers). Amongst construction workers, the prevalence of any MSD increased from a minimum for the youngest age group to a maximum for those aged 55-59 years followed by slightly lower prevalence in those aged 60 years and over. In the youngest age group (<24 years) the prevalence of any MSD was higher for construction workers compared to foremen and white-collar office workers. Prevalence of hip disorders was highest in the > 60 years age group and prevalence of elbow disorders highest for the 45-49 years age group. Although in general, prevalence rates of the specific regional symptoms increased with age, they did not develop in the same manner as the prevalence rate for any MSD. Thus, among construction workers, the prevalence of shoulder disorders had a linear increase from 8.8% in the youngest age group up to 41.1% in the 55-59 years age group; the prevalence of hip disorders initially increased slowly with age across the younger age groups till the 45-49 years age group and thereafter increased sharply across the older age groups. Similar patterns in the onset of MSD were seen for both foremen and office workers. In general the increase in prevalence with age was more rapid among the construction workers than among the foremen and office workers, especially for neck, shoulder and knee disorders. For construction workers, the location with the highest disorder prevalence rate was the low back for ages below 45 years and the shoulder region for ages above 45 years. No similar pattern was seen among foremen or office workers.

These observations confirm the relationship between some adverse working conditions (repetitive work under time constraints, awkward work, high job demand) and the incidence of MSD. In general, they indicate that the prevalence of MSD is typically higher among older workers than younger workers and that complaints about the low back tend to be most common for older workers. Under unfavourable work conditions however, head–neck–shoulder symptoms may become more prominent than low back complaints. To prevent the expected increase in MSD in the aging workforce, preventive measures should be taken at all stages of a working life.

4.4 CONSEQUENCES OF MSD

The studies in this regard identify three main consequences of MSDs: sick leave/absence from work; severity of injury and functional impairment; and medical costs and early retirement. The findings in these regards are presented in the following sections.

4.4.1 Sick leave/absence from work

Two types of absences are differentiated – short-term absence (less than a week) and long-term absence (more than a week). According to Barham and Begum (2005) the majority of absence for both manual and non-manual workers is short-term absence due to minor illness such as colds, flu and stomach upsets. However, among manual workers, back pain, musculoskeletal injuries, stress and home and family responsibilities may also result in short-term absence from work (CIPD, 2008). Long-term absence on the other hand tends to accounts for 5% of all sickness absence cases, but is responsible for around 40% of all time lost (Leaker, 2008). The studies generally suggest that older workers typically take more long-term absences from work due to injury than their younger colleagues.

Peele *et al.* (2005) for example, found that among workers who had lost workdays, younger workers lost significantly fewer workdays (median of 30 lost days per worker) than older workers (median of 51 lost days per workers). The work by Peek-Asa *et al.* (2004) that investigated age related patterns for low back injuries causing days away from work, found that a higher proportion of older workers aged 55 years or more, missed work time because of their injury and that workers over 45 years had a higher average number of lost workdays per injury than those younger than 45 years. The average number of days missed per injury was 9.0 for those aged 45-54 and 8.5 for those > 54 years of age, compared to 5.6 for those < 45 years of age. The average number of missed workdays was significantly higher for workers aged > 55 years than for both groups of younger workers when stratified by length of employment and lifting intensity. In the overall cohort, there were 1070 low back injuries that led to missed workdays. For women, those aged 45-54 years were slightly less likely, and those aged 55 years and over slightly more likely to have missed work injuries than the youngest age group, though the differences did not reach significance level. Among those employed for 3 years or less, the average number of missed days increased with age with an apparent dose-response relationship pattern. Generally, workers in the lowest intensity of lifting categories had the highest average number of workdays missed per injury. This may be explained by the healthy worker effect in that those who perform regular high intensity lifts develop the necessary musculature to maintain heavy lifting jobs or have developed better lifting techniques. Hartman *et al.* (2003) analysed a database of 22,807 sick leave claims of 12, 627 farmers between 1994 and 2001 to provide base line data on the diagnosis, occurrence and duration of sick leave amongst self-employed workers in Holland. Most of the claims were for musculoskeletal injuries and disorders and the mean cumulative incidence was 10.2 claims per year per 100 farmers. The duration of sick leave depended both on MSD diagnosis and age category and the slowest recovery from sick leave was seen in farmers with respiratory diseases and farmers in the oldest category. Lotters and Burdorf (2006) conducted a prospective cohort study with a one-year follow-up period to determine prognostic factors for duration of sickness absence specifically due to MSD. 186 workers, who had made a compensation claim for lost-time at work due to an MSD injury, completed a questionnaire relating to personal and work-related factors, perceived pain, functional disability, and general health perceptions during their sickness absence. Multivariate factor analysis revealed that older age, gender, perceived physical workload, poorer general health, worker's perception of own ability of return to work, and chronic complaints were associated with lengthening sickness absence. High pain intensity was found to be a major prognostic factor for duration of sickness absence, especially in low back pain.

Though, the studies above suggest that older workers are more absent from work than their younger colleagues, others have reported results that suggest sickness absence may not be higher for older workers (for example Leaker, 2008). From analysis of a more recent set of labour force survey data (Table 2), Leaker (2008) concluded that younger employees were more likely to take short-term sickness absence than older employees. Table 2 shows that around 2.6% of 16-34 year olds were absent due to sickness or injury compared with 2.5% of 35-49 year olds and 2.4% for those aged 50-59/64. The data indicate that employees aged 16-24 are 32 % times more likely to be absent than those aged 50-59/64.

Table 2: Summarised previous 12 months sickness absence rates in rates by age and gender (adapted from Leaker, 2008)

	Sickness absence rate		
			Women
-			3.0
-			3.1
-			2.9
-			2.6
			2.1
			2.9

Furthermore, Peele *et al.* (2005) found that among workers with medical claims for occupational injuries, 10.5% reported an occupational MSD, but there was no significant difference in the distribution of age between all workers who used occupational medical services and those who used medical services for MSD. 663 workers incurred a total of 44,655 lost days in 2000, of which 304 workers (45.9%) had a total of 20, 800 lost days due to MSD. There was no significant difference in the distribution of sex and age between all workers, and workers with MSD with respect to lost workdays. The work by Taimela *et al.* (2007) supports this finding. These authors found the proportion of those reporting no sickness absence was lower in the less than 40 years age groups than in the 40 years or older age group. Further analysis showed that those who reported one health problem had on average almost twice the number of sickness absence days and those with two or more health complaints had 3.4 times the number of absence days than those who did not report any health problems. When self-reported health problems and occupational grade were accounted for, age was not associated with the total number of absence days and older workers were less likely to stay out of work than their younger counterparts. Kaila-Kangas *et al.* (2006) investigated the socio-economic distribution of 6166 hospital admissions for severe back injury by age and gender, and the extent to which the differences in back morbidity were related to manual work. The results showed that blue-collar (manual) workers had a higher risk of being hospitalised because of back disorders compared to white-collar employers (non-manual) in all age groups. The authors suggested age was not a factor but that; people in physically strenuous occupations had an increased risk of being hospitalised because of back disorders than those in less strenuous occupations.

4.4.2 Severity of injury and functional impairment

The studies in this regard investigated severity in terms of functional impairment, and longer recuperation for the same condition.

Layne and Pollack, (2008) reported overall increases in the number of hospitalisations due to injury as participants' age, particularly for those in blue-collar jobs or with a low educational status, in comparison with white-collar work or those with a high educational status. Hoonakker *et al.* (2006) reported large increases in the number of deaths among elderly workers suggesting that this may reflect a greater likelihood of serious complications and poorer prognosis after injury. The work by Peek-Asa *et al.* (2004) found that workers, employed as materials handlers in a home improvement retail company, over the age of 55 had longer periods of missed work following a low-back injury than the younger counterparts. Those in the lowest group for lifting intensity reported the longest time off, which suggested increased severity of injury as a consequence of poor lifting technique or underdeveloped, task-specific musculature. The incidence rates for all injuries, and injuries resulting in lost days from work, generally decreased as the length of employment increased. Among workers employed less than 3 years, those over 45 had lower incidence rates than those 45 and younger. However, among workers with 4 or more years of experience, individuals over the age of 55 had the highest incidence rate for both injuries and injuries resulting in lost days. The relationship between age and length of employment may reflect the combination of a self-selecting cohort and age effect in which healthy older workers have developed protective factors over time.

Gardner *et al.* (2008) identified limited ability to work, decreased work productivity and functional limitation (as measured on the Functional Status Scale) as the most commonly reported function impairments due to upper extremity (UE) symptoms for 1,108 workers employed in a new job. Results showed increased risk of functional impairment for older age, physical work exposures and work-related psychosocial factors. The authors opined from the results that the risk factors for UE symptoms might be different than the risk factors for functional impairment due to UE symptoms. Welch *et al.* (2008) found for the studied population of construction workers that increased age was significantly associated with decreased physical functioning independent of the presence of medical condition or MSD. Those with medical and MSD conditions had more work limitations than those without, such that 14% of their respondents with a medical condition indicated a limitation in three or more work activities, compared to only 4% of respondents with no condition. The authors concluded from their study that the presence of a health condition, physical functioning, missed work and work limitations were intertwined.

Lipscomb *et al.* (2008) investigated upper extremity musculoskeletal problems among women employed in poultry processing and identified difficulty to maintain work speed or quality due to symptoms reported; age, being overweight and job insecurity at baseline were associated with incident disorders. Data were collected from a cohort of 291 women through interviews and physical examinations conducted at 6-month intervals over 3 years. An index of cumulative exposure based on departmental rankings and work history, was the primary exposure variable. The authors concluded from the results that the pattern of risk was consistent with onset of early musculoskeletal problems among women new to the industry followed by a later increase with continued exposure.

4.4.3 Medical costs and early retirement

In these regards, the work by Hoonakker *et al.* (2006) examined the effects of age and working conditions on self-reported health over a 12-year period using data from a previous study. Results showed that self-reported health deteriorated significantly in the period 1992-2004 (χ^2 2283, df=16, $p<0.001$), and there was a considerable increase in the number of symptoms, especially musculoskeletal complaints. Respondents who were still working in 2004 had significantly more lack of energy and complained more about fatigue than those who retired in 2004; the differences in respect of frequency and severity of complaints were not significant. In 2004, respondents reported less physical effort, lower work pressure and less autonomy than in 1992. Respondents who reported high physical effort in 1992 and who were still working in 2004 had worse general health in 2004 than employees who experienced low physical effort (χ^2 11.6, df=4, $p<0.05$). The respondents with high physical effort in 1992 did not report a decrease in energy in 2004, but did complain significantly more often about the frequency and the discomfort such work caused than respondents who reported low physical effort. Respondents with a high amount of repetitive movements in their jobs in 1992 had worse general health in 2004 than those who reported a low amount of repetitive movements (χ^2 20.9, df = 4, p<0.0001). Respondents working under high time pressure in 1992 did not have worse general health in 2004 than those working under low time pressure in 1992 (χ^2 1.6, df = 4, p<0.81). Respondents with a low level of autonomy in 1992 had worse general health in 2004 than those who reported a high level of autonomy (χ^2 48.7, df =4, p<0.001). Results from the study were considered to show the long-term adverse impact of working conditions on health.

Pransky *et al.* (2005a) identified health-related early retirement as an adverse outcome unique to older workers and that the retirement theory literature, while extensive, provided limited direct evidence about the factors that influence a decision to leave the workforce. None of the investigations had focused on work injuries or other acute trauma events. The study was intended to develop new information on the frequency and characteristics of workers whose occupational injuries changed their plans regarding early retirement. The working hypothesis was that plans to retire early after a work injury would be associated with several pre- and post injury factors as well as certain post-injury outcomes. In the population of workers studied, 11% reported intent to retire early due to their work injury. Though demographically similar to other older workers who had been injured on the job, those who planned early retirement differed significantly with respect to many pre- and post injury factors. Prior to injury, they reported more health problems and more difficulties at work, including lower job satisfaction. In addition to experiencing more severe injuries, they appeared to return to a work environment that was less supportive, where changes were less available or effective. Intent to pursue early retirement because of the work injury was strongly associated with other adverse outcomes. These included negative trends in quality of work life, more difficulty keeping up with required tasks, and more health related work limitations. Even though there was little difference in the length of work absence, between the two groups, almost twice as many of those with changed retirement decisions had not returned to performing their usual job tasks. This was considered a likely consequence of persistent post-injury work and health problems. The lack of self-efficacy demonstrated in the reduced capacity to perform job tasks also may lead to a desire to withdraw from the workforce.

Gleeson and Gallagher (2005) studied to determine the incidence rates, trends and medical causes of ill-health retirement (IHR) among different occupational classes, based on data from 14,702 permanent employees of a health board who were divided into six occupational classes. The occupational classes were compared for incidence rates of IHR, age at IHR, years of service and medical causes of IHR. The overall incidence rate of IHR was 2.9 per 1000 employees per annum and the common causes of IHR were MSD (38%) mental illness, (17%), circulatory disorders (12%) and neoplasia (8%). With regard to age and years of service, they found that IHR peaked at the time that coincided with enhancement of pension entitlements. The authors concluded from the results that IHR was common among healthcare workers, but the structure of the pension scheme had a greater influence on the timing of IHR than occupational class or age of worker.

4.4.4 Summary

Musculoskeletal disorders are a problem amongst both young (<25 years of age) and elderly workers (>55 years of age), but tend to be more severe for elderly workers than younger workers, in terms of longer recuperation, lost work time and costs, for the same condition. However, a higher probability of sickness absence has been reported for younger workers in terms of higher total counts of recorded absence days, and a decreased number of one-day (short-term) absences has been reported for older aged workers.

4.5 THE QUALITY OF THE EVIDENCE FOR AGE AS RISK FACTOR

Various systematic reviews have evaluated the strength of evidence concerning risk factors for MSD (for example D'Souza *et al.*, 2005; Lorusso *et al.,* 2007; Jensen, 2008a,b). These identify prospective cohort studies as the preferred design, followed by a case-control study and then by cross-sectional studies. Important drawbacks associated with the cross-sectional design methodology, include, poor assessment of the physical exposures to risk factors and an inability to make causal inferences from the results. In these regards, Tables 3 and 4, presents summarised the data obtained from the literature concerning the risk factors for MSD symptoms. The information is for eight prospective/longitudinal and fourteen cross-sectional/case control studies, which reported significant associations different risk factors (including age) after adjustment for confounding variables.

Paul *et al.* (2005) investigated the factors that influence mine-related injuries with specific reference to age and human behaviour aspects using a case control study design. 175 cases and 200 controls were involved as participants and a multi-item questionnaire was applied for data collection. The cases were mineworkers who had sustained a prior mine-related injury, while controls were mineworkers with no history of a prior mine-related injury. Bivariate analysis (estimating the crude odds of injury from an examination of the association between age and injury) generally showed that those aged 46 years or more were 3.48 times more likely to be injured than the youngest age group (<29 yrs), multivariate analysis was used to refine the model (taking into account the influence of other covariates) and showed equal likelihood of injury for the older workers and the youngest age group of workers. The bivariate analyses also showed increased likelihood of injury for the most experienced workers (>23 yrs) compared to the least experienced group (<5 yrs), and that irrespective of their age, workers who perceived their work environment as being more hazardous were more likely to be injured than those who did not. The multivariate analysis showed reduced likelihood of injury for high safety performance and negative affinity. The authors opined from the results that older (>49 yrs) and more experienced (>23 yrs) workers are more likely to become injured compared to younger groups due not necessarily to ageing, but to overconfidence, and consequent underestimation of potential work dangers.

Table 3: Risk factors for work-related MSD/injuries in populations of workers including aged workers

Reference/population	*Region of injury/definition*	*Risk factor*	*Measure of risk*	*Design/Exposure evaluation*
Hoonakker *et al.* 2006 General aged worker population, age based on graduation year 1957, 1964, 1975, 1992/93, 2004	General health Medical symptoms	Job characteristics High physical workload High repetitive movement High time pressure Low autonomy	 χ^2 11.6, df=4, p<0.05 χ^2 20.9, df=4, p<0.0001 χ^2 1.6, df=4, p<0.81 χ^2 48.7, df=4, p<0.001	Prospective (12 year follow-up), questionnaire survey, bivariate Pearson χ^2 test analysis
Hartman *et al.* 2003 Farming population, in 3 age groups (<35, 36-45, >45 yrs)	Incidence of claims	Age (oldest group)	OR 1.6	Data base analysis of claims
Breslin and Smith 2005 General workers, in 4 age groups (15-19, 20-24, 25-35, 35-64 yrs)	General work injuries	Age (< 35 yrs) Occupation (low demand)	OR 1.59, CI 1.24-2.04 OR 2.67, CI 2.05-3.49	Cross-sectional, population study, archival data
Peek-Asa *et al.* 2004 Manual handlers in home depot, in 3 age groups (≥55yrs, 45-54, <45yrs)	Low-back injury (acute)	Male/ Older age	RR 0.73, CI 0.59-0.92	Prospective (5 year follow-up, 1989-1994) Questionnaire survey, bivariate analysis
Lin *et al.* 2008 General workers, in 5 age groups (15-24, 25-34, 35-44, 45-54, >55yrs)	Fatal injuries	Male / young age	χ^2 test, p<0.001	Analysis of 1890 case reports 1996-1999
Wang *et al.* 2007 Garment industry workers in 4 age groups (<30, 30-39, 40-49, >49 yrs)	Neck/shoulder UL pain	Age (30-39yrs)	OR 0.5, CI 0.27-0.94	Cross-sectional, questionnaire, face-to-face interviews
Paul *et al.* 2005 Coal mine workers in 3 age groups (<29, 29-46, >46 yrs)	General injuries	Safety performance (high) Negative affinity (high)	OR 0.71, CI 0.02-0.24 OR 9.34, CI 2.20-39.73	Case-control study, questionnaire survey

χ^2 – Chi-squared coefficient/analysis, CI – 95% Confidence Interval, OR – Odds Ratio,

Table 3: Risk factors for work-related MSD/injuries in populations of workers including aged workers (continued)

Reference/population	***Region of injury/definition***	***Risk factor***	***Measure of risk***	***Design/Exposure evaluation***
Holmstrom and Engholm 2003 Construction industry workers in 9 age Groups (<25, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, >59 yrs)	Upper back symptoms	Older age >55yrs	RR 2.11, CI 1.88-2.38	Cross-sectional questionnaire survey study
		Insulators v foremen	RR 2.70, CI 2.09-3.48	
	Lower back symptoms	Older age >35yrs	RR 2.32, CI 2.17-2.48	
		Roofers v foremen	RR 5.01, CI 3.83-6.54	
	Hip symptoms	Older age >30yrs	RR 2.33, CI 2.01-2.71	
		Roofers v foremen	RR 2.42, CI 1.72-3.40	
	Knee symptoms	Older age >45yrs	RR 2.00, CI 1.87-2.14	
		Floorers v foremen	RR 4.54, CI 3.95-5.23	
	Ankle/foot symptoms	Older age >50yrs	RR 2.53, CI 2.28-2.81	
		Scaffolders v foremen	RR 2.48, CI 1.89-3.25	
	Neck symptoms	Older age >55yrs	RR 8.40, CI 7.64-9.24	
		Crane operators v foremen	RR 4.50, CI 3.74-5.42	
	Shoulder symptoms	Older age >50yrs	RR 8.69, CI 8.00-9.44	
		Scaffolders v foremen	RR 8.35, CI 6.62-10.53	
	Elbow symptoms	Older age >45yrs	RR 9.17, CI 8.22-10.23	
		Scaffolders v foremen	RR 6.53, CI 5.07-8.41	
	Wrist/hand symptoms	Older age >50yrs	RR 2.18, CI 1.99-2.39	
		Scaffolders v foremen	RR 9.10, CI 7.18-11.52	
Antonopoulou *et al.* 2007 General worker population in 3 age groups (20-39, 40-64, >64 yrs)	Low back pain	Older age	OR 1.02, CI 1.00-1.05	Cross-sectional, self-filled questionnaire survey
		Gender	OR 2.36, CI 1.48-3.77	Primary care centre archival data
	Neck pain	Older age	OR 1.06, CI 1.03-1.08	
		Gender	OR, 3.76 CI 2.19-6.43	
	Shoulder pain	Gender	OR 1.88, CI 1.11-3.17	
		Years in present job	OR 1.03, CI 1.03-1.06	
	Knee pain	Older age	OR 1.03, CI 1.01-1.06	
		Gender	OR 2.74, CI 1.58-4.74	
Lipscomb *et al.* 2008 Poultry workers, in 3 age groups (<30, 30-40, >40 yrs)	Upper extremity incidence of disorders	Age (> 40)	OR 6.30, CI 2.54-45.62	Longitudinal (six month intervals, 3 year total) Multivariate analysis

OR – Odds Ratio, RR - Relative Risk, CI – 95% Confidence Interval

Table 3: Risk factors for work-related MSD/injuries in populations of workers including aged workers (continued)

Reference/population	***Region of injury/definition***	***Risk factor***	***Measure of risk***	***Design/Exposure evaluation***
Alexopoulos *et al.* 2006 Shipyard employee population in 3 age groups (<31, 31-44, >44 yrs)	Low back pain	Mid age (31-44yrs)	OR 1.53, CI 1.04-2.25	Cross-sectional, self-filled questionnaire survey
		Manual handling	OR 1.55, CI 1.02-2.36	
		High need for recovery	OR 2.11, CI 1.49-2.98	
		Low perceived general health	OR 1.76, CI 1.25-2.48	
	Hand/wrist pain	Gender (females)	OR 3.82, CI 1.93-7.58	
		Manual handling	OR 1.99, CI 1.18-3.35	
		Low perceived general health	OR 2.52, CI 1.64-3.87	
	Shoulder/neck pain	Older age (31+yrs)	OR 1.94, CI 1.21-3.11	
		Low perceived general health	OR 3.63, CI 2.55-5.16	
Werner *et al.* 2005a Industrial and clerical workers, in 2 age groups (≤ 40 yrs, >40 yrs)	Upper extremity tendonitis	Older age (40 +)	OR 1.76, CI 1.04-2.98	Prospective cohort study (5.4 years follow-up)
		BMI (30 +)	OR 1.93, CI 1.12-3.34	
		SNP complaint at base line	OR 1.84, CI 1.03-3.29	
		Shoulder posture rating (high)	OR 1.92, CI 1.14-3.24	
		Baseline discomfort (worst)	OR 1.21, CI 1.06-1.38	
Ghasemkhani *et al.* 2006 Automobile assembly line workers in 3 age groups (<25, 35-30, >30 yrs)	Neck pain	Educational status (low)	OR 0.19, CI 0.04-0.88	Cross-sectional, self-filled questionnaire survey
	Shoulder pain	Educational status (low)	OR 2.05, CI 1.10-3.81	
	Elbow pain	Educational status (low)	OR 6.44, CI 1.89-21.91	
		Cigarette smoking	OR 2.78, CI 1.07-7.23	
	Low back pain	Educational status (low)	OR 2.36, CI 1.38-4.03	
	Wrist/hands pain	Educational status (low)	OR 5.01, CI 2.38-10.55	
	Feet pain	Educational status (low)	OR 3.84, CI 2.29-6.42	
Cassou *et al.* 2002 Genera worker population	Chronic neck/shoulder pain:	Age (older)	OR 2.00, CI 1.60-2.60	Prospective study (5 year follow-up 1990-1995), questionnaire survey, clinical examination
	Incidence	Repetition (time constrained)	OR 1.30, CI 1.00-1.70	
		Awkward work	OR 1.30, CI 1.10-1.70	
	Disappearance	Older age	OR 0.60, CI 0.40-0.90	
		Repetitive work	OR 0.50, CI 0.30-0.70	

OR – Odds Ratio, CI – 95% Confidence Interval

Table 3: Risk factors for work-related MSD/injuries in populations of workers including aged workers (continued)

Reference/population	***Region of injury/definition***	***Risk factor***	***Measure of risk***	***Design/Exposure evaluation***
Conway *et al.* 2008 Nurses, RN/Assistants, in 2 age groups (< 45, 45 + yrs)	Physical health - MSD	Age (older) Commitment (high) Commitment x Age	OR 1.58, CI 1.22-2.04 OR1.51, CI 1.09-2.21 OR 2.61, CI 1,75-3.90	Cross-sectional, questionnaire survey, loglinear regression, multi-variate analysis, Rothman Index
Gardner *et al.* 2008 Industrial workers, aged 18 yrs and over	Upper limb symptoms - Prevalence, moderate severity, incidence	Age Previous injury (baseline) Job demands	OR 1.20, CI 1.00-1.40 OR 4.72, CI 3.00-7.45 OR 1.76, CI 1.17-2.66	Longitudinal (6 month follow-up), questionnaire Survey, univariate, multi-variate analysis, Chi-square test

OR – Odds Ratio, CI – 95% Confidence Interval

Table 4: Risk factors for post MSD injury outcomes in populations of industrial workers

Reference/population	*Injury (inj) outcomes*	*Risk factor*	*Measure of risk*	*Study design/Exposure evaluation*
Pransky *et al.* 2005a General older workers (≥55yrs old)	Early retirement	Pre-injury job dissatisfaction	OR 1.16, CI 0.97-1.38	Cross-sectional, questionnaire survey
		Dissatisfaction with medicare	OR 1.70, CI 1.04-2.77	4 Focus groups, 28 persons, multi-variate
Pransky *et al.* 2005b General worker in 2 age groups (≥55yrs old, <55yrs young)	Pre-injury (Pinj) poor health	Age (older)	t –3.53, $p<0.0001$	Cross-sectional, questionnaire survey
	Pinj job dissatisfaction	Age (younger)	t 6.70, $p<0.0001$	4 Focus groups, 28 participants, uni-variate
	Severity rating	Age (older)	χ^2 13.6, $p<0.004$	
	Negative employer response	Age (younger)	t 5.70, $p<0.0001$	
	Job related problems	Age (younger)	t 3.70, $p<0.01$	
	Lack of co-worker support	Age (younger)	χ^2 12.6, $p<0.0001$	
	Economic problems	Age (younger)	t 5.10, $p<0.0001$	
	Impact on quality of life	Age (younger)	t 3.30, $p<0.01$	
Arndt *et al.* 2005 Construction workers	Disability	Older age (>50yrs)	OR 2.09, CI 1.76-2.46	Prospective cohort study (6-yrs follow-up),
		Heavy work occupations	OR 2.37, CI 2.09-2.69	archival data analysis
		Length of employment >15yr	OR2.46, CI 2.27-2.67	
Alexopoulos *et al.* 2006 Shipyard employees in 3 age groups (<31, 31-44, >44 yrs)	HCU - Low back pain	Chronic complaint	OR 1.55, CI 1.02-2.36	Cross-sectional, self-filled questionnaire survey
	Hand/wrist pain	Mid age (31-44yrs)	OR 3.51, CI 1.19-10.34	
		Heavy job (blue collar)	OR 9.45, CI 2.20-40.51	
		Strenuous shoulder movements	OR 0.17, CI 0.06-0.50	
		Co-morbidity	OR 5.27, CI 1.09-25.39	
	Shoulder/neck pain	Chronic complaint	OR 2.85, CI 1.52-5.35	
	SL - Low back pain	Co-morbidity	OR 2.78, CI 1.17-6.60	
	Hand/wrist pain	Mid age (31-44yrs)	OR 0.29, CI 0.10-0.83	
	Shoulder/neck pain	Strenuous shoulder movements	OR 3.87, CI 1.50-9.99	
		High job demand	OR 0.41, CI 0.17-0.96	
		Chronic complaint	OR 3.42, CI 1.38-8.46	

HCU – Health care use, SL – Sick leave, χ^2 – Chi-squared coefficient, t – student's t test coefficient, OR – Odds Ratio, CI – 95% Confidence Interval,

Table 4: Risk factors for post MSD injury outcomes in populations of industrial workers (continued)

Reference/population	***Injury (inj) outcomes***	***Risk factor***	***Measure of risk***	***Study design/Exposure evaluation***
Peele *et al.* 2005 Manufacturing industry workers in 2 age groups (<45, ≥ 45 yrs; N=3123)	Wage compensation Days lost due to illness Medical care cost	Age (older) Age (younger)	χ^2, p=0.0190 χ^2, p=0.0025	Cross-sectional, χ^2, Wilcoxon,
Werner *et al.* 2005b Auto assembly workers, in 2 age groups (≤ 40 yrs, >40 yrs)	Upper extremity tendonitis Visit medical department	Older age (40 +) Diagnosis of diabetes Diagnosis of elbow tendonitis Diagnosis of CTS	HR 0.96, CI 0.92-0.99 HR 3.20, CI 1.20-8.30 HR 2.80, CI 1.30-6.00 HR 3.80, CI 1.80-8.10	Longitudinal cohort study (5one years follow-up), stepwise Cox regression analysis

HR – Hazard Ratio, χ^2 – Chi-squared coefficient/analysis, CI – 95% Confidence Interval

Peek-Asa *et al.* (2004) examined age-specific incidence rates of acute low-back injury overall and within a stratum of gender, job-specific lifting intensity and length of employment in a prospective study design, using a large cohort (n = 2152) of manual handlers and a multi-variate analysis of the data. The central hypothesis was that age-specific rates of acute low-back injury would be similar when stratified by the exploratory variables. The results showed that workers aged 55 years and over had a rate ratio of 0.84 (CI 0.69-0.92) compared to those aged less than 45 years and a trend of decreasing rates with increasing age, which was more apparent for men than for women. Workers aged 45-54 years were 0.69 times likely to sustain an injury causing days away from work (CI 0.53-0.88), and those aged 55 years and above were slightly but not significantly less likely to have missed workday injuries than workers younger than 45 years of age (RR 0.93, CI 0.70-1.23). For all age groups, the rate of injury decreased with length of employment and increased with increasing lifting intensity. The authors concluded from the results that workers over the age of 55 years were no more likely to suffer a low back injury at work than younger workers (< 45 years of age), irrespective of the lifting intensity in the work and their length of employment. Werner *et al.* (2005a) investigated the incidence rate and risk factors of upper extremity tendonitis (UET) with a longitudinal study design. 501 active workers were involved as participants and they were followed over 5.4 years. The factors found to have the highest predictive value for identifying persons likely to develop UET in the future included older age (> 40 years), high BMI (> 30), complaint at base line, history of injury and job with high effort requirement. The authors concluded that older, heavier workers who also had a history of discomfort or injury were at the highest risk for developing new injury.

Cassou, *et al.* (2002) prospectively analysed the effects of age and occupational factors on both the incidence and the disappearance of chronic neck and shoulder pain (CNSP) over a five year follow up period. Questionnaire data were taken from a longitudinal study involving a large representative sample of French workers participating in the Health Work and Aging Investigation Study (ESTEV). During the initial stage of investigation (1990), 21,378 participants (57% were men), who were born in 1953, 1948, 1943, or 1938, were randomly selected, 18,695 (87.4%) of which were interviewed again in 1995. In the population as a whole, 16,950 (90.6%) participants were still at work in 1995, however, the proportion of participants born in 1938 that was available for follow up in 1995 was lower for both sexes, as more participants from this cohort had retired. The prevalence rate was lower among the younger respondents (men aged 47 and 52 years and women aged 42 and 47 years old) than among older respondents (aged 57, 62, 52 and 57 respectively). In addition, the disappearance rate was found to decrease with age, especially among women. The incidence rate of CNSP was not statistically different when the social class of respondents was considered (executives 6.7%; clerks 7.8%; blue collar workers 7.5%; others 8.2%). Among male respondents, repetitive work under time constraints (before 1990), awkward work (in 1990), and high job demand (in 1990) were the occupational factors identified as risk factors for CNSP, independent of age. Among women, two occupational factors were related to incidence rate; repetitive work under time constraints in 1990 and before, and high job demand in 1990. The majority of workers with chronic pain were still at work at the end of the study period and coping with their disability.

Arndt *et al.* (2005) prospectively investigated the patterns of the nature and extent of occupational disability with 14,474 male workers from the construction industry. The participants were aged 25-64 years and they were grouped into six age categories (25-39, 40-44, 45-49, 50-54, 55-59, and 60-64 years). At the end of the follow up period (6 years) 8493 men were still working. The results showed that MSD were the leading reason for occupational disability in all age categories; the crude disability rate was 2049 per 100,000 person years, and risk of disability strongly increased with age. Though the proportion of MSD among the cases of disability strongly increased with age, some other causes like mental disorders, injury and poisoning were important contributors to occupational disability among the young age groups.

When the cohort was stratified by age, a widening gap in all-cause disability with increasing age and duration of employment was revealed between construction workers (who were exposed to high physical work demands) and the general workforce (white and blue collar workers with generally lower work demands). The associations of age and duration of employment with disability caused by MSD appeared to be stronger than those for all-cause disability, though the association between age and MSD disability was more U-shaped, with the highest relative risk among the youngest and older age groups.

Furthermore, Pransky *et al.* (2005b) studied to provide detailed information on occupational injury circumstances and outcomes in workers aged 55 and over, compared with a similar cohort of younger workers. The contribution of age to outcomes after a work injury was evaluated using a multi-step process. First, age-related differences in various factors related to outcomes were analysed and bivariate analyses were employed to assess the relationship of age to outcomes. Thirdly, age and other factors were entered into multivariate models of selected outcomes in order to observe the effect of age when other variables were also considered. In this way it was hoped that the separate role of age in outcomes after a work injury could be clarified. The results showed no evidence of significant age-related differences for the majority of the outcomes examined, including change in ability to do one's job compared to before the injury, current injury-related pain, use of pain medications or concerns about future job capacity or job retention as a consequence of the injury. Age by itself was unrelated to all but one outcome, i.e., financial problems attributed to the injury; a positive effect of age was shown, which indicated, that being older was protective. The findings were considered remarkable as older workers reported more frequent pre-existing illnesses, and had more severe injuries. But the types of jobs and industries, physical job demands, rates of prior work-related injury, injury onset and body part involved were similar for both groups and had little association with outcomes in multivariate analysis. The authors suggested that workplace psychosocial issues were key to the relative advantage of older workers. Indeed, younger workers had significantly lower pre-injury job satisfaction, experienced less positive responses from employers, were less satisfied with the response of the workers' compensation insurer post injury, and had more problems on returning to work (perhaps a consequence of less well-established relationships in the workplace).

The work by Hoonaker *et al.* (2006) examined the relationship between job characteristics in 1992 and self-reported health in 2004 in an older population of workers (individuals who graduated from high school in 1957) using data from the Wisconsin Longitudinal Study (WLS). The respondents were followed over time until they were on the brink of retirement in 2004. Between the study periods, the results showed that working conditions of the respondents improved significantly, and general health of the respondents deteriorated with a number of health complaints increasing dramatically. Prior to this time however, they identified that in general, working conditions had deteriorated between the last decades. Respondents with high physical workload, high repetitive work, low autonomy and high pressure in 1992 had more significantly worse general health and more medical symptoms in 2004 than those who scored low on these job characteristics. General health of respondents who retired between 1992 and 2004 was significantly worse than those who were still working in 2004; 300 of the 5462 respondents recruited in 1992 retired because of health reasons between 1992 and 2004. When the results for those who retired for health reasons were excluded, overall health and the number of symptoms reported by the respondents who retired for other reasons and respondents who still worked in 2004 were largely the same. The authors opined from the results that, even though retirement meant they were no longer exposed to the adverse working conditions, those who retired early were no more in better or worse health than those who were still working and continuously exposed. The results were however, not clear on what caused the health reasons for retirement of respondents, i.e., whether they were work-related or not. Breslin and Smith (2005) examined age-related differences in work injuries, using a cross-sectional study design, with an emphasis on adjusting for the potential confounding effects of job characteristics. The results showed that, adolescents and young adult workers, especially males, showed elevated rates of work injury compared to adults who were aged 35 years and over. The injured young workers had proportionally more acute, traumatic injuries, and fewer musculoskeletal injuries than older workers. Multivariate analysis indicated that differences in the types of jobs young workers held played an important role in their elevated risk for injury. For men this was such that age related differences were reduced when job characteristics were controlled for, though even in the fully adjusted model, young males 15-34 years continued to exhibit a moderately elevated risk of injury. The age differences in injury rates for women were less marked than those for males.

Landau *et al.,* (2008) carried out a cross-sectional workload-strain-symptoms study on 256 workers and workstations in a company of the automotive industry, to identify the independent role played by age. They applied the recursive partitioning creating regression trees statistical analysis procedure to identify features or combinations of features exhibiting a strong association with the target variables and influences attributable to worker age. The analysis, like cluster analysis, makes it possible to segment a sample into sub-groups which are homogeneous, but also different from each other. In contrast to most cluster analysis procedures, it is also possible to identify the variables or combination of variables causing segmentation. The distribution for presence of musculoskeletal symptoms derived from the study revealed no correlations with worker age. Indeed, athough multivariate analysis showed a strong association of age with workload situation, such that more unfavourable high workload jobs (based on expert rating) were occupied by younger workers and low workload jobs occupied by older workers, the association with physical health symptoms did not have any primary explanatory value. The authors opined from the results, that potential age-related performance deficits in the older workers were more or less completely compensated for by allocation to jobs less likely to cause them strain.

Based on the observations from the literature, the evidence for ageing/older age as an independent risk factor for MSD is inconclusive or weak; most of the studies reviewed, particularly those that applied prospective study designs, reported no age effect or higher relative risk for work factors and psychosocial factors than age.

5 DISCUSSION

This work was undertaken to examine more closely the role of age, specifically older age, as a risk factor for MSD injury in the workplace. The objective was to enable evidence based assessment of the impact an increase in the number of older workers would have on duty holder responsibilities and HSE's responsibilities for provision of guidance. The literature reviewed showed that MSDs are a problem amongst both young and older workers in many workplaces but tend to be more severe for elderly workers than younger workers.

5.1 CURRENT THINKING

Shearn (2005) reported predictions of significant demographic change over forthcoming decades such that, older workers will constitute a greater proportion of the available workforce. Benjamin and Wilson (2005) showed that many negative beliefs about ageing and work, which hitherto had tended to preclude older workers from the workplace, were baseless and the work by Harris and Higgins (2006) identified that older workers are a valuable resource for employers as they bring to work a number of real benefits:

- Increased employee reliability, commitment, loyalty and dedication, decreased turnover and absenteeism. Older workers have a commitment to doing quality work; can be counted on in a crisis and have a solid performance record.
- Diversity of expertise, knowledge and skills. Older workers bring a whole wealth of knowledge and experience as well as a strong work ethic.
- Older workers can share their expertise with younger colleagues through mentoring and leadership opportunities and provide inspirational models for other members of staff.
- Older workers tend to set an example of hard work for their younger co-workers.
- The relationship between work capacity and demands is complex and the literature mixed. However, older workers can often compensate for losses of work related functional capacity with strategies and skills gained through experience.

Harris and Higgins (2005) also identified a reasonable quantity of information relating to the retention of older workers and some useful interventions. However, while many employers did show increased appreciation of the value of older workers, only a few actually implemented measures, or increased their intake of older workers. This they attributed to insufficient information about laws governing workplace bias and equal opportunity, fear of being open to discrimination charges and sparse evidence base for comprehensive programs and policies are often cited.

The current work found evidence that older workers are already a significant component of the workplace as there is a shortage of younger people to replace them, should they retire. It also identified case studies of organisational efforts to implement age friendly policies in the workplace (for example, Moyers and Coleman, 2004; Martin, 2005; Buckle *et al.,* 2008; Landau *et al.*, 2008). These observations support the previous observations of a general changed attitude towards ageing and increasing willingness of employers to retain /take on older workers.

5.2 SUSCEPTIBILITY TO MSD

Benjamin and Wilson (2005) discuss the concept of 'determinants of health' and concluded that lifestyle, education, socio-economic status, genetics, stress, exercise, nutrition and healthcare needs have an equal if not greater importance, than age as determinants of individual health.

The current work identified that human functional capacity declines progressively with age, and that several factors other than chronological age, such as level of physical activity and the demands of the work, tend to contribute more to susceptibility for MSD during work (Pransky *et al.,* 2005a&b; Werner *et al.,* 2005; Ghasemkhani *et al.* 2006; Antonopoulou *et al.,* 2007; Lin *et al.,* 2008). These studies all reported lower levels of risk for increasing age compared with other risk factors or they reported higher risk levels for younger workers compared to older workers. Also, studies such as Hartman *et al.*, 2003, Roquelaure *et al.*, 2004, Pransky *et al.*, 2005 and Hotopp, 2007, suggested that irrespective of their age, workers employed in physically demanding occupations, where they are exposed to challenging tasks are more likely to report underlying health problems than those in sedentary occupations. Furthermore, older workers are often forced to work closer to their individual maximum capacity than younger workers. Typically, in most industries the demands of work do not change with the passage of time (Savinainen *et al.*, 2004; Kenny *et al.*, 2008). Thus, though a higher prevalence of MSD is often reported for older workers compared to younger workers, this may reflect the fact that many older workers are working closer to their physical capacity. This observation suggests the propensity for injury is related more closely to the difference between the demands of work and the worker's physical work capacity (or work ability) than their age. Physical work capacity (and/or work ability) rather than age should be the criteria used to determine if an individual is capable of performing a specific job and the likely level of risk of MSD it presents.

It can be concluded that age is not an independent risk factor for MSD but that older workers are more susceptible to work-related MSD because of a decrease in functional capacity.

5.3 IMPLICATIONS OF AGEING WORKFORCE

According to Alpass and Mortimer (2007), the main challenge an ageing workforce brings, is the need to deal with demographic change from a rapidly growing economically viable population to a slower growing and rapidly ageing population. These authors noted that the main working-age population (15-64 year old group) will probably contract after 2020, and opined that the effect of the trend on the workforce depends partly upon whether people decide to continue working into old age or whether they choose to retire. They identified a number of issues that employers would need to consider as a consequence of increased labour participation of older people, such as impact on working patterns, use of technology and corporate attitudes towards older workers.

Silverstein, (2008) identified the need for employers to encourage older employees to stay longer in work as they age by taking steps that support their productive capacities and minimise their vulnerabilities. Specifically, the author recommended measures to protect these groups of workers, promote their health and build their competencies. Arndt *et al.* (2005) identified two policy implications of ageing workforces from their study to establish a detailed pattern of the nature and extent of occupational disability among construction workers: first, need to sustain the health of workers generally and older workers particularly and secondly need to develop prevention measures (including job alternatives in sufficient numbers). These both require increased understanding of the needs of older workers. Furthermore, Yassierli *et al.* (2007)

identified the need to consider individual factors and workers physical capabilities when defining procedures for assigning tasks. Letvak (2005) identified the need to improve job attributes, which impact health, especially high job demands as well as the need for schemes that provide the workforce with increased support.

Based on the observations from the literature the implications of an ageing workforce for health and safety in the workplace are as follows.

Future requirements

- Greater interest in the requirements of older workers: These need to be understood so that work, work equipment and work environment may be designed accordingly.

- Employers will need to be able to anticipate the physical and cognitive capabilities of their workers. There will be an increased challenge, i.e., to find the adjustments needed at work due to deterioration of health.

Workplace design and accommodation

- The strategies applied for provision/adoption of workplace will need to be such that they build upon workers strengths and protect against their vulnerabilities, i.e.:
    - The physical work environments support the needs and capabilities of older workers
    - The general working environments are age friendly and preserve the capacity of employees to function safely and effectively as they age.

6 CONCLUSIONS

Attitudes towards ageing and work are changing. More employers regard older workers as a valuable asset and they are willing to keep current employees on for longer periods past the usual retirement age. However, while many do now appreciate the value of older workers, only a few workplaces actually implement measures, to support and increase their retention of older workers.

Age is not an independent risk factor for work related MSDs. Older workers are more susceptible to work-related MSDs than younger workers because of decreased functional capacity. The propensity for injury is related more to the difference between the demands of work and the worker's physical work capacity (or work ability) than to age.

An older workforce has implications for the health and safety responsibilities of employers. These include providing additional support for worker requirements, changing the workplace attitudes towards ageing, providing a positive knowledge base, adjusting the workplace design and accommodations and improving worker/employer relationships (co-operation).

7 RECOMMENDATIONS

It is recommended that awareness campaigns are implemented to disseminate the benefits of ageing workers in the workplace and raise awareness of those elements of the workplace that are not suited to their needs. The expectation is that this will change the attitudes of employers and employees towards ageing and aged workers.

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Published by the Health and Safety Executive 05/10

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Ageing and work-related musculoskeletal disorders

A review of the recent literature

This work was commissioned to provide a review of the recent literature concerning ageing and occupational MSD, and to carry out scoping activities to inform the formulation of future policy or guidance and provision of advice. However, as the findings were developed, the scoping element was dropped at the customer's request.

Attitudes towards ageing and work are changing; more employers regard older workers as a valuable asset and are willing to keep current employees on for longer periods past the usual retirement age. Older workers are more susceptible to work-related MSD than younger workers because of decreased functional capacity; the propensity for injury is related more to the difference between the demands of work and the worker's physical work capacity (or work ability) rather than their age. An older workforce has implications for the health and safety responsibilities of employers. These include providing additional support for worker requirements, changing the workplace attitudes towards ageing, providing a positive knowledge base, adjusting the workplace design and accommodations and improving worker/employer relationships (co-operation).

This report and the work it describes were funded by the Health and Safety Executive (HSE). Its contents, including any opinions and/or conclusions expressed, are those of the authors alone and do not necessarily reflect HSE policy.

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