



UNIVERSITY^{OF}
BIRMINGHAM

**THE PREVENTION OF MUSCULOSKELETAL DISORDERS
WITHIN THE TELECOMMUNICATIONS SECTOR**

A Systematic Review of the Scientific Literature

**Joanne O Crawford
Elpiniki Laiou
Anne Spurgeon
Grant McMillan
Antonia Ieromnimon**

**Institute of Occupational and Environmental Medicine
Division of Primary Care, Public and Occupational Health
School of Medicine
The University of Birmingham**

EXECUTIVE SUMMARY

Method

The systematic review was carried out using the methodology developed by the University of York Centre for Systematic Reviews. A number of keywords were identified after visits were made to a call centre and a training centre for service technicians. Inclusion criteria were also developed to ensure the research identified was relevant to the systematic review. All literature was reviewed by two researchers independently who assessed the content against the inclusion criteria. The review is based upon 40 publications.

Best Practice

With regard to best practice, the principles of manual handling for inclusion in training courses have been identified. Other recommendations include ensuring that joint employer-employee initiatives are set up when assessing risk factors. For specific areas guidance on ladder handling has been identified. For manhole cover removal, two important areas were highlighted including ensuring that the tools used actually reduce biomechanical stress and that employees are trained to use tools where possible. Recommendations were also made in the use of cable handling in both the external and internal environment and for management of workers exposed to vibrating tools

When using Display Screen Equipment, areas identified as important include the following, rest breaks and ensuring that rest breaks are taken; workstations and equipment that allow neutral postures and are set up in optimal positioning for the users. Work organisation issues identified as important within the review included time pressure, high information processing demands, workload surges, job security issues and routine work.

Psychosocial issues identified as affecting call centre workers included job stress, decreased social support, low job satisfaction and perceived lack of job control. This highlights a further area of intervention but further research is needed to quantify how psychosocial factors affect the aetiology of MSDs.

No research was found with regard to the use of laptops or DSE in vehicles. Guidance was identified that recommended not using DSE in vehicles unless a suitable workstation has been developed.

Which MSDs are likely to be associated with telecommunication working and specifically underground cabling and portable display screen equipment use in vehicles?

The review identified that the MSDs were linked to manhole cover manoeuvring (back injuries), ladder handling, overhead line work, cable handling and road breaking work (HAVS) in service technicians. For call centre workers it has been identified that in comparison with other professional computer users there is increased reporting of MSD symptoms and the most common body areas associated with symptoms or discomfort were the neck, shoulder and hand/wrist. No specific disorders were linked to particular activities in call centre workers.

Which functional activities in this type of work are particular risk factors for the development of MSD?

Activities identified as being risk factors for MSDs include manhole cover handling, ladder handling, working overhead, cable handling and road breaking tasks for service technicians. Risk factors for call centre workers included non-optimal keyboard height, screen height and desk height; chair discomfort, shoulder abduction, shoulder elevation, working with computers for the whole working day, using the telephone more than 8 hours per day and symptoms were reduced by introducing rest breaks.

How important are psychosocial factors in the development of MSD and can they be quantified?

Current research has identified that physical and psychosocial risk factors are implicated in the aetiology of MSDs and appear to have more of an impact for the neck and shoulder region in call centre workers. Factors associated include gender (female), age (older), long hours, job stress, increased job demands, decreased social support, decreased job satisfaction, high information processing demands, job security issues and routine work lacking in decision-making. The review was unable to quantify the impact of psychosocial factors on the aetiology of MSDs due to the cross-sectional nature of the research studies.

What predictive factors are there for the development of MSD in this type of work?

There were no research papers that identified the predictive factors for the development of MSDs in service technician work. Predictive factors for call centre workers included an increased risk of symptoms compared to other computer users, symptoms associated with arm abduction, non-optimal screen position, shoulder elevation, bifocal use, job security including fear of being replaced by a computer, high information processing demands, routine work, workload surges, time pressure and work-rest scheduling. Currently no association has been found between electronic performance monitoring and symptoms.

What measures are effective in the prevention of MSD in this type of work?

No papers were identified that examined prevention of MSDs in service technician work. For call centre workers minimal research was available that identified there is no current evidence that forearm support on the workstation reduces MSDs or interventions based on occupational health training or muscle learning therapy reduce symptoms.

Is health surveillance of benefit in preventing or modifying the progression of MSDs?

There is no current evidence to support or refute the usefulness of health surveillance in preventing or modifying the progression of MSDs in telecommunications workers.

Data Gaps

There is a lack of information regarding prevalence and incidence of MSD symptoms in telecommunications workers. This is also impacted upon by poor research design. Although information was found on some aspects of service technician work, hand-rodging was not evaluated in any research papers. There is also a lack of information on psychosocial issues in heavy physical work.

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GLOSSARY

ATC	Active Telemarketing Centre
BLPC	British Library Public Catalogue
CI	Confidence Intervals
CTD	Cumulative Traumatic Disorder
CTS	Carpal Tunnel Syndrome
DSE	Display Screen Equipment
DWHS	Division of Workplace Health and Safety, Queensland
EDUC	Education
EEC	European Economic Community
EMG	Electromyography
EU	European Union
FOM	Faculty of Occupational Medicine of the Royal College of Physicians
HAVS	Hand Arm Vibration Syndrome
HSE	Health and Safety Executive
L5/S1	5 th Lumbar vertebrae/Sacrum Joint
MDQ	Musculoskeletal Discomfort Questionnaire
MLT	Muscle Learning Therapy
MSD	Musculoskeletal Disorder
NIOSH	National Institute for Occupational Safety and Health, USA
NMQ	Nordic Musculoskeletal Questionnaire
OHN	Occupational Health Nurse
OR	Odds Ratio
OSHA	Occupational Safety and Health Administration, USA
OWAS	Ovako Working Posture Analysing System

PC	Personal Computer
RCT	Randomised Controlled Trial
RF	Radio Frequency
RULA	Rapid Upper Limb Assessment
SIGLE	System for Information on Grey Literature in Europe
TCC	Telephone Call Centre
TNS	Tension Neck Syndrome
UC	Utility Cover
UK	United Kingdom
ULD	Upper Limb Disorder
VAS	Visual Analogue Scale
VDT	Visual Display Terminal
VDU	Visual Display Unit

1. INTRODUCTION

1.1 Background to the Study

The sponsors identified the need for a systematic review of the scientific literature regarding musculoskeletal disorders (MSDs) within the telecommunications industry. The need for the review was recognised after a questionnaire survey was carried out across the telecommunications industry in the European Union (EU). Fourteen telecommunications companies responded to the survey. The analysis identified several principle musculoskeletal hazards including ergonomics and posture in display screen equipment (DSE) users; manual handling by service technicians and cabling activities.

The systematic review is one part of a planned phase of work. The review was conducted using the methodology developed by the Centre for Reviews and Dissemination at the University of York (The University of York: NHS centre for reviews and dissemination 1996).

2. PROTOCOL FOR SYSTEMATIC REVIEW

Initial identification of research papers was carried out using a number of keywords that were derived from existing research and agreed between the researchers. To help develop search terms, the researchers visited a Call Centre to obtain an understanding of equipment used, work carried out and organisation of work. Dr Crawford also spent two days with Accenture at Yarnfield Park to observe training in pole climbing, cable handling and other work carried out by Service Technicians.

Several search engines were used for the literature search including: -

Medline

Web of Knowledge (which includes the Science Citation Index and the Social Science Citation Index),

Ergonomics Abstracts Online

Psychinfo

SIGLE

Copac

BLPC

Cochrane Database of Systematic Reviews

Government literature was also reviewed from sources including the Health and Safety Executive (HSE) and the European Agency for Health and Safety. The sponsor was asked to provide any industry publications not in the public domain.

2.1 Review Questions

The review questions developed by the sponsor were as follows: -

1. Which MSDs are likely to be associated with telecommunication working and specifically underground cabling and portable display screen equipment use in vehicles?
2. Which functional activities in this type of work are particular risk factors for the development of MSD?
3. How important are psychosocial factors in the development of MSD and can they be quantified?
4. What predictive factors are there for the development of MSD in this type of work?
5. What measures are effective in the prevention of MSD in this type of work?
6. Is health surveillance of benefit in preventing or modifying the progression of MSDs?
7. Identification of best practice in manual handling and DSE activities.

2.2 Search Strategy

The search strategy was developed after a scoping study and the visits to workplaces to identify the work tasks and equipment involved. Below are the search terms that were agreed on for the two different working populations.

2.2 1 Call Centre/Office Based Staff Search Terms

The search terms for call centre and office based workers were prepared after the visit to the Call Centre and the scoping study. The terms were used to search the above electronic sources. The sponsors were also asked to invite other telecommunications companies involved in the research to send any reports or research that they had carried out to be reviewed for the study.

Table 2.1 presents the search terms for this group of staff. The health outcomes scope of the search included

Osteoarticular diseases of the hands and wrists
Angioneurotic diseases
Diseases of the periarticular sacs due to pressure (bursitis or traumatic bursitis)
Diseases due to overstraining of the tendon sheaths
Diseases due to overstraining of the peritendineum
Diseases due to overstraining of the muscular and tendonous insertions
Paralysis of the nerves due to pressure (entrapment neuropathy)

Table 2.1 Search Terms for Call Centre Workers

POPULATION Call centre workers Contact centre workers DSE workers Office workers Open-plan office workers	WORKPLACES Call centre Contact centre Office Open-plan office Home office
HEALTH OUTCOMES Musculoskeletal disorders Upper limb disorders (ULD) Musculoskeletal pain/discomfort Neck pain Shoulder pain Back pain Low back pain Tenosynovitis (hand/forearm) Tendonitis (fingers/hand/forearm) Rotator cuff tendonitis (including supraspinatus) Bicipital tendonitis De Quervain's disease Carpal tunnel syndrome Shoulder capsulitis Epicondylitis (medial and lateral) Diffuse/non-specific ULD Tension neck	EQUIPMENT Display screen equipment DSE VDU Computer PC Keyboard Mouse Screen Laptop Notebook Chair, seat Footrest Telephone handset Telephone headset Lighting

Table 2.1 (continued)

WORK FACTORS Static work Seated work Breaks Work Organisation Multi-tasking	PSYCHOSOCIAL WORK FACTORS Job demands Job control Social support Decision latitude, autonomy Workload Time pressure Target hitting Job satisfaction Relationships with other workers Organisational factors Role ambiguity Role conflict Mental load, tension, worry Change, job change Monitoring Quality of working life Conditions of employment: uncertainty of the future
STUDY DESIGNS RCTs Quasi-experimental Observational Cross-sectional Case reports Qualitative research	
OTHER FACTORS RELATED TO MSDS Risk factors Predictive factors Prevention Health surveillance Best practice	

2.2.2 Field Engineers Search Terms

The search terms for the field engineers were developed after a scoping study and a visit to a training centre. The terms are presented in Table 2.2. The health outcome scope of the search included

Osteoarticular diseases of the hands and wrists

Angioneurotic diseases (Raynaud's phenomenon of occupational origin)

Diseases of the periarticular sacs due to pressure (bursitis or traumatic bursitis)

Diseases due to overstraining of the tendon sheaths

Diseases due to overstraining of the peritendineum

Diseases due to overstraining of the muscular and tendonous insertions

Paralysis of the nerves due to pressure (entrapment neuropathy)

Table 2.2 Search Terms for Service Technicians

POPULATION Service technician Field technician/engineer Cable technician Linesman Maintenance worker Rigger Climber Installation team Antenna engineer Line of sight technician Radio engineer Estate controller Build controller Property surveyor Network facilities engineer/technician Transmitter engineer Power systems technician RF surveyor Field operations engineer Field support engineer Satellite engineer	WORKPLACES (+ ELECTRIC /WATER/ MINING INDUSTRY) Network Installation Maintenance Underground Work in confined spaces /shafts Working at height Vehicles Antenna Poles Manholes, utility covers Lighting Cold/hot temperatures
	EQUIPMENT Ladder Portable computer Notebook Hydraulic lifting device Rods Tools Drills DSE in vehicles

Table 2. 2 (continued)

HEALTH OUTCOMES	PSYCHOSOCIAL WORK FACTORS
Musculoskeletal disorders Upper limb disorders Musculoskeletal pain/discomfort Tenosynovitis (hand/forearm) Tendonitis (fingers/hand/forearm) De Quervain's disease Raynaud's phenomenon Carpal tunnel syndrome Epicondylitis (medial and lateral) Rotator cuff tendonitis (including supraspinatus) Bicipital tendonitis Shoulder capsulitis Diffuse/non-specific ULD Tension neck Back pain Low back pain Knee pain Meniscus lesions Ankle pain Neck and shoulder pain	Work organisation Work characteristics Work conditions Job demands Job control Social support Decision latitude Workload Time pressure Job satisfaction Organisational factors Work relationships Role ambiguity, role conflict Mental load, tension, worry Change, job change, uncertainty of the future Alternation in the job, learn possibilities Autonomy, participation, commitment Quality of working life Solitary work Deadlines

Table 2.2 (continued)

SERVICE TECHNICIANS TASKS Manual handling (load handling) Underground structure cover handling (manholes/utility covers) Hand rodding Cabling Handling heavy tools Handling ladders Cable splicing Portable computer work Lifting equipment Handling equipment Team lifting Constrained lifting Climbing Kneeling Squatting Bending Driving Static muscle work Working above shoulder height	OTHER FACTORS RELATED TO MSDS Risk factors Predictive factors Prevention Health surveillance Best practice
	STUDY DESIGNS RCTs Quasi-experimental Observational Cross-sectional Case reports Qualitative research

2.3 Inclusion Criteria

The inclusion criteria were developed to ensure that the first screening of abstracts identified papers and articles that were relevant to the questions to be addressed. The inclusion criteria are listed below.

Population

Telecommunication workers, field engineers or jobs that require similar activities, e.g., postures, physical handling

Call centre, contact centre workers or jobs that require similar activities, e.g., office workers, and DSE workers

Interventions

Measurement of incidence and prevalence of MSDs

Measurement of functional activities associated with the development of MSDs

Assessment of psychosocial factors in the development of MSDs

Measurement of predictive factors in the development of MSDs

Assessment of preventive interventions in MSDs in this type of work

Identification of best practice

Outcome

Reduction in MSDs

All outcomes to be assess in relation to the studies obtained based on population, interventions and study design

Study Design

RCTs

Quasi-experimental

Observational

Cross-sectional

Case reports

Observational

Qualitative Research

2.4 Management of Information

The searches were managed by Reference Manager (version 11) which is a software programme developed for this purpose. All papers identified from searches were stored onto this programme. The programme allowed printing of abstracts for review. The abstracts were independently reviewed by two of the team members and a consensus reached as to the relevance of the papers with regard to the inclusion criteria. For abstracts that met the inclusion criteria, full papers were ordered.

2.5 Review Strategy

One hundred and eighty four papers were obtained for the review. Two team members reviewed each of the papers obtained independently. The data was extracted onto a data extraction form that is presented on the following page. Where team members were unable to agree on the quality of research, a meeting was organised to review the extracted data and paper.

The reviewers were asked to summarise the main points of the paper and grade it on the following scales.

- *** Strong evidence, provided by consistent findings in multiple, high quality scientific studies
- ** Moderate evidence, provided by generally consistent findings in fewer, smaller or lower quality scientific studies
- * Limited or contradictory evidence, produced by one scientific study or inconsistent findings in multiple scientific studies
- No scientific evidence

During the review process, a number of papers were rejected from the review. There were several reasons for this including the population description not meeting the criteria, the work tasks not being similar to those carried out by telecommunications workers and the work being review and summary in nature rather than research. This resulted in the selection of 40 papers for inclusion in the review.

DATA EXTRACTION SHEETS

Date of Data Extraction	
Author Title Source Institution	
Reviewer Information	
Notes	
Study Characteristics	
Verification of study eligibility Correct Population, interventions, outcome, study design	
Population Characteristics	
Methodological Quality of the Study	
Interventions	

Outcomes/Outcome Measures**Analysis****QUALITY OF EVIDENCE**

Please circle opinion of evidence from this study

***	Strong Evidence
**	Moderate Evidence
*	Limited or contradictory evidence
-	No scientific evidence

Other comments

3. BEST PRACTICE IN MANUAL HANDLING ACTIVITIES AND DSE WORK

3.1 MSDs within Europe

Within the EU, there has been research carried out to identify the prevalence of MSDs within the working population. At a European level it has been difficult to identify the incidence and prevalence rates of low back pain due to differing definitions and reporting systems in each member state. However, De Beeck and Hermans in 2000 in a review of EU states identified that between 60 and 90% of individuals will suffer from low back pain at some time and at any particular time, between 15% and 42% will be from suffering this condition (De Beeck & Hermans 2000). The main physical risk factors across the general population for low back pain are heavy manual labour, manual materials handling, awkward posture and whole body vibration (De Beeck & Hermans 2000). Other risk factors identified in this research were low social support, low job satisfaction, poor work organisation and low job content (De Beeck & Hermans 2000).

For MSDs, specifically neck and upper limb disorders, a lack of agreement on diagnostic criteria, exposures and health outcomes has made prevalence data difficult to calculate. From self-report general surveys, prevalence rates range from 17% to 46% (Buckle & Devereux 1999). At a general population level, risk factors for developing such disorders include poor posture, applying force, exposure to vibration through the hand or arm, direct mechanical pressure on soft tissues, work organisation and worker perceptions of the work organisation (Buckle & Devereux 1999). However, it is not currently possible to disentangle the interactions of each of those risk factors in the aetiology of MSDs.

3.2 Manual Handling

3.2.1 Manual Handling General Guidance

Council Directive 90/269/EEC on the minimum health and safety requirements for the manual handling of loads where there is a risk of injury to workers sets out specific requirements for EU member states to comply with (E.E.C. 1990b). These include taking organisation measures to avoid the need for manual handling. Where this is not possible, there is a requirement to assess the health and safety conditions involved and take appropriate measures to reduce the risks identified (E.E.C. 1990a).

A number of prevention strategies have been suggested to reduce the risk of injury from manual handling. Primary recommendations include redesigning the work task to design out the need to handle the load, reducing physical demands, allowing enough space for body movement and ensuring that the work tasks are designed for adequate rest opportunities (De Beeck & Hermans 2000). Mechanical lifting devices have also been suggested to reduce the stress on the body (De Beeck & Hermans 2000).

Education and training has been suggested as a means of reducing risk, however, only after primary interventions have occurred. Training in specific lifting techniques alone is not perceived to be appropriate due to the variety in manual handling tasks that may be required by an individual worker (De Beeck & Hermans 2000). In a Delphi Exercise involving 37 experts, a series of principles were recommended for

inclusion in training programmes (Graveling, Melrose, & Hanson 2003). These included the following: -

- Think before you lift
- Keep the load close to your waist
- Adopt a stable position
- Ensure a good hold on the load
- At the lift start, slight bending of the back hips and knees is preferable to stooping or squatting
- Do not flex your spine any further when you lift
- Avoid twisting the trunk or leaning sideways
- Keep your head up when handling
- Move smoothly
- Do not lift more than you can manage
- Put down then adjust the load

(Graveling, Melrose, & Hanson 2003)

With regard to work organisational factors, suggestions include joint employer-employee initiatives to identify risk factors and risk strategies and ensuring that the worker is involved at all stages (De Beeck & Hermans 2000). This is a suggested way to deal with work organisation factors; there is no clear evidence to the effectiveness of this approach.

3.2.2 Manual Handling in the Telecommunications Industry

With general industry guidance available, there are some specific work tasks within the telecommunications industry where further evidence-based guidance is required. These are discussed individually below.

Ladder Handling

One low quality paper was identified in the review with regard to telecommunications workers and ladder handling (Imbeau et al. 1998). Within this paper a number of recommendations were made with regard to handling ladders. These include the following: -

- The use of lightweight materials in ladder manufacture
- The lightest and shortest ladder should be selected for particular tasks
- Shoulder carrying the ladder should only be carried out in ideal conditions, these were identified as no wind, no obstacles overhead and on even, flat and non-slippery surfaces
- Heavy ladders should be carried suspended to the shoulder
- Workers should receive adequate training on ladder handling – training was not specified
- Ladder handlers should be trained to risk assess the route to the ladder installation site based on risk rather than distance
- Ladder handling equipment including vehicle support should be designed to allow safer handling, e.g., prevent overreaching to grasp the ladder

The recommendations identified in this study have not been assessed as to their effectiveness or appropriateness in the telecommunications industry.

Manhole Cover Manoeuvre

Within the review, manhole cover removal was identified as being high risk for back injuries. A number of proposals can be made to aim to reduce risks from manhole cover removal. These are as follows: -

Exploring the use of composite materials rather than steel to reduce the weight of the manhole covers

Ensuring that the tools and lifting aids used to move manhole covers reduce the biomechanical stress on the lower back

Ensuring employees are trained in the use of tools

(The authors appreciate that in some environments, lifting aid use is not possible.)

Cable Handling

Part of the research identified for cable handling was based in the mining industry. Therefore caution should be taken with data from this source due to different weights of cables used. With this borne in mind, recommendations from the research include mechanising the process using conveyers for the cables or identifying other means of powering the process rather than using manual force.

One low quality paper was identified in the review with regard to telecommunications cable technicians and cable installation in the indoor environment (Picton 2003). Within this paper a number of recommendations were made with regard to cable installation. These include the following: -

Make alterations to the size of the frames attached to the ceiling to decrease the handling zone difficulties and lower the ceiling support beams attached to the ceiling frames to minimise awkward working postures

Use a crimping tool with a double-handed grip as an interim measure to help decrease the load and exertion on muscles and tissues

Place the frames in the cable rooms in such a way that they elicit the best working postures and make best use of the available space

Use a lightweight collapsible trolley to transport cables and other items, such as tools to the worksite (to be kept in the van and used when needed)

Use task specific lighting such as desk lamps, clip-on lamps or a light weight head torch to provide better lighting in hard to reach places and panel rooms

Complete one work cycle (e.g. strip, crimp and terminate) before beginning the next

Perform precision work supporting upper limbs on a work surface, in seated position. The table and perch stool must be lightweight, collapsible and adjustable in height to accommodate for a range of workers

Use thick rubber mats in situations where kneeling is unavoidable

The recommendations identified in this study have not been assessed as to their effectiveness or appropriateness.

3.3 Exposure to Vibrating Tools

The research reviewed identified that with enough exposure to vibration, individuals involved in road breaking can develop Hand-arm Vibration Syndrome (HAVS). Unpublished research from the UK has suggested a number of recommendations for the management of individuals exposed to vibration (BT 2001). These are listed below: -

Ensure that the awareness of vibration as a hazard is raised across the company and that systems are in place to manage it effectively.

Ensure that vibration levels for all existing vibrating tools are known and taken fully into account when making risk assessments.

Ensure that personal exposures are reduced as far as is reasonably practicable and, where possible, to below the action level.

Ensure that new tools procured have low vibration emissions and, where possible, within the limits proposed under the Physical Agents Directive.

Form a Closed User Group (CUG) for operators of stipulated vibrating tools, as determined by risk assessment, and record individual exposures.

Ensure prospective operators are examined before joining the CUG and six months thereafter.

Establish an ongoing annual health surveillance programme for operators.

Report all cases identified through health surveillance.

Review procedures and practices relating to chainsaw use.

Review the requirement to dig

Although the recommendations have been made, there is no further data at the current time to identify their effectiveness in managing HAVS.

3.4 Display Screen Equipment

3.4.1 Display Screen Equipment General Guidance

Council Directive 90/270/EEC sets down the minimum health and safety requirements for employees working with display screen equipment (E.E.C. 1990c). The directive defines the equipment and workstation, which must comply with it, the minimum requirements in terms of the equipment used, the environment and the user/computer interface. Employers must also analyse workstations to evaluate risks to eyesight, physical problems and problems of mental stress. Appropriate measures must also be taken for risk reduction measures for any risks identified. In addition to this the directive also requires that workers receive information about the risks associated with their workstations, training in the use of workstations and be informed of any measures carried out to comply with the directive.

In terms of best practice in managing DSE work a number of different areas have been highlighted in relation to MSDs. These have been summarised by the HSE in the UK (HSE 2002).

Ensuring frequent short rest breaks during the working day

Provision of training to minimise the risks of musculoskeletal problems; such training should include postural aspects, adjustment of equipment, arranging the workstation, cleaning and maintenance of equipment and rest breaks

Ensuring the minimum requirements for the workstation are achieved including the display screen, the keyboard, the work desk, the work chair, the environment and the human-computer interface

Encouraging early symptom reporting

Ensuring workers can be rehabilitated back into work

Although these are given as best practice in the use of DSE equipment, the evidence base for the guidance is unclear but likely to be derived from previous research and contract research reports within the UK.

3.4.2 Display Screen Equipment use in Call Centre Workers

From the review a number of evidence-based guidance statements can be made for call centre workers. These include the following: -

Rest Breaks

The review identified that the incidence of musculoskeletal symptoms reduced with the introduction rest breaks during the working day and were positively related to working with computers the whole working day. It would be recommended that rest breaks be taken and ensured that staff takes such breaks away from the DSE equipment.

Workstation Design and Set Up

Non-optimal positioning of equipment at the workstation was found to influence discomfort. This highlights the need for risk assessment of workstations and ensuring that workstations and equipment can be set up to allow neutral postures without shoulder elevation or abduction and that staff are equipped to be able to make this judgement.

Work Organisation Issues

From the review, time pressure at work, high information processing demands, workload variability, surges in workload, increased job demands and routine work lacking decision-making were associated with symptoms. Although the research was two star studies, this identifies the impact that such work organisation issues may be having. Job security issues including fear of being replaced by a computer was associated with neck symptoms and shoulder symptoms. Again this was two star researches but perhaps identifies a source of stress within the workplace. This is perhaps an area where employers need to examine ways to manage any future changes.

In this regard, it is important that working practices are reviewed to identify the magnitude of these factors within the industry and whether interventions can be made to reduce them.

Psychosocial Issues

Psychosocial factors associated with MSDs included job stress, decreased social support, low levels of job satisfaction and perceived lack of job control. This highlights an area where a number of intervention strategies may be taken, however more research is required to evaluate the aetiology of psychosocial issues in MSDs and which intervention strategies are likely to be successful.

3.4.3 The Use of DSE in Vehicles

Although no research material was found with regard to DSE in vehicles, the HSE in the UK do make reference to it in their guidance for DSE work (HSE 2002). Their recommendations are that portable computers should not be used in motor vehicles. However, where there is a requirement to use portable computers, users should use a suitable workstation and be directed by the guidance for DSE.

4. WHICH MSDS ARE LIKELY TO BE ASSOCIATED WITH TELECOMMUNICATION WORKING AND SPECIFICALLY UNDERGROUND CABLING AND PORTABLE DISPLAY SCREEN EQUIPMENT USE IN VEHICLES?

4.1 Service Technician Work

No papers were found that had specifically surveyed service technician workers in relation to MSDs. Using the search terms, 59 papers were identified but the majority were excluded based on the populations surveyed and a lack of relevance of work tasks assessed. In carrying out the review, a number of studies identified which MSDs were associated with telecommunication work. It should be noted that there were no research papers that covered hand rodding or using DSE in vehicles.

4.1.2 Evidence Statements

Manhole cover removal is linked to severe back injuries in the telecommunications sector. (**)

71% of ladder accidents were related to the manual handling of the ladder as opposed to working on the ladder. (-)

Overhead line work has been associated with musculoskeletal symptoms, specifically low back discomfort, knee discomfort, shoulder discomfort, hip/thigh discomfort and ankle/feet discomfort in the electricity industry. (*)

Telephone linesmen have reported using connecting tools as a perceived cause of cumulative trauma disorder. (*)

Handling of cables in mines is linked to increased levels of low back pain. (*)

Prevalence rates for hand-arm vibration syndrome in gas distribution road breakers range from 9.6% to 24%. (**)

Evidence Table 4.1 Association between MSDs and Service Technician Work

Study	Study design	Study population	Method	Outcomes	Comments
(Chang, Robertson, & McGorry 2003) (**)	Experimental study	9 telecommunication field technicians	Reaction forces and moments were recorded with a force and moment transducer and participants' motion tracked with a motion-tracking device during utility cover (UC) removal operations. Three tool designs (J-hook, fulcrum bar, magnet lift) were tested. Eight tool configurations were used.	The tools had significant effects on the handle forces required for the participants to remove the UCs. The J-hook type tools type tools required a significantly higher level of exerted force than the fulcrum bar and magnetic lift type tools. The J-hook tools with the short-shaft design resulted in significantly higher lower back compressive force values on the L5/S1 joint than the J-hook long-shaft tools, magnetic lift tool, and fulcrum bar tools. The fulcrum bar tools exhibited the lowest L5/S1 compressive force.	The study was performed under a dry surface condition. Factors such as wet or slippery surfaces were not investigated. The effects of work duration and demand e.g. repetitive tool use were not investigated. The effects of participants' experience were not included in the outcome variables.
(Chang, Robertson, & McGorry 2003) (**)	As above	As above	As above Questionnaire to evaluate the subjective perception of tool usability using a rating from one to five.	As above Participants rated all the J-hook tools, except the one with the short bent shaft design, easier to use than the fulcrum bar tools. The fulcrum bar tools were rated easier to use than the magnetic tool and the J-hook tool with the short bent shaft design.	As above The authors suggest that if tool selection is only based on the ease of use of the tool, subjects may end up using a tool that will result in higher force requirements.

(Gallacher et al. 2001) (**)	Laboratory based experimental study	6 underground miners	Subjects performed 12 cable-hanging tasks in standing, stooping, and kneeling postures in restricted roof space. Kinematic and ground reaction force data were collected using a 3-dimensional motion analysis system and force platforms respectively.	Decreasing vertical workspace resulted in a monotonic increase in the peak moment experienced by the lumbar spine during the lifting tasks. The lumbar spine was found to be near the end-range of motion in the performance of stooping lifts, potentially relying on the interspinous ligaments that may result in potentially damaging shear forces on the lumbar spine. Analysis of the kinematics of the lumbar spine and pelvis indicated that stooping entailed the greatest amounts of lumbopelvic flexion, followed by the standing and kneeling postures. It was concluded that biomechanical loading might be an inherent aspect of working in confined vertical workspaces.	The study states that manual handling of cables has been identified as a particularly stressful task and is likely to contribute to low back pain in mine working. The cable used in the study was an 8m long mine cable of 0.05 m in diameter (7.5kg weight per meter), the characteristics of which may be unique to the mining industry.
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(Gallacher, Hamrick, & Redfern 1993) (**)	Laboratory based experimental study	7 coal miners	Subjects performed 12 cable-hanging tasks involving six posture/vertical space constraint conditions and two techniques of securing a continuous 4.8 cm diameter miner cable to the ceiling. Ground reaction forces were measured using biomechanics platforms.	The stooping postures resulted in significantly higher forces than when kneeling in the tests involving restricted ceiling heights. Greater forces were associated with higher lifting conditions. Using a baling wire to secure the cable resulted in significantly higher peak resultant forces than hanging the cable on a hook.	The study states that cable handlers experience 2.5 times the number of lost-time back injuries as compared to the overall mining population. The biomechanical instrumentation worn by the subjects may have influenced their lifting motions. The authors note that variables such as floor conditions, tension in the cable, and/or cables getting caught around corners were not included in this experiment.
(Graves et al. 1996) (*)	Cross-sectional study	143 electricity distribution linesmen	Nordic musculoskeletal questionnaire (NMQ), OWAS and biomechanical analysis of postures that contributed most risk of musculoskeletal discords in electricity distribution linesmen tasks.	More than 25% of participants reported musculoskeletal discomfort over an 8-month period. 63.6% reported low back discomfort, 33.6% reported knee trouble, 31.5% reported shoulder discomfort, 18.9% reported hip/thigh discomfort and 18.9% reported ankle/feet discomfort.	49% response rate. The study recommends future work should provide practical solutions in improving task design.

(Hamrick, Gallacher, & Redfern 1993) (**)	Laboratory based experimental study	7 coal miners	Subjects performed a cable-pulling task in 8 different lifting conditions involving four levels of posture and two levels of cable pulling resistance. Ground reaction forces were measured using biomechanics platforms.	Peak cable tension, peak resultant force and peak ground reaction forces were all significantly higher in the high pulling resistance conditions than in the low pulling resistance conditions. Peak ground reaction forces in the Y-direction were significantly higher while pulling cable in the kneeling posture than those in the other postures.	The study states that miners who perform these tasks account for 24% of lost time due to back injuries although the accidents only account for 9.2% of the population. The authors note that variables such as mining apparatus and floor conditions were not included in this experiment. The authors suggest that the higher Y-forces in the kneeling position indicate less postural stability when performing cable-pulling tasks in this posture and a greater likelihood of musculoskeletal injury.
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(Imbeau, Montpetit, Desjardins, Riel, & Allan 1998) (-)	Observational study	42 telephone technicians	Videotaped observations of the technicians handling their fibreglass extension ladder (20 ft, 24 ft, 26 ft or 28ft) on seven sites representative of actual work conditions, interviews about the various aspects of the ladder handling manoeuvres and the usual work methods, incident analysis.	The method used by the telephone technicians to carry a ladder had many drawbacks that made it hazardous in the presence of several environmental conditions (wind gusts, unseen or hidden holes in the ground, slippery slopes, overhead obstacles e.g. tree branches, clothes lines). The method taught to and used by the telephone technicians to verify the inclination of the ladder appeared to be a risk factor for sliding-at-the-base accidents. The observations lead the authors to suggest that the ladder itself represented a risk factor for overexertion injury, which cannot be eliminated from the technician's work but can be reduced through safer work methods.	The authors of this review acknowledge that the study did not address MSDs directly and that, due to the nature of the study, the evidence provided presents numerous limitations. However, it was included in the review in the absence of any other available evidence found on ladder handling in association to MSDs. The study also reports on a previous confidential study that identified that 71% of ladder accidents in one company were related to handling ladders. Accident reports for handling ladders were lacking in detail.
May et al. 1997 (*)	Cross-sectional study	120 linesmen	Questionnaire on musculoskeletal discomfort, on-site task analysis, Extreme Posture Checklist, RULA.	66% of the respondents reported low back discomfort, 30% reported knee trouble, 43% reported shoulder discomfort, and 41% reported neck discomfort.	43% response rate. No information given on the validity of the questionnaire. The study also included EMG laboratory measurements on 1 volunteer.

(Palmer, Crane, & Inskip 1998) (**)	Cross-sectional survey	153 gas distribution operatives	Modified FOM questionnaire, clinical examination and a cold challenge test.	24% of the sample had vibration white finger; HAVS was linked to a lifetime use of vibrating tools of 5000 hours or more; lifetime dose of vibration of more than 26500 ms ⁻² d. Blanching was linked to a lifetime use of tools of 5000 hours or more and a lifetime dose of vibration of 36000 ms ⁻² d or more. Neurological symptoms were linked to a lifetime use of tools of 5000 hours or more and a lifetime dose of vibration of 26500 ms ⁻² d or more.	81% response rate. The study does highlight that new road breaking techniques have reduced the exposure level of workers to vibrating tools. However, with enough exposure, HAVS does occur.
(Walker et al. 1985) (**)	Cross-sectional study	895 gas distribution workers and 546 meter readers (control group)	Nurse-administered questionnaire on circulation to the hands.	Prevalence of white finger was 9.6% in the exposed group and 9.5% in the control group. Prevalence of white finger in the exposed group, adjusted for age differences between the two groups, was 12.2% in the exposed group.	97% and 92% response rates for distribution workers and meter readers respectively.
(Vilkkii, Kivisto-Rahnasto, & Mattila 1996) (*)	Cross-sectional study	72 telephone linesmen	Questionnaire on hand tools known to cause problems and hand tools commonly used. Linesmen were asked to rate the perceived strain in hand/arm while working with different hand tools.	40% of the linesmen answered that during their work history they had had a cumulative trauma disorder (CTD) caused by hand tools. 70% answered that the main reason causing their CTDs had been the connecting tool.	84% response rate. No information given regarding the validity of the questionnaire. The study also included EMG laboratory measurements on 20 volunteers. The study was started because of a high incidence of hand tool related complains from the workers.

4.2 Call Centre Workers

Fifteen studies were included for review. Among these, twelve studies were included to identify which MSDs are linked to DSE working. None of the studies identified specific disorders in relation to call centre work. However, out of the fifteen studies, four included clinical examination, two reviewed medical records, seven used validated questionnaires and five used other non-validated measures. This in itself affects the quality of the research reviewed and the evidence statements presented.

4.2.1 Evidence Statements

The incidence of new symptom cases for MSDs was calculated at 1.7 case/person-year for males and 0.93 case/person-year for females. (*)

Prevalence of MSD symptoms identified from questionnaires ranged from 17% to 75%. (**)

Prevalence of MSD symptoms from clinical examination was 22%. (**)

In a population of call centre workers, physician diagnosed prevalence of symptoms were identified as 35.1% as normal, 53.9% possible cases and 11% cases. (*)

In comparison to other professional computer users, call centre workers report a higher proportion of MSD symptoms. (*)

The most common symptoms reported were myofascial pain syndrome, tendon related symptoms, joint related symptoms and nerve related symptoms. (*)

The most common body areas affected by discomfort were the neck, shoulder and hand/wrist. (**)

Evidence Table 4.2 MSDs associated with Call Centre Work

Study	Study design	Study population	Method	Outcomes	Comments
(Baker, Jacobs, & Tickle-Degnen 2003) (***)	Cross-sectional study	274 call centre workers	The Meaning of Working Survey and the Musculoskeletal Discomfort Questionnaire (MDQ).	Prevalence of neck discomfort 57%, shoulder discomfort 41%, elbow discomfort 19%, wrist discomfort 52% and back discomfort 63%; overall 83% of respondents reported discomfort.	69% response rate. The authors report that previous applications of the MDQ obtained a high level of reported musculoskeletal discomfort within this population and that, thus, this instrument may have inflated the actual presence of mild musculoskeletal discomfort.
(Baker, Jacobs, & Carifio 2000) (**)	Cross-sectional study	122 call centre workers	A background factors questionnaire, a somatic complaints questionnaire, the MDQ, a work practices questionnaire and a psychosocial questionnaire.	72% reported neck discomfort in the previous year, 54% shoulder discomfort, 18% elbow discomfort, 48% wrist discomfort and 67% low back discomfort.	61% response rate (91% from site 1 and 32% from site 2). 33 out of the 155 participants were excluded from analysis due to incomplete data. The background factors questionnaire, somatic complaints questionnaire, and work practices questionnaire were adapted from NIOSH questionnaires. The psychosocial questionnaire was adapted from the General Job Stress Questionnaire.

(Bergqvist et al. 1995) (**)	Cross-sectional study	322 office workers from 7 Stockholm companies; 52% interactive workers, 29% data entry workers, 19% non-VDT users	Questionnaire on muscle discomfort, VDT use and individual and organizational factors, the NMQ, physiotherapy examination, workplace examination.	59.6% reported neck/shoulder discomfort, 7.4% reported intense neck/shoulder discomfort, 40.7% reported back discomfort and 28.9% reported arm/hand discomfort. From the physiotherapist's examination, 21.1% had a TNS diagnosis, 22.7% had a cervical diagnosis, 13.0% had a shoulder diagnosis and 9.0% had an arm/hand diagnosis.	Questionnaire response rate: 92% Participation rates: 91% physiotherapy exam, 82% workplace exam. All comparisons were made between VDT users and non-VDT users. Concern was raised by the authors about possible bias from the 'healthy worker effect' (34% dropout of the 535 workers original sample queried in 1981).
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(Chung & Choi 1997) (*)	Cross-sectional study	297 VDT operators in a telecommunication company	Questionnaire survey of demographic information and self-reported musculoskeletal discomfort rating via body maps. 70 participants were randomly selected and their workstations evaluated. Anthropometric data was collected on a number of body dimensions and angles related to posture at the VDU.	The study reports that discomfort was reported almost constantly in the neck 20%, left shoulder 28%, right shoulder 46%, left upper arm 11%, upper back 26%, lower back 9%, left wrist 15%, right wrist 22%, left hand 15%, right hand 25%.	Unclear whether the tools used were validated measures.
(Cook, Burgess-Limerick, & Chang 2000) (**)	Cross-sectional study	302 workers in 15 workplaces including a telecommunication company	Questionnaire on work patterns, use of computer and mouse. Questions on musculoskeletal symptoms based on the NMQ.	75.7% of participants reported musculoskeletal symptoms in one or more region in the last 12 month; 46.4% in the last 7 days.	70% response rate.

(Cook & Burgess-Limerick 2004) (**)	Randomised controlled trial	57 call-centre workers	NMQ, workstation measurement. Interventions included positioning of the keyboard and the mouse; forearm support posture introduced to the intervention group (6 weeks duration).	At baseline 75% reported musculoskeletal discomfort in the last 7 days.	
(Faucett et al. 2002b) (**)	Randomised controlled trial	55 telemarketers, 10 engineers, 43 assembly workers	Symptom measures at the end of each workday for two weeks on a Visual Analogue Scale (VAS) for pain, stiffness and numbness. Surface EMG measures and identification of new MSD symptoms at 32 weeks from medical records. Interventions included a Muscle Learning Therapy and OHN delivered education and training.	At baseline level, 73% reported symptoms of pain, stiffness or numbness. This data cannot be broken down into the three work sites.	
(Ferreira, Conceicao, & Saldiva 1997) (**)	Retrospective cohort study	106 call centre workers	All data retrieved from personnel and medical records from January 1993 to June 1995.	During the time period of the study, 24 cases of ULDs were physician diagnosed.	

(Ferreira & Saldiva 2002) (*)	Cross-sectional study	62 call centre workers in two groups; ATC – active telemarketing N=14 and TCC – customer services N=38	Questionnaire on MSD symptoms, habits, workstation, information network, work organisation and social environment. Interviews, observation and measures of workplace dimensions and physical environment.	54% of ATC workers had neck/shoulder problems for more than 7 consecutive days and 33% had hand/wrist problems for more than 7 consecutive days. 10.5% of the TCC staff reported neck/shoulder problems for more than 7 consecutive days and 8% reported hand/wrist problems for more than 7 consecutive days.	The questionnaire used was 'tailor-made'.
(Hales et al. 1994) (**)	Cross-sectional study	533 telecommunication s workers in 5 job types	Self-administered questionnaire on musculoskeletal symptoms, followed by a medical examination. Psychosocial issues were assessed by a validated measure. Demographics information was obtained, as was information about keystrokes and electronic performance monitoring.	Overall symptom prevalence was 22%. The types of symptoms identified in the sample were probable tendon disorders (15%), probable muscle related disorders (8%), probable nerve entrapments (4%), joint related findings (3%) and ganglion cysts (3%).	93% response rate.

(Hoekstra, Hurrell, & Swanson 1992) (**)	Cross-sectional study	108 teleservice representatives	Self-administered questionnaire survey on musculoskeletal symptoms, job tasks, work history, work environment and indicators of job stress. Ergonomic evaluation of representative workstations.	68% of the sample reported symptoms meeting case definitions for neck, shoulder, hand/wrist or back disorders. The prevalence of individual symptoms were neck, 44%, shoulder, 35%, elbow, 20%, hand/wrist, 30% and back 33%.	95% response rate. Questionnaire items were derived primarily from questionnaires used in previous NIOSH investigations. The authors report possible disease misclassification due to MSDs prevalence rates being determined solely by self-reported symptoms.
(Jensen et al. 2002) (**)	Cross-sectional study	3475 employees including 629 call centre workers	Questionnaire on physical and psychosocial factors and musculoskeletal symptoms.	For women working full-time, 53% reported neck symptoms lasting 7 days or more in the past year, 42% reported shoulder symptoms lasting 7 days or more in the past year and 30% reported hand/wrist symptoms lasting 7 days or more in the last year. For men working full-time, 27% reported neck symptoms, 23% reported shoulder symptoms and 19% reported hand/wrist symptoms. For female call centre employees the odds ratio was 2.06 for shoulder symptoms (95% CI 1.19-3.56) and 1.95 for hand/wrist symptoms (95% CI 1.06-3.61).	69% response rate.

(Norman et al. 2004) (*)	Cross-sectional baseline study	57 call centre employees; reference group of 1459 professional computer users	Questionnaire on physical and psychosocial working conditions and symptoms during the previous month.	A higher proportion of the call-centre workers reported symptoms from each body region than those in the reference group. 86% of females reported significantly more musculoskeletal symptoms lasting more than 3 days in the previous month compared to 72% in the reference group. For men, 68% of call-centre workers reported significantly more symptoms than the reference group (50%).	81% and 84% response rates for the call centre and the reference group respectively. Possible bias in the selection of operators in the call centre group, reported by the authors. The authors have stated that the low number of participants in the call centre group limits the precision and power to study differences between the two groups.
(Park, Park, & Song 1997) (*)	Cross-sectional study	827 female telephone operators using VDUs; Domestic Operators, N=188, International Operators, N=91 and Directory Assistance Operators N=548	Self-administered questionnaire, medical examination including range of motion, strength and anthropometric measurement and ergonomic evaluation of the workplace.	80% of respondents complained of pain in multiple body areas; 35% reported pain in all upper extremity areas with 9.8% of respondents reporting no pain or pain in one single body area. The study found that of 827 operators included in the analysis, 35.1% were graded as normal, 53.9% were graded as potential cases and 11.0% were graded as cases. The most common types of disorders were myofascial pain syndrome, followed by tendon related symptoms, joint related symptoms and nerve related symptoms. The most commonly affected areas were the shoulder, followed by the neck, hand/wrist and elbow area.	The paper does not give detail on the questionnaire or the ergonomics analysis.

(Toomingas et al. 2003) (*)	Closed prospective cohort study	57 call centre workers at one call centre; reference group of 1226 professional computer users	Baseline questionnaire on musculoskeletal symptoms. Participants were studied with 10 monthly follow-ups. Medical examination performed on 78% of the incident call centre cases.	At the baseline questionnaire, 17% of women and 25% of men reported aches and pains. This compares to the reference group figures of 15% and 13% respectively. The incidence of new symptoms was approximately 1 case/person-year. This was significantly higher among male call centre workers (1.7 case/person-year) and for women this was 0.93 case/person-year. The authors suggest that this is due to the higher prevalence of symptoms among the female participants in that more than 50% of female participants had symptoms every month.	Response rates in the baseline ranged between 79% and 88% and follow-up response rates between 68% and 88%. The authors report possible selection bias due to supervisors selecting those call-centre operators who were supposed to remain during the follow-up period. They also report possible bias in the examination and diagnostic process. The examiners were not blinded to the symptoms or the exposure situation.
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5. WHICH FUNCTIONAL ACTIVITIES IN THIS TYPE OF WORK ARE PARTICULAR RISK FACTORS FOR THE DEVELOPMENT OF MSDS?

5.1 Service Technicians

5.1.1 Manhole cover handling

5.1.1.1 Evidence Statements

There is evidence that manhole cover removal results in high compression forces of the low back that are linked to an increased risk of injury. (**)

Different tools available to help with manhole cover removal can reduce the compression forces on the low back and thus reduce the number of back injuries. (**)

Evidence Table 5.1 Manhole cover handling and risk factors for MSDs

Study	Study design	Study population	Method	Outcomes	Comments
(Chang, McGorry, & Robertson 2003) (**)	Laboratory based experimental study	9 telecommunication field technicians	Reaction forces and moments were recorded with a force and moment transducer and participants' motion tracked with a motion-tracking device during UC removal operations. 8 different manhole cover removal tool configurations were used including 5 J-hook designs, a magnetic lift and two fulcrum bar tools. Questionnaire to evaluate the subjective perception of tool usability using a rating from one to five.	The study found that for the 5 J-hook tools tested that the peak handle force was approximately 80% of the manhole cover weight. This was reduced to 45-51% for the fulcrum bar tools. For low back compression forces, the J-hooks resulted in the greatest compression forces apart from the two with long shafts, range 3593-6183 N. The Magnetic lift tool also had a high level of compressive back force. The results indicated that the fulcrum bar tools produced significantly less low back compression force 2310-2403 N. However, the ease of use rating identified the J-hook tool with the long shaft as the easiest to use. The fulcrum bar tools were rated as more difficult to use. .	The study highlights the need to evaluate tools in more than one dimension. It also demonstrates that through tool design, low back compression forces can be reduced to below the NIOSH recommended cut off level of 3400 N. The study was performed under a dry surface condition. Factors such as wet or slippery surfaces were not investigated. The effects of participants' experience were not included in the outcome variables.
(Chang, Robertson, & McGorry 2003) (**)	Same study reported in a second paper	As above	As above	As above	

(Imbeau et al. 2001) (*)	Biomechanical evaluation	20 volunteers experienced in handling aqueduct-access well and sewer manhole covers	Volunteers were observed lifting 20 manhole covers, their weights ranging from 75 to 132kg, using different tools. The data of the 400 lifts was analysed using the 3D Static Strength Prediction Programme and The Observer software. Tools used included a simple hook, a pick and a lever.	The study suggests that a relatively important proportion of healthy workers would not have been able to perform the lifting safely regardless of the tool used. However, there is little evidence given in the paper with regard to risk of musculoskeletal injury.	
(Mital & Motorwala 1995) (**)	Laboratory based case study	20 male and 20 female volunteers	Measures to evaluate the use of steel (80.36 kg) and composite (38.13 kg) manhole covers, which included isometric back strength, individual and unmatched team psychophysical capacities, rating of perceived exertion and spinal compression forces.	Males had significantly higher back strength than females. Male teams had significantly higher back strength than female teams. Team lifters had significantly higher lifting strength than individuals. The individual lifting strengths were significantly lower than the weight of the steel access cover; female individual strengths were also significantly lower than the weight of the composite access cover. The steel cover if lifted individually would impose spinal compression of 13210 N. When lifted in a team this is reduced to 6186 N which still exceeds the compressive strength of the spinal column.	The study suggests that steel covers of this weight are unsafe for manual handling and a high risk to back injury.

5.1.2 Ladder handling

5.1.2.1 Evidence Statements

There is evidence that the handling of ladders between 24kg and 31 kg represent a risk of injury to those involved in carrying them. (*)

Evidence Table 5.2 Ladder Handling and Risks of MSDs

Study	Study design	Study population	Method	Outcomes	Comments
(Imbeau, Montpetit, Desjardins, Riel, & Allan 1998) (-)	Observational study	42 telephone technicians	Workplace observations on ladder handling in the telecommunications industry carried out in 7 different sites judged to be representative of the work.	The handling of ladders represents a risk factor for overexertion injuries; specifically the weight of the ladder used (24-31kg), the environment in which the ladder is handled, the loading of the ladder onto the shoulder that creates an unstable load and difficulties identified loading and unloading ladders from vehicles due to a need to reach upwards.	The authors of this review acknowledge that the study did not address MSDs directly and that, due to the nature of the study, the evidence provided presents numerous limitations. However, it was included in the review in the absence of any other available evidence found on ladder handling in association to MSDs.

5.1.3 Working Overhead

5.1.3.1 Evidence Statements

Functional activities identified as creating a possible risk of injury for MSDs in electricity distribution linesmen overhead work include lifting tools via a pulley rope, hammering nails into poles, circuit testing, using pick axes, lifting wooden blocks, handling heavy tools, crimping tool work, drilling for new poles, pole climbing, using the Power Auger, pole work using the wrench, tightening wire between two poles and using the crimping tool. (*)

Evidence Table 5.3 Working Overhead and risk factors for MSDs

Study	Study design	Study population	Method	Outcomes	Comments
(Graves, De Cristofano, Wright, Watt, & White 1996) (*)	Cross-sectional study	143 electricity distribution linesmen	NMQ, OWAS and biomechanical analysis of postures that contributed most risk.	High risk tasks identified included lifting tools up via a pulley rope, lifting pole platforms, hammering nails into poles, circuit testing, using pick axes, lifting wooden blocks and heavy tools, crimping tool work, drilling for new poles and working on the pole.	49% response rate. The study recommends future work should provide practical solutions in improving task design.
(May et al. 1997) (*)	Cross-sectional study	120 linesmen	Questionnaire on musculoskeletal discomfort, task analysis, Extreme Posture Checklist, RULA.	Over 68% of the linesmen experienced low back discomfort while performing the crimping task. Over 90% of the crimping was done at or above shoulder height. The main task that involved awkward positions of the arms while working was using the crimping task tool (56.7%). Tasks identified to have extreme postures included pole climbing, using the Power Auger, pole work using the wrench, lifting tools up via a pulley rope, lifting pole platforms, changing insulators using a wrench, tightening wire between two poles, using the crimping tool, hammering actions, using a ratchet, changing an old transformer to a new one, earthing the wire, putting a fuse box up on pole, taking barbed wire off and putting it on the pole. Crimping was identified as having extreme postures for each part of the body.	43% response rate. No information given regarding the validity of the questionnaire. Unclear on what part of the study population the task analysis, Extreme Posture Checklist, RULA were used upon.

(Picton 2003) (-)	Case study	Cable technicians	2 month period observations, video footage, unstructured interviews, ergonomic analysis. The Queensland Manual Tasks Advisory Standard 2000 (DWHS 1999) was used to compile the information and guide recommendations.	The current frame design did not allow for optimal handling zones and cable technicians worked in awkward postures perched atop ladders. The crimping tool (KM8 termination tool) had no mechanical leverage and dug into the soft tissue of the palm of the hand. The cable technicians use this tool 150-200 times per day. The frames were placed into the rooms before the cable technicians arrived on the scene.	The author does not disclose the number of cable technicians participating in the study nor any other description of the study population.
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5.1.4 Cable Handling

5.1.4.1. Evidence Statements

Cable handling in mining has an increased risk of back injuries associated with it. (*)

Telephone linesmen have reported using connecting tools as a perceived cause of cumulative trauma disorder. (*)

Evidence Table 5.4 Cabling Handling Tasks and Risks of MSDs

Study	Study design	Study population	Method	Outcomes	Comments
(Gallacher, Hamrick, Cornelius, & Redfern 2001) (**)	Laboratory based experimental study	6 underground miners	Subjects performed 12 cable-hanging tasks in standing, stooping, and kneeling postures in restricted roof space. Kinematic and ground reaction force data were collected using a 3-dimensional motion analysis system and force platforms respectively.	Decreasing vertical workspace resulted in a monotonic increase in the peak moment experienced by the lumbar spine during the lifting tasks. The lumbar spine was found to be near the end-range of motion in the performance of stooping lifts, potentially relying on the interspinous ligaments that may result in potentially damaging shear forces on the lumbar spine. Analysis of the kinematics of the lumbar spine and pelvis indicated that stooping entailed the greatest amounts of lumbopelvic flexion, followed by the standing and kneeling postures. It was concluded that biomechanical loading might be an inherent aspect of working in confined vertical workspaces.	The study states that manual handling of cables has been identified as a particularly stressful task and is likely to contribute to low back pain in mine working. The cable used in the study was an 8m long mine cable of 0.05 m in diameter (7.5kg weight per meter), the characteristics of which may be unique to the mining industry.

(Gallacher, Hamrick, & Redfern 1993) (**)	Laboratory based experimental study	7 coal miners	Subjects performed 12 cable-hanging tasks involving six posture/vertical space constraint conditions and two techniques of securing a continuous 4.8 cm diameter miner cable to the ceiling. Ground reaction forces were measured using biomechanics platforms.	The stooping postures resulted in significantly higher forces than when kneeling in the tests involving restricted ceiling heights. Greater forces were associated with higher lifting conditions. Using a baling wire to secure the cable resulted in significantly higher peak resultant forces than hanging the cable on a hook.	The study states that cable handlers experience 2.5 times the number of lost-time back injuries as compared to the overall mining population. The biomechanical instrumentation worn by the subjects may have influenced their lifting motions. The authors note that variables such as floor conditions, tension in the cable, and/or cables getting caught around corners were not included in this experiment.
(Hamrick, Gallacher, & Redfern 1993) (**)	Laboratory based experimental study	7 coal miners	Subjects performed a cable-pulling task in 8 different lifting conditions involving four levels of posture and two levels of cable pulling resistance. Ground reaction forces were measured using biomechanics platforms.	Peak cable tension, peak resultant force and peak ground reaction forces were all significantly higher in the high pulling resistance conditions than in the low pulling resistance conditions. Peak ground reaction forces in the Y-direction were significantly higher while pulling cable in the kneeling posture than those in the other postures. The authors suggest that the higher Y-forces in the kneeling position indicate less postural stability when performing cable-pulling tasks in this posture and a greater likelihood of musculoskeletal injury.	The study states that miners who perform these tasks account for 24% of lost time due to back injuries although the accidents only account for 9.2% of the population. The authors note that variables such as mining apparatus and floor conditions were not included in this experiment.

(Picton 2003) (-)	Case study	Cable technicians	2 month period observations, video footage, unstructured interviews, ergonomic analysis. The Queensland Manual Tasks Advisory Standard 2000 (DWHS 1999) was used to compile the information and guide recommendations.	The crimping tool (KM8 termination tool) had no mechanical leverage and dug into the soft tissue of the palm of the hand. The cable technicians use this tool 150-200 times per day. The frames were placed into the rooms before the cable technicians arrived on the scene. Cable technicians were carrying boxes of copper cables weighting up to 25kg, the nature and package of which made it difficult to grip. When filling the bottom quarter of the frames, the cable technicians were kneeling for over 30 minutes on concrete floors with no support.	The author does not disclose the number of cable technicians participating in the study nor any other description of the study population.
(Vilkkii, Kivisto-Rahnasto, & Mattila 1996) (*)	Cross-sectional study	72 telephone linesmen	Questionnaire on hand tools known to cause problems and hand tools commonly used. Linesmen were asked to rate the perceived strain in hand/arm while working with different hand tools.	40% of the linesmen answered that during their work history they had had a cumulative trauma disorder (CTD) caused by hand tools. 70% of the linesmen answered that the main reason causing their CTDs had been the connecting tool. Connecting tools were rated as the most stressful tools. Climate conditions (cold), working in the poles, too little working room and dirty and greasy cables were perceived as the main causes making the work with hand tools more straining.	84% response rate. No information given regarding the validity of the questionnaire.

5.1.5 Hand-arm Vibration from Tools

Two papers were identified that had assessed hand-arm vibration syndrome in gas distribution workers. One comment from the papers was that road breaking techniques have changed in recent years to reduce exposure to vibration.

5.1.5.1 Evidence Statements

The development of hand arm vibration syndrome in gas distribution workers involved in road breaking and reinstating is linked to a cumulative lifetime exposure of 5000 hours or a lifetime dose exceeding $26500 \text{ ms}^{-2}\text{d}$. (**)

The prevalence of hand arm vibration syndrome is not significantly higher in gas distribution workers involved in road breaking and reinstating versus a control group. (**)

Evidence Table 5.5 Hand-arm Vibration from Tools and its link to MSDs

Study	Study design	Study population	Method	Outcomes	Comments
(Palmer, Crane, & Inskip 1998) (**)	Cross-sectional survey	153 gas distribution operatives	Modified FOM questionnaire, clinical examination and a cold challenge test.	24% of the sample had vibration white finger; HAVS was linked to a lifetime use of vibrating tools of 5000 hours or more; lifetime dose of vibration of more than 26500 ms ⁻² d. Blanching was linked to a lifetime use of tools of 5000 hours or more and a lifetime dose of vibration of 36000 ms ⁻² d or more. Neurological symptoms were linked to a lifetime use of tools of 5000 hours or more and a lifetime dose of vibration of 26500 ms ⁻² d or more.	81% response rate. The study does highlight that new road breaking techniques have reduced the exposure level of workers to vibrating tools. However, with enough exposure, HAVS does occur.
(Walker, Jones, Ogston, Tasker, & Robinson, 1985) (**)	Cross-sectional study	895 gas distribution workers; 546 meter readers (control group)	Nurse-administered questionnaire on circulation to the hands.	Prevalence of white finger was 9.6% in the exposed group and 9.5% in the control group. Prevalence of white finger in the exposed group, adjusted for age differences between the two groups, was 12.2% in the exposed group. No significant associations were found between the prevalence rates and the number of years vibrating tools had been used.	97% and 92% response rates for distribution workers and meter readers respectively.

5.2 Call Centre Workers

Much of the research identified for inclusion into the review was cross-sectional in design and self-report based rather than a medical examination leading to diagnosis being carried out. Low numbers in some of the studies further compounded this. The evidence statements below are therefore based on two-star research rather than three star studies.

5.2.1 Evidence Statements

The incidence of musculoskeletal symptoms was found to reduce with the introduction of rest breaks. (**)

Physical influencing factors on discomfort include keyboard height, screen height above or below eye level, low level of satisfaction with the workstation, non-optimal desk height, chair discomfort, shoulder abduction and shoulder elevation. (**)

Work factors positively influencing discomfort included working with computers for the whole working day (**) while hand/wrist symptoms were associated with using the telephone more than 8 hours per day. (**)

Evidence Table 5.6 Risk Factors from Functional Activities in Call Centre Work

Study	Study design	Study population	Method	Outcomes	Comments
(Bergqvist, Wolgast, Nilsson, & Voss 1995) (**)	Cross-sectional study	322 office workers from 7 Stockholm companies; 52% interactive workers, 29% data entry workers, 19% non-VDT users	Questionnaire on muscle discomfort, VDT use and individual and organizational factors, the NMQ, physiotherapy examination, workplace examination.	VDT users did not show elevated odds of muscle problems compared to non-VDT users. No associations were found between muscle problems and accumulated VDT use in person-years. Working more than 20hrs per week at a VDT was associated with intensive neck and shoulder discomforts if it occurred in a situation with repetitive movements for individuals who often reported stomach reactions (O.R.=3.9, 95% CI 1.1-13.8). Working more than 20hrs per week at a VDT was associated with a diagnosis of TNS for users of bifocal or progressive glasses (O.R.=6.9, 95% CI 1.1-42.1). Working more than 20hrs per week at a VDT was associated with arm/hand diagnosis for individuals with limited rest break opportunity combined with the non-use of lower arm support (O.R.=4.6, 95% CI 1.2-17.9). The study did not find any significant associations between interactive work, symptoms, length of career and working hours.	Questionnaire response rate: 92%. Participation rates: 91% physiotherapy exam, 82% workplace exam. All comparisons were made between VDT users and non-VDT users. Concern was raised by the authors about possible bias from the 'healthy worker effect' (34% dropout of the 535 workers original sample queried in 1981).

(Chung & Choi 1997) (*)	Cross-sectional study	297 operators	Questionnaire survey of demographic information and self-reported musculoskeletal discomfort rating via body maps. 70 participants were randomly selected and their workstations evaluated. Anthropometric data collected on a number of body dimensions and angles related to posture at the VDU.	Regression analysis revealed that relative seat back height and left shoulder abduction angle had significant influence in trunk discomfort. Trunk discomfort increased as left shoulder abduction became larger. The study identified that relative keyboard height, body size, shoulder abduction, sitting posture and relative seat back height were influencing factors on discomfort.	Unclear whether the tools used were validated measures. The study recommends that worker should be provided with a fully adjustable workstation and trained in the adjustment of their workstation.
(Cook, Burgess-Limerick, & Chang 2000) (**)	Cross-sectional study	302 workers in 15 workplaces including a telecommunications company	Questionnaire on work patterns, use of computer and mouse. Questions on MSD symptoms based on the NMQ.	Neck and shoulder symptoms were associated with screen position above eye height (OR= 3.19, 95%CI 1.50-6.78 and OR=2.38, 95% CI 1.20-4.71 respectively). Shoulder elevation was associated with neck (OR=2.01, 95% CI 1.04-3.88), shoulder (OR= 2.69, 95%CI 1.49-4.90), wrist/hand (OR= 2.28, 95%CI 1.30-4.00) and upper back (OR= 2.26, 95%CI 1.28-3.98) symptoms. Neck symptoms were associated with arm abduction (OR=2.07, 95% CI 1.11-3.84) and screen position above eye height (OR= 2.19, 95%CI 1.16-4.14).	70% response rate. Confounding variables considered included age, gender, time spent in present type of work and frequency of exercise. The study states that mouse use may contribute to musculoskeletal injuries in the neck and upper extremities.

(Ferreira, Conceicao, & Saldiva 1997) (**)	Retrospective cohort study.	106 call centre workers.	All data retrieved from personnel and medical records from January 1993 to June 1995.	Cases of ULDs ranged from 1 per month to 6 per month with an incidence rate of 0.2 The study did not find any associations between length of service or ergonomic hazards and the development of ULDs. ULD incidence was reduced when 10 minute per hour rest breaks were introduced where previously there had been no rest breaks ($p < 0.02$).	A physician had diagnosed all ULD cases. Although a small sample. According to the authors, ergonomic hazards due to workstation, VDT and keyboard inadequacies, lack of postural and muscle personnel stretching training, evaluated in this study and found not significantly associated with upper extremity MSDs may be biased due to new work conditions introduced in late 1994.
(Ferreira & Saldiva 2002) (*)	Cross-sectional study	62 call centre workers in two groups; ATC – active telemarketing N=14 and TCC – customer services N=38	Questionnaire on MSD symptoms, habits, workstation, information network, work organisation and social environment. Interviews, observation and measures of workplace dimensions and physical environment.	Duration in the job, work in ATC and low level of satisfaction with the workstation arrangement were significantly associated with neck/shoulder and hand/wrist musculoskeletal symptoms and MSD induced time away from work.	The questionnaire used was ‘tailor-made’. The authors state that the sample studied constituted almost all the call centre workers in the departments selected.

(Hoekstra, Hurrell, & Swanson 1992) (**)	Cross-sectional study	108 teleservice representatives	Self-administered questionnaire survey on musculoskeletal symptoms, job tasks, work history, work environment and indicators of job stress. Ergonomic evaluation of representative workstations.	The study identified that neck symptoms were significantly associated with perceived chair discomfort (OR= 3.5, 95%CI 1.4-8.9). Shoulder symptoms were significantly associated with reporting a non-optimal desk height (OR= 5.1, 95%CI 1.7-15.5) and non-optimal VDU screen height (OR= 3.9, 95%CI 1.4-11.5). Elbow symptoms were significantly associated with perceived non-optimally adjusted chair (OR= 4.0, 95%CI 1.2-13.1). Hand/wrist symptoms were significantly associated with using the telephone more than 8 hours per day (OR= 4.7, 95%CI 1.3-17.4). Back symptoms were significantly associated with perceived non-optimally adjusted chair (OR= 4.6, 95%CI 1.7-12.5).	95% response rate. The authors suggest that since telephone headsets were used continuously, the number of telephone hours associated with hand/wrist symptoms probably reflects total work hours involving all aspects of the teleservice job. The authors report possible disease misclassification due to MSDs prevalence rates being determined solely by self-reported symptoms.
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(Jensen, Finsen, Sogaard, & Christensen 2002) (**)	Cross-sectional study	3475 employees including 629 call centre workers	Questionnaire on computer work, psychosocial factors and musculoskeletal symptoms.	For females, neck symptoms were significantly associated with working all the time at the computer (OR=1.92, 95% CI=1.21-3.02); shoulder symptoms were significantly associated with working all the time at the computer (OR=1.83, 95% CI=1.13-2.95). For men, hand/wrist symptoms were associated with working at the computer for three quarters of the time (OR=2.09, 95% CI=1.17-3.72) and all the time (OR=2.76, 95% CI=1.51-5.06) Age-adjusted odds ratios for female call centre employees compared to female computer users performing any other computer work were 1.59 (95% CI=0.98-2.60) for neck symptoms, 2.06 (95% CI=1.19-3.56) for shoulder symptoms and 1.95 (95% CI=1.06-3.61) for hand/wrist symptoms.	69% participation rate. Call centre data was excluded from part of the analysis due the low usage of the mouse by such workers. Questions on musculoskeletal symptoms were according to a modified version of the NMQ.
(Marcus & Gerr 1996) (**)	Cross-sectional study	Female office workers including those using VDUs and telephones; n=416 for neck and shoulder symptoms, n=409 for arm or hand symptoms.	Questionnaire on lifestyle, musculoskeletal symptoms (derived from the NIOSH questionnaire), occupational psychosocial stress (derived from the Job Content Instrument), job tasks and medical history.	When compared with those reporting no current and no past VDT use, for neck or shoulder symptoms ORs were 4.13 (95% CI 1.53-11.15) for <3 year duration of VDT use, 5.56 (95% CI 1.97-15.73) for 4-6 years and 4.28 (95% CI 1.35-13.60) for female subjects who had used a VDT for >6 years. Female subjects reporting more than 6 years of VDT use were significantly more likely to report hand or arm symptoms than women who never used a VDT (OR = 3.87 95% CI 1.24-12.02).	70% Response rate. Information on 2/3 of the non-participants was checked for differences in age and job title – none found. The authors suggest that individuals with symptoms may be more likely to reduce their VDU work thus biasing the results of cross-sectional research.

6. HOW IMPORTANT ARE PSYCHOSOCIAL FACTORS IN THE DEVELOPMENT OF MSD AND CAN THEY BE QUANTIFIED?

A total of 26 papers were identified from abstracts obtained by the researchers. The number selected for inclusion within the review was 12. Further papers were rejected based on population descriptions or no link to MSDs. The majority of the studies were carried out in call centre environments. The only two studies which dealt with heavy physical work were those of (Devereux, Buckle, & Vlachonikolis 1999; Devereux, Vlachonikolis, & Buckle 2002).

6.1 Evidence Statements

Both physical and psychosocial risk factors are implicated in the aetiology of MSDs. (**)

Psychosocial work factors appear to have more importance for the neck/shoulder region than the hand/wrist region. (**)

Musculoskeletal discomfort is significantly linked to gender, age, promotion/power, long hours and negatively associated with job satisfaction. (***)

Back symptoms are negatively associated with perceived degree of job control. (**)

Arm or hand symptoms are significantly associated with job stress, increased crowding, increased job demands, increased occupational psychosocial strain, decreased social support and high information processing demands. (**)

Neck symptoms are significantly associated with job security issues, routine work lacking in decision-making opportunities, high information processing demands, not having productivity standards and jobs requiring a variety of tasks (**).

Elbow symptoms are significantly associated with job security issues including fear of being replaced by a computer, surges in workload and increasing time pressure. (**)

Shoulder symptoms are associated with job security issues including fear of being replaced by a computer. (**)

Prevalence rates for musculoskeletal symptoms based on the reviewed studies were between 22% and 83% for the self-report questionnaires. (**)

It is not possible at the current time to quantify the impact of psychosocial factors on the development of MSDs due to the experimental design of the studies included in the review. (**)

Evidence Table 6.1 Psychosocial Factors in the Development of MSDs

Study	Study design	Study population	Method	Outcomes	Comments
(Baker, Jacobs, & Tickle-Degnen 2003) (***)	Cross-sectional study	274 call centre workers	The Meaning of Working Survey and the Musculoskeletal Discomfort Questionnaire (MDQ).	Prevalence of neck discomfort 57%, shoulder discomfort 41%, elbow discomfort 19%, wrist discomfort 52% and back discomfort 63%; overall 83% of respondents reported discomfort. Multiple regression analysis revealed a significant association between musculoskeletal discomfort and gender, age, promotion/power and average hours worked.	69% response rate. The authors report that previous applications of the MDQ obtained a high level of reported musculoskeletal discomfort within this population and that, thus, this instrument may have inflated the actual presence of mild musculoskeletal discomfort. The pattern suggested that females who work longer hours, valued promotion and disliked social support were more likely to develop moderate to severe musculoskeletal discomfort. Non-work related variables were not studied.

(Baker, Jacobs, & Carifio 2000) (**)	Cross-sectional study	122 call centre workers	A background factors questionnaire, a somatic complaints questionnaire, the MDQ, a work practices questionnaire and a psychosocial questionnaire.	72% reported neck discomfort in the previous year, 54% shoulder discomfort, 18% elbow discomfort, 48% wrist discomfort and 67% low back discomfort. Neck symptoms were significantly associated with somatic complaints and age; shoulder symptoms were significantly associated with somatic complaints, age, quantitative workload, alcohol and workload; elbow symptoms were significantly associated with somatic complaints, having another job, job satisfaction and skill utilisation; wrist symptoms were significantly associated with workload variety and having own workstation and back symptoms were significantly associated with somatic complaints, childcare, workstation monitor and social support from co-workers.	61% response rate (91% from site 1 and 32% from site 2). 33 out of the 155 participants were excluded from analysis due to incomplete data. The background factors questionnaire, somatic complaints questionnaire, and work practices questionnaire were adapted from NIOSH questionnaires. The psychosocial questionnaire was adapted from the General Job Stress Questionnaire. The study suggests that musculoskeletal discomfort may be a somatic stress symptom.
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(Devereux, Vlachonikolis, & Buckle 2002) (**)	Cross-sectional study	891 participants working in varied physical environments and office environments	Self-administered validated questionnaire on physical and psychosocial factors and musculoskeletal symptoms. Participants grouped into low physical/low psychosocial, high physical/low psychosocial, low physical, high psychosocial and high physical/high psychosocial exposure groups.	55% had reported musculoskeletal symptoms in the past 7 days. Hand/wrist symptoms were significantly associated with low physical/high psychosocial (OR = 2.32 95% CI 1.15-4.70), high physical/low psychosocial (OR= 4.42 95% CI 2.20 -8.90) and high physical/high psychosocial exposure (OR=7.50 95%CI 3.76-15.16). Upper limb symptoms were significantly associated with the high physical/low psychosocial (OR =2.28 95%CI 1.31-3.98) and high physical/high psychosocial exposure (OR=3.74 95% CI 2.12-6.60).	59% response rate. Response bias due to outcome or years spent at the job could not be assessed. The study indicates that both physical and psychosocial risk factors are implicated in the aetiology of upper limb disorders and future interventions need to address both of those.
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(Devereux, Buckle, & Vlachonikolis 1999) (**)	Cross-sectional study	As above	As above	39% had a recurrent back problem more than 3 times per year lasting over one week. There was a significant association between back pain in the past 7 days and the high physical/high psychosocial group (OR=2.41 95% CI=1.51-3.85). Recurrent back problems (not experienced before present job) were significantly associated with high physical/low psychosocial (OR=2.80 95% CI 1.48-5.35) and high physical/high psychosocial exposures (OR=3.58 95%CI 1.99-6.77).	57% response rate. Response bias due to outcome or years spent exposed could not be assessed. The study indicates that both physical and psychosocial factors increase the risk of back disorders. However, it does not identify if interactions between the two increase or reduce risk.
(Ferreira, Conceicao, & Saldiva 1997) (**)	Retrospective cohort study	106 call centre workers.	All data retrieved from personnel and medical records from January 1993 to June 1995.	24 ULD cases were diagnosed by at least two physicians. Time pressure at work and work/rest scheduling were associated with ULD incidence.	
(Ferreira & Saldiva 2002) (*)	Cross-sectional study	62 call centre workers in two groups; ATC – active telemarketing and TCC – customer services	Questionnaire on MSD symptoms, habits, workstation, information network, work organisation and social environment. Interviews, observation and measures of workplace dimensions and physical environment.	Significantly higher levels of job satisfaction were found in the TCC group. An association was found between ergonomic of the workstation, work organisation, the social environment and musculoskeletal complaints.	The questionnaire used was ‘tailor made’. The authors state that work in the ATC influenced higher reports of neck-shoulder and hand-wrist symptoms and musculoskeletal induced time away from work.

(Hales, Sauter, Peterson, Fine, Putz-Anderson, Schleifer, Ochs, & Bernard 1994) (**)	Cross-sectional study	533 telecommunications workers in 5 job types	Self-administered questionnaire on musculoskeletal symptoms, followed by a medical examination. Psychosocial issues were assessed by a validated measure and demographics information was also obtained, as was information about keystrokes and electronic performance monitoring.	Overall symptom prevalence was 22%. The types of symptoms identified in the sample were probable tendon disorders (15%), probable muscle related disorders (8%), probable nerve entrapments (4%), joint related findings (3%) and ganglion cysts (3%). Significant associations found in the study included bifocal use with neck disorders (OR=3.8 95% CI 1.5-9.4); job security including fear of being replaced by computers with neck (OR=3.0 95% CI 1.5-6.1), shoulder (OR=2.7 95% CI 1.3-5.8) and elbow disorders (OR= 2.9 95% CI 1.4-6.1); routine work lacking decision making opportunities with neck (OR=4.2 95%CI 2.1-8.6) and elbow disorders (OR=2.8 95%CI 1.4-5.7); high information processing demands with neck (OR=3.0 95%CI 1.4-6.2) and hand/wrist disorders (OR=2.3 95%CI 1.3-4.3); neck disorders with not having a productivity standard (OR= 3.5 95% CI 1.5-8.3), jobs requiring a variety of tasks (OR= 2.9 95%CI 1.5-5.8) and increasing work procedure (OR=2.4 95%CI 1.1-5.5); and elbow disorders with surges in workload (OR= 2.4 95%CI 1.2-5.0).	93% response rate. The study provides some support in relating upper limb disorders to the psychosocial work environment. The psychosocial factors appear to be more important for the neck/shoulder region than the hand/wrist area.
(Halford & Cohen 2003) (*)	Cross-sectional survey	67 call centre workers currently or recently working	Interview/questionnaire in five parts including questions on demographics, hardware issues, MSD symptoms, computer use psychosocial factors, technology used, management/worker relations and workplace conditions.	No significant relationship was found between cumulative musculoskeletal problems and cumulative psychosocial factors. Individual factors found to be significantly associated with musculoskeletal symptoms included monitoring by management, workload and managerial support.	Details on this study were limited and contradict other studies.

(Hoekstra et al. 1996) (**)	Cross-sectional study	108 employees from two call centres.	Validated questionnaire on symptoms, stress and job satisfaction.	68% of the sample reported musculoskeletal symptoms, 44% neck, 35% shoulder, 33% back, 30% hand wrist, 20% elbow. A higher prevalence of symptoms was found in Centre B. Centre B was significantly associated with shoulder symptoms (OR=4.0, 95% CI 1.1-14.6). Neck symptoms were associated with perceived workload variability (continually changing workload during the day) (OR=1.2, 95% CI 1.0-1.4). Back symptoms were inversely associated with perceived degree of job control (OR=0.6, 95% CI 0.5-0.7). Self-reported exhaustion was significantly associated with perceived workload variability, perceived lack of influence and control and perceived lack of future certainty. Job satisfaction was significantly associated with perceived lack of future certainty, perceived non-optimally adjusted keyboard, perceived poor supervision and perceived non-optimally adjusted screen.	95% response rate. Centre A had up-graded furniture, Centre B had not. Study indicates the need for consideration of both ergonomic and work organisation factors to reduce the risk for musculoskeletal disorders. The authors report possible disease misclassification due to MSDs prevalence rates being determined solely by self-reported symptoms.
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(Marcus & Gerr 1996) (**)	Cross-sectional study	Female office workers including those using VDUs and telephones; n=416 for neck and shoulder symptoms, n=409 for arm or hand symptoms	Questionnaire on lifestyle, musculoskeletal symptoms (derived from the NIOSH questionnaire), occupational psychosocial stress (derived from the Job Content Instrument), job tasks and medical history.	34.2% reported arm or hand symptoms; 63% reported neck and shoulder symptoms. The proportion of female participants reporting neck or shoulder symptoms (n=374) increased significantly with increased reporting of job stress during the previous 2 weeks (OR= 2.47 95% CI 1.20-5.10) and reporting of increased likelihood of job loss (OR= 2.23 95% CI 1.35-3.69). No significant associations were observed between either occupational psychosocial strain or social support and neck or shoulder symptoms in the multivariate model. In crude analyses, the proportion of subjects reporting neck or shoulder symptoms also increased significantly with decreased job satisfaction, decreased social support and increased occupational psychosocial strain. The proportion of female participants reporting arm or hand symptoms (n=367) increased significantly with increased reporting of job stress during the previous weeks (OR=2.04 95% CI 1.04-4.00). Neither occupational psychosocial strain nor social support were significantly associated with hand or arm symptoms in the multivariate model. In crude analysis, the proportion of subjects reporting arm or hand symptoms, also increased significantly with reporting of increased crowding, increased job demands, increased occupational psychosocial strain and decreased social support.	70% Response rate. Information on 2/3 of the non participants was checked for differences in age and job title – none found. The authors suggest that individuals with symptoms may be more likely to reduce their VDU work thus biasing the results of cross-sectional research. They also report that the Job Content instrument may have not been appropriate for this study.
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(Nag & Nag 2004) (**)	Cross-sectional study	136 female call centre operators.	Survey of workstation, equipment and work methods. Interview using a validated checklist.	Different factors identified including organisational, environmental, mechanistic, perceptual and motor and motivational. Prevalence of musculoskeletal pain was greatest in the lower back, with night shift and evening shift reporting 47% and 45% respectively. Long hours and seated work resulted in constant musculoskeletal symptoms, mainly lower back complaints. Day workers had fewer complaints than other shift workers.	There was a variance between work stressor and health with shift schedules. However evidence is unclear.
(Norman, Nilsson, Hagberg, Tornqvist, & Toomingas 2004) (*)	Cross-sectional base line survey	57 employees at a call centre in Sweden. 1459 other computer users (reference group).	Questionnaire on physical and psychosocial working conditions and symptoms during the previous month. Structured observations made by ergonomists on healthy workers.	Psychosocial environment was deficient including poor support from the immediate supervisor, low control and limited opportunities to influence their work. A higher proportion of call centre employees had long continuous work in front of the computer compared to controls. Compared to the reference group, call centre workers reported a higher proportion of musculoskeletal symptoms.	81% and 84% response rates for the call centre and the reference group respectively. Possible bias in the selection of operators in the call centre group, reported by the authors. The study identifies that call centre operators are exposed to physical and psychosocial risk factors that have been linked to an increase in musculoskeletal symptoms.

7. WHAT PREDICTIVE FACTORS ARE THERE FOR THE DEVELOPMENT OF MSD IN THIS TYPE OF WORK?

7.1 Service Technicians

Due to the lack of information with regard to service technician work, there are currently no available predictive factors for the development of musculoskeletal disorders in telecommunications workers.

7.2 Call Centre Workers

Seven papers were identified and included in this section. Again the research was mostly two stars in quality rather than three star research. A number of associations have been identified. However, due to the cross-sectional nature of the research, the associations have not yet been verified in the aetiology of MSDs.

7.2.1 Evidence Statements

In comparison with other computer users, the odds ratio for being classified as a symptom case among call centre employees was 2.3, 95% CI=1.2-4.3. (*)

No associations were found between symptoms and electronic performance monitoring or keystrokes per day. (**)

Neck symptoms were associated with arm abduction, screen position above or below eye height, shoulder elevation, bifocal use, job security issues, workload variability (loading), routine work lacking decision-making and high information demands. (**)

Shoulder symptoms were associated with screen position above eye height, shoulder elevation and job security issues. (**)

Hand/wrist symptoms were associated with shoulder elevation and high information processing demands. (**)

Upper back symptoms were associated with shoulder elevation. (**)

Elbow symptoms were associated with routine work lacking decision-making and surges in workload. (**)

General MSD symptoms were associated with time pressure at work and work rest scheduling. (**)

Evidence Table 7.1 Predictive Factors for MSDs in Call Centre Workers

Study	Study design	Study population	Method	Outcomes	Comments
(Bergqvist, Wolgast, Nilsson, & Voss 1995) (**)	Cross-sectional study	322 office workers from 7 Stockholm companies. 52% reported as being interactive workers.	Questionnaire on muscle discomfort, VDT use and individual and organizational factors, the NMQ, physiotherapy examination, workplace examination.	VDT users did not show elevated odds of muscle problems compared to non-VDT users. No associations were found between muscle problems and accumulated VDT use in person-years. Working more than 20hrs per week at a VDT was associated with intensive neck and shoulder discomforts if it occurred in a situation with repetitive movements for individuals who often reported stomach reactions (O.R.=3.9, 95% CI 1.1-13.8). Working more than 20hrs per week at a VDT was associated with a diagnosis of TNS for users of bifocal or progressive glasses (O.R.=6.9, 95% CI 1.1-42.1). Working more than 20hrs per week at a VDT was associated with arm/hand diagnosis for individuals with limited rest break opportunity combined with the non-use of lower arm support (O.R.=4.6, 95% CI 1.2-17.9). The study did not find any significant associations between interactive work, symptoms, length of career and working hours.	Concern was raised by the authors about the healthy worker effect in losing 34% of the sample.

(Cook, Burgess-Limerick, & Chang 2000) (**)	Cross-sectional study	302 workers in 15 workplaces including a telecommunications company.	Questionnaire on work patterns, use of computer and mouse. Questions on musculoskeletal symptoms were based on the NMQ.	From logistic regression analysis, neck symptoms were associated with arm abduction (OR=2.07, 95% CI=1.11-3.84), screen position above eye height (OR=3.19, 95% CI=1.5-6.78), screen below eye height (OR=2.19, 95% CI=1.16-4.14) and shoulder elevation (OR=2.01, 95% CI=1.04-3.88). Shoulder symptoms were associated with age, 31-40 (OR=2.49, 95% CI=1.23-5.06), age 41-50 (OR=2.79, 95% CI=1.31-5.94), screen height above eye level (OR=2.38, 95% CI=1.20-4.71) and shoulder elevation (OR=2.69, 95% CI=1.49-4.9). Wrist/hand symptoms were associated with shoulder elevation (OR=2.28, 95% CI=1.3-4.0). Upper back symptoms were associated with female gender (OR=2.39, 95% CI=1.33-4.31) and shoulder elevation (OR=2.26, 95% CI=1.28-3.98). The study did not find a significant association between hours of mouse usage per day and symptoms.	70% response rate. Confounding variables considered included age, gender, time spent in present type of work and frequency of exercise. The study states that mouse use may contribute to musculoskeletal injuries in the neck and upper extremities.
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(Ferreira, Conceicao, & Saldiva 1997) (**)	Retrospective cohort study	106 call centre workers	All data retrieved from personnel and medical records from January 1993 to June 1995.	From a multiple linear regression model, variables associated with musculoskeletal disorders were time pressure at work and rest/work schedule.	According to the authors, ergonomic hazards due to workstation, VDT and keyboard inadequacies, lack of postural and muscle personnel stretching training, evaluated in this study and found not significantly associated with MSDs maybe biased due to new work conditions introduced in late 1994.
(Hales, Sauter, Peterson, Fine, Putz-Anderson, Schleifer, Ochs, & Bernard 1994) (**)	Cross-sectional study.	533 telecommunications workers in 5 job types	Self-administered questionnaire on musculoskeletal symptoms, followed by a medical examination. Psychosocial issues were assessed by a validated measure and demographics information was also obtained, as was information about keystrokes and electronic performance monitoring.	From the logistic regression analysis, bifocal use was associated with neck disorders (OR = 3.8, 95% CI=1.5-9.4). Job security issues including fear of being replaced by computers was associated with neck disorders (OR = 3.0, 95% CI=1.5-6.1), shoulder disorders (OR=2.7, 95% CI=1.3-5.8) and neck disorders (OR=2.9, 95% CI=1.4-6.1). Routine work lacking decision-making opportunities was associated with neck disorders (OR=4.2, 95% CI=2.1-8.6) and elbow disorders (OR=2.8, 95% CI=1.4-5.7). High information processing demands were linked to neck disorders (OR=3.0, 95% CI=1.4-6.7) and hand wrist disorders (OR=2.3, 95% CI=1.3-4.3). Surges in workload were associated with elbow disorders (OR=2.4, 95% CI=1.2-5.0). No associations were found with electronic performance monitoring and keystrokes per day.	93% response rate.

(Hoekstra, Hurrell, & Swanson 1992) (**)	Cross-sectional study	108 teleservice representatives	Self-administered questionnaire survey on musculoskeletal symptoms, job tasks, work history, work environment and indicators of job stress. Ergonomic evaluation of representative workstations.	Odds ratios were calculated from multiple regression models to evaluate the independent variables assessed. Those found to be positive were neck symptoms and chair discomfort (OR=3.5, 95% CI=1.4-8.9) and workload variability (OR=1.2, 95% CI=1.0-1.4). For shoulder symptoms, these were significantly associated with non-optimally adjusted desk height (OR=5.1, 95% CI=1.7-15.5) and non-optimally adjusted VDU screen (OR=3.9, 95% CI=1.4-11.5) Elbow symptoms were increased for those reporting a non-optimally adjusted chair (OR=4.0, 95% CI=1.2-13.1) Hand/wrist symptoms were increased for those reporting using the telephone for more than 8 hours per day (OR=4.7, 95% CI=1.3-17.4). Back symptoms were associated with having a non-optimally adjusted chair (OR= 4.6, 95% CI=1.7-12.5) and negatively associated with perceived job control (OR=0.6, 95% CI=0.5-0.7)	95% response rate. The authors report possible disease misclassification due to MSDs prevalence rates being determined solely by self-reported symptoms.
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(Jensen, Finsen, Sogaard, & Christensen 2002) (**)	Cross-sectional study	3475 employees including 629 call centre workers.	Questionnaire on computer work, psychosocial factors and musculoskeletal symptoms	For females, neck symptoms were significantly associated with working all the time at the computer (OR=1.92, 95% CI=1.21-3.02); shoulder symptoms were significantly associated with working at the computer all the time (OR=1.83, 95% CI=1.13-2.95). For men, hand/wrist symptoms were associated with working at the computer for three quarters of the time (OR=2.09, 95% CI=1.17-3.72) and all the time (OR=2.76, 95% CI=1.51-5.06) Age-adjusted odds ratios for female call centre employees compared to female computer users performing any other computer work were 1.59 (95% CI=0.98-2.60) for neck symptoms, 2.06 (95% CI=1.19-3.56) for shoulder symptoms and 1.95 (95% CI=1.06-3.61) for hand/wrist symptoms. Call centre work was characterised by the highest level of repetitiveness as both work tasks and movements were perceived as repetitive by a large fraction of the call centre respondents.	69% participation rate. For the logistic regression models, males and females were analysed separately due to females reporting twice as many symptoms as men.
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(Toomingas, Nilsson, Hagberg, Hagman, & Tornqvist 2003) (*)	Closed prospective cohort study	57 call centre operators at one call centre Reference group of 1226 professional computer users	Baseline questionnaire on musculoskeletal symptoms. Participants were studied with 10 monthly follow-ups. Medical examination performed on 78% of the incident call centre cases.	The odds ratio for being classified as a symptom case among call centre operators versus the reference group was OR=2.2, 95% CI=1.2-4.3. The age and gender adjusted relative risk for incident symptoms among call centre operators versus the reference groups was 1.3, 95% CI 0.79-2.1.	Response rates in the baseline ranged between 79% and 88% and follow-up response rates between 68% and 88%. The authors report possible selection bias due to supervisors selecting those call-centre operators who were supposed to remain during the follow-up period. They also report possible bias in the examination and diagnostic process. The examiners were not blinded to the symptoms or the exposure situation.
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8. WHAT MEASURES ARE EFFECTIVE IN THE PREVENTION OF MSD IN THIS TYPE OF WORK

8.1 Service Technicians

No papers were identified that evaluated the effectiveness of measures in the prevention of MSDs in service technicians in the telecommunications industry.

8.2 Call Centre Workers

Only two papers were identified which examined prevention measures of MSDs in call centre workers.

8.2.1 Evidence Statements

There is no current evidence to support the use of forearm support on the workstation among call centre workers. (**)

Interventions including occupational health based training and muscle-learning therapy did not reduce symptom reporting in call centre staff. (**)

Evidence Table 8.1 Effective Measures in the Prevention of MSDs

Study	Study design	Study population	Method	Outcomes	Comments
(Cook & Burgess-Limerick 2004) (**)	Randomised controlled trial	59 call centre workers.	Participants were randomly sampled into a study group of 30 and a control group of 29. Participants were all given training in workstation adjustment and posture. The study group had their workstations adjusted to allow forearm support on the desk surface. The NMQ was administered at baseline, 6 weeks and 12 weeks.	At baseline, 98% of participants reported musculoskeletal discomfort in one or more body region in the past 12 months; 75% reporting discomfort in the 7 days prior to the study. In the intervention group, the proportion of reported discomfort in one or more body area in the last 7 days decreased from 79% to 62% at 6 weeks. For the control group, reports of discomfort increased from 71% to 75%. However, there were no significant differences between the two groups. At 12 weeks, there was a significant decrease in discomfort for both groups. However, there were no significant differences between the study and control group.	The control group workstations were assessed to insure compliance with the national standard. Within the first week of intervention, 9 participants (15%) withdrew due to discomfort or difficulty in maintaining the posture. The results were of an intention to treat analysis. Authors suggest that forearm support may be preferable to the floating posture; however the study has a short intervention period and small numbers.

(Faucett et al. 2002) (**)	Randomised controlled trial	55 telemarketers, 10 engineers, and 43 assembly workers.	Interventions included a Muscle Learning Therapy (MLT) and Occupational Health Nurse delivered education and training (EDUC). Participants were randomly assigned into a control group of 47, and two experimental groups of 46. Symptom measures at the end of each workday for two weeks on a VAS for pain, stiffness and numbness. Surface EMG measures and identification of new MSD symptoms at 32 weeks from medical records.	No significant differences found between the groups for age, gender, education, handedness, smoking status or VDU use outside work. At baseline there were no significant differences in symptoms between the control and intervention groups. Over the intervention period, the education and training group initially improved then returned to baseline at 32 weeks. For the muscle learning therapy, symptom reports stayed the same at 6 weeks but worsened at 32 weeks. The control group symptom level increased throughout the study. The study indicates that in the short-term symptom severity was improved at 6 weeks but this was not maintained at 32 weeks.	The method of randomisation was not described. Participation retention was 83% for the controls, 80% for EDUC, and 70% for MLT.
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9. IS HEALTH SURVEILLANCE OF BENEFIT IN PREVENTING OR MODIFYING THE PROGRESSION OF MSDS?

Although eight papers were identified in the review process in relation to health surveillance, the majority of them were unrelated to telecommunications work or measuring the effectiveness of health surveillance. The three papers included in the review are not specifically related to telecommunications. One of the papers describes a methodology of setting up health surveillance for MSDs with a further two aiming to evaluate health surveillance for MSDs.

9.1 Evidence Statements

When using self-report measures, the magnitude of MSDs is greater than that identified through medical records or medical examination. (*)

There is no current evidence available to support or refute that health surveillance is of benefit in preventing or modifying the progression of MSDs in telecommunications workers. (*)

Evidence Table 9.1 Health Surveillance in Preventing or Modifying the Progression of MSDs

Study	Study design	Study population	Method	Outcomes	Comments
(Ricci, De Marco, & Occhipinti 1998) (-)	Review Paper	Workers exposed to repetitive movements	A paper that reviews the evidence for health surveillance for workers exposed to repetitive movements and gives an outline strategy for a health surveillance programme for the upper limbs. Paper describes a two-stage approach covering both individual and group analysis.	No outcome measures in this paper.	This paper describes a methodology for health surveillance but no evidence is given to its effectiveness.
(Roquelaure et al. 2002) (*)	Cross-sectional prevalence study with incidence data calculated at one year	253 blue-collar shoe factory workers; At follow-up 191 reviewed	Interview and examination by occupational physician. Health outcomes defined for CTS, rotator cuff syndrome, TNS and cubital tunnel syndrome. Ergonomic exposure measurements by direct observation and using a risk factor checklist.	Prevalence data identified detected 3 high-risk areas for MSDs (cutting, sewing and assembly preparation). Incidence data identified sewing preparation, mechanised assembling and finishing as high risk for MSDs. The diagnostic value of the methods used could not be assessed. Authors state that surveillance of adverse outcomes and ergonomic risk factors are important in preventing MSDs.	Little evidence given to support the use of health surveillance.

(Silverstein et al. 1997) (*)	Cross-sectional study	626 active workers in the automotive industry	Authors compared the strengths and limitations of surveillance tools for MSDs including workers compensation, sickness and accident insurance, OSHA 200 logs, plant medical records, self-administered questionnaires including body maps from the NMQ, professional interviews and physical examination.	The magnitude of MSDs was greater using self-administered questionnaires and professional interviews than surveillance based on pre-existing health data. Plant medical records yielded the lowest rates. The study suggests that symptoms questionnaires and checklist based hazard surveillance are more sensitive indicators of ergonomic problems than pre-existing data sources.	Response rate was 67%. Study is flawed in terms of design, responses and incomparability of scenarios for data sources. Authors also comment that there is a need to develop a gold standard that evaluated workplace exposures and MSD symptoms.
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10 DATA GAPS

10.1 Service Technician Work

With regard to Service Technician work, there is a lack of information considering incidence and prevalence of MSD symptoms in telecommunications work. Although the previous questionnaire survey carried out in the EU identified major risk factors for the development of MSDs, there is no indication of the scale of the problem. From these studies included in the review, there was a lack of consistency in medical diagnosis and for self-report data, the tools used. It would be recommended that a baseline measure be taken of diagnosed or reported MSDs within this working population before any future interventions are taken. Although high-risk areas have already been identified, a baseline measure will allow the success or failure of any future interventions to be assessed; thus, the use of consistent diagnostic techniques or validated questionnaires is essential in this process.

The majority of the research included in the review was one or two star quality. This needs to be addressed in the design of future research projects to ensure that evidence-based guidelines for the industry can be set up.

Individual tasks in the review included manhole cover removal, ladder handling, working overhead, cable handling and hand-arm vibration from tools. The studies reviewed included research from other industries so caution must be taken with these results. Hand-rodding was identified as a risk factor by the telecommunications industry, however, no research in the public domain was identified and at the moment there is little general research available on the impact of pushing and pulling on MSDs. The lack of research in this area specific to hand rodding would suggest that future research should encompass this work task.

The role of psychosocial factors in the development of MSDs does suggest that they have an impact in MSD development. What is unclear at the moment is the role that psychosocial factors play in heavy physical work related to the telecommunications sector. Future research should address this issue.

10.2 Call Centre Work

Research on call centre workers, again was limited by inconsistency in diagnostic criteria or the survey tools used, cross-sectional design employed and a lack of description of different ergonomic workplace evaluations. A number of areas were identified as important including workstation set-up and layout, rest breaks and using the telephone. Again it would be useful to identify the magnitude of the problem within call centre workers by monitoring and identifying incidence rates. This would be vital before any workplace changes are made to identify the efficacy of those changes.

The majority of the research with regard to psychosocial factors was based in call centre work. This research was mostly cross-sectional in design but did indicate a number of factors that were association with MSD symptoms. Future research needs to address the issue of cross-sectional experimental design and enable data to be collected over longer time periods.

No research papers were identified in relation to using DSE equipment in vehicles. Only advisory information was obtained which recommended not using DSE equipment in vehicles but if it had to occur, designing a specific workstation for this. The working practices project running alongside the review may need to identify how individual telecommunications companies manage this issue. Where there are instances of workstations being developed within vehicles, these should be evaluated as to their usefulness.

11. CONCLUSIONS

The review identified that the MSDs were linked to manhole cover manoeuvring, ladder handling, overhead line work, cable handling and road breaking work in service technicians. For call centre workers it has been identified that in comparison with other professional computer users there is increased reporting of MSD symptoms and the most common body areas associated with symptoms and discomfort were the neck, shoulder and hand/wrist.

Activities identified as being risk factors for MSDs include manhole cover handling, ladder handling, working overhead, cable handling and road breaking tasks for service technicians. Risk factors for call centre workers included non-optimal keyboard height, screen height and desk height; chair discomfort, shoulder abduction, shoulder elevation, working with computers for the whole working day, using the telephone more than 8 hours per day and symptoms were reduced by introducing 10 minutes per hour rest breaks.

The research on psychosocial factors in the development of MSDs has on the whole been carried out within call centre workers rather than the physical work of service technicians. Current research has identified that physical and psychosocial risk factors are implicated in the aetiology of MSDs and appear to have more of an impact for the neck and shoulder region. Factors associated include gender, age, long hours, job stress, increased job demands, decreased social support, decreased job satisfaction, high information processing demands, job security issues including fear of being replaced by a computer and routine work lacking in decision making. The review was unable to quantify the impact of psychosocial factors on the aetiology of MSDs due to the cross-sectional nature of the research studies.

There were no research papers that identified the predictive factors for the development of MSDs in service technician work. With regard to call centre workers, the research identified that in comparison with other computer users there is an increased risk for call centre workers being classified as a symptom case. No association was found between electronic performance monitoring or keystrokes per day in call centres. Neck symptoms were associated with arm abduction, screen position, shoulder elevation, bifocal use, job security issues, work loading and routine work. Shoulder symptoms were linked with screen position and job security issues. Hand/wrist symptoms were associated with shoulder elevation and high information processing demands. Elbow symptoms were associated with routine work lacking decision-making and surges in workload. General MSD symptoms were associated with time pressure and work rest scheduling.

The research with regard to health surveillance has identified that self-report measures increase reporting of MSDs in comparison to medical record evaluation or medical examination. There is no current evidence to support or refute the usefulness of health surveillance in preventing or modifying the progression of MSDs in telecommunications workers.

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