Prevention of work related musculoskeletal disorders: setting priorities using the standardized Dutch Musculoskeletal Questionnaire

The studies presented in this thesis stem partly from research conducted at TNO for the Dutch Ministry of Social Affairs and Employment, the European Coal and Steel Community, Hoogovens IJmuiden, Stigas (the former occupational health service for Dutch agriculture) and the Dutch Ministry of Health, Welfare and Sport.

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Prevention of work related musculoskeletal disorders: setting priorities using the standardized Dutch Musculoskeletal Questionnaire

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geboren te ‘s-Gravenhage

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1. Introduction

1.1 The problem

Musculoskeletal disorders constitute a major health problem to our society. Lifetime prevalence rates of low back pain up to 85-90% have been reported (Von Korff et al. 1988, Frymoyer & Catz-Baril 1991), and the annual incidence rate for low back pain is estimated to be around 1-5% (Frymoyer & Catz-Baril 1991, Hashemi et al. 1997). Almost 75% of the general population in The Netherlands reported musculoskeletal symptoms in 1998 (Picavet et al. 2000); main regions were the neck, shoulder or upper back (one year prevalence rate 45%) and the low back (one year prevalence rate 44%). In the worker population in The Netherlands, one-year prevalence rates of neck-shoulder-arm symptoms, including the so-called Repetitive Strain Injuries (RSI), varied between 11 and 32%, depending on industrial branch (Otten et al. 1998).

Only a small part of all musculoskeletal disorders can be diagnosed as distinct clinical entities (e.g. hernia nucleï pulposi, carpal tunnel syndrome). Most low back symptoms have been reported to be unspecific or undiagnosable (Spitzer et al. 1987; Frank et al. 1995). Proper treatment is often difficult because 'evidence based' therapies are still scarce, but guidelines for treatment of low back symptoms have become available in recent years in The Netherlands, both for family and occupational physicians (Faas 1996; NVAB 1999) and abroad (Bigos et al. 1994).

The aetiology and risk factors of musculoskeletal disorders are still insufficiently known (Kilbom 1994, Frank et al. 1995). Although the debate on the work relatedness of these disorders is still unfinished (National Research Council 1999), it is estimated that approximately 30% of the musculoskeletal disorders is work related (Waters et al. 1993). Prevalence rates do vary significantly with the kind of work (Johanning 2000), presumably related to the levels of exposure to physical loads. In 1997, The American National Institute for Occupational Safety and Health (NIOSH) concluded that strong evidence existed for several occupational risk factors (lifting, forceful movements, whole body vibration and – to a lesser extent – heavy physical work in general an awkward postures) (Bernard 1997). Recent systematic reviews indicate there is indeed strong evidence for manual materials handling, bending and twisting and whole-body vibration and moderate evidence for patient handling and heavy physical work as risk factors for back pain (Hoogendoorn et al. 2000) as well as some evidence for the duration of sitting, twisting or bending of the trunk, neck flexion, arm force, arm posture, hand-arm vibration and workplace design as risk factors for neck pain (Ariens et al. 2000).

The impact of musculoskeletal morbidity upon society is vast. Musculoskeletal symptoms, although no threat to the individual's life, can be very disabling for work participation, social activities and financial income. It is, as the Dutch Foundation of Rheumatic Diseases puts it, a 'silent' disease.

Musculoskeletal disorders are the fifth most expensive disease category in terms of in- and–out patient hospital care in The Netherlands. For low back pain only, costs in The Netherlands in 1991 amounted to 368 billion US dollars for hospital care, 22 billion US dollars for general practice care and 139 billion US dollars for paramedical care, e.g. physiotherapy (Van Tulder 1996).

In trade and industry in The Netherlands, musculoskeletal disorders are one of the most expensive disease category regarding work absenteeism and disablement, with an estimated 4,6 billion US dollars for low back pain only (Van Tulder 1996). Notably, the high costs of rehabilitation and return-to-work programs are not included in these estimates. It is therefore not surprising that these issues have also given rise to a broad political discussion on how to control the ever-increasing costs of health care and social expenditures.

The (maintenance of) work ability of the workforce and optimal worker participation has become a major issue within trade and industry in The Netherlands, reinforced by the present tight labour market, the forthcoming increase in ageing of the worker population, and the general tendency of labour intensification. Every manager wants a more productive and innovative work force in this period of globalisation, turbulent markets and ICT growth; and every employee wants a healthy and stimulating working environment. Reduction of work related risk factors, an anticipating policy in the early weeks of sick leave to identify workers at risk of chronic disability and rapid rehabilitation are today’s keys to achieving optimal work ability, work satisfaction, work participation and prevention of chronic disability of workers. In addition, the tight labour market forces trade and industry to enhance their attractiveness to new employees and to increase commitment within the organisation. This results in a growing attention for favourable secondary labour conditions and appealing employee benefit programs. High disability rates and unfavourable working conditions do not appeal to potential applicants; they will even have a negative effect on the company’s image.

As a consequence, trade and industry engage occupational health services to contribute to efficient and effective solutions, to prevent sick leave and disability, and to stimulate early return to work. Since musculoskeletal disorders are the most common work related cause for dropout, the prevention of these disorders and associated disability is an important part of the daily ‘business’ of occupational health services. An urgent need is thus felt to develop cost-effective and efficient strategies to control, reduce, and prevent the risks related to these disorders at work.

According to the Dutch law on working conditions, every employer has to order a risk assessment and evaluation (RI&E). Since musculoskeletal disorders are widespread, such a risk assessment and evaluation almost always includes musculoskeletal risks. A ‘musculoskeletal-RI&E’ is thus an important product for occupational health services. Its quality benefits from using standardized methods specifically pointing to musculoskeletal risks, and also from a standardized approach to implement and evaluate ergonomical, organizational or therapeutic interventions to reduce risks and morbidity. This thesis addresses such an approach and evaluates an instrument for the assessment of musculoskeletal symptoms and workload in daily practise of occupational health services.

1.2 A step-by-step approach towards prevention

A model representing the relation between work and musculoskeletal morbidity (Figure 1) is presented by Dul et al. (1992) and refined by Paul et al. (1994).

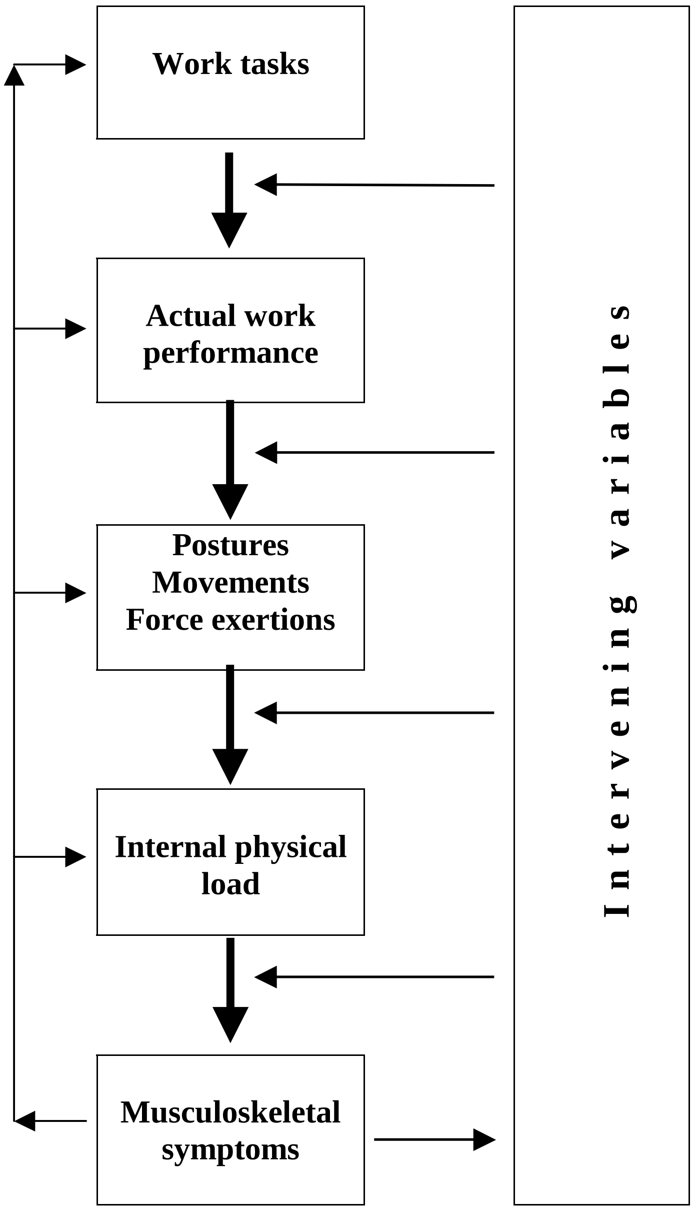

Figure 1. A model of the relation between work, intervening factors and musculoskeletal morbidity, after Dul et al. (1992) and Paul et al. (1994).

The musculoskeletal workload of workers is determined by their work tasks and the actual work performance during these tasks. These induce the worker to specific postures, movements, and force-exertions, constituting a certain level of internal physical load. A high internal physical load may cause short term and/or long-term musculoskeletal symptoms. Many variables may influence these relations, in particular work related factors (e.g. work pressure, work satisfaction, co-operation with other workers, climate), and individual factors (e.g. age, gender, physical fitness, coping capacities and motivation). Symptoms may cause a change of the actual work performance (e.g. fewer repetitions) or worker characteristics (e.g. motivation) (Winkel et al. 1994).
For prevention of symptoms a proper analysis of work tasks and associated exposure to work related factors is necessary. Below, a step-by-step preventive approach to reduce exposure is given (see e.g. Dul et al. 1992):

- Analysis of problems
- Selection of solutions
- Implementation of solutions
- Evaluation of the effectiveness of the solutions

Step 1. Analysis of problems
An inventory is made of both risk factors and symptoms. After this, a priority ranking is made of all problems identified. Priorities are set on the basis of the inventory by all parties involved (employer, employees, experts).

Step 2. Selection of solutions
A more detailed analysis is carried out of high risk workplaces involving the largest groups of workers with the highest prevalence rates of symptoms, as identified in step 1. On the basis of this analysis, possible solutions are identified and – again – priorities are set which solutions will be selected first, based on feasibility and estimated effect on health and costs. Again, this selection is made by all parties involved (employer, employees, experts).

Step 3. Implementation of solutions
The solutions chosen in step 2 are implemented. When new solutions are called for, prototypes will be developed, tested and – if necessary – adjusted prior to implementation on a larger scale.

Step 4. Evaluation of the effectiveness of the solutions
In this final step, it is evaluated whether the solutions implemented achieved the goal: reduction of workload and musculoskeletal symptoms. This step indicates whether adaptations, refinements or additional measures are needed.

In this thesis the focus of interest lies on the first step of this preventive approach. In daily practice, it is often difficult to decide where to start prevention, since musculoskeletal problems are widespread and resources are often too limited to address all problems at once. Therefore, the management has to prioritise budget allocations to reduce musculoskeletal problems as effectively as possible. This applies to policy making in companies and company departments, but also at the more aggregated levels e.g. of industrial branches or the government. At all those levels, priorities have to be set concerning sectors which require interventions, given the levels of risk factors and work related morbidity.
Experiences in daily occupational health care settings indicate that employers often demand quantitative data to support any investment decisions to optimise the employability of their

workforce. In addition, the professionals involved often want to verify their personal findings or intuition, and present more convincing 'evidence' to their company's decision makers.
This implies that an instrument is needed in the decision making process to quantify to some extent both work related risk factors and musculoskeletal morbidity in worker groups. However, both are not easily measured in a valid way (Hagberg 1992). Several more or less sophisticated methods are available to measure and quantify musculoskeletal workload (Hagberg 1992, Lavender et al. 1998, Marklin et al. 1999), but only few are applicable in daily practice of occupational health services. In addition, most of symptoms (for back pain more than 95%) lack demonstrable pathology, even when in-depth and extensive diagnostic procedures are applied (Frank et al. 1995).

1.3 An instrument to set priorities

The instrument necessary to obtain data to set priorities has to meet certain prerequisites, given the context of use and users (occupational health professionals). It has to be valid, feasible, and practical (Van Dijk et al. 1993). Instruments for detailed measurements (postures, movements and force exertions) such as observation methods or inclinometry are complicated, time-consuming and expensive, in particular when large worker groups are involved and highly skilled professionals are needed for reliable measurements and data analysis (Punnett et al. 1987). A questionnaire may be an attractive screening tool, when used as inexpensive 'proxy measurement' of biomechanical exposures (Frank et al. 1995). It is capable to collect information on a versatility of different exposure variables (Winkel et al. 1994) and may be used to gather data on cumulative exposure over longer periods (Kilbom 1994, Torgèn et al. 1999). It also has the advantage of providing not only data on exposures to work related factors, but also on associated health symptoms, and on suggestions for improvement given by workers themselves. Measurement of not only risks but also of potential health-effects is indicated as long as the precise relation between exposure to physical workloads and the occurrence of musculoskeletal symptoms is inconclusive. Besides, employers are notably more often impressed by health related data than by work related data. A questionnaire has also the advantage that both exposures and effects can be measured at same time with the same instrument without entailing systematic errors (Kuorinka and Kilbom 1990, Wiktorin et al. 1999), although symptoms may cause a differential bias for some exposures (Wiktorin et al. 1993, Viikari-Juntura 1996).
Although exposure can hardly be measured in detail with a questionnaire (Wiktorin et al. 1993), the information gathered may be sufficient to identify groups exposed to more hazardous working conditions. Just that is the goal in the first step towards prevention. Subsequently, a more laborious detailed ergonomic analysis providing more quantitative data may be restricted to subsets of workers and workplaces identified as potentially hazardous in the first screening (Buckle 1987). This approach will save a lot of time and money.
The assessment of work related musculoskeletal morbidity by a questionnaire also has its limitations: only self-reported symptoms are measured. However, other instruments (including thorough clinical evaluations using modern sophisticated measuring instruments) that can classify cases into well-defined clinical syndromes and predict future course are hard to find (Frank et al. 1995), which makes this drawback seems less relevant.
Using a questionnaire offers another advantage: it ensures participation of the workers even in the preliminary phase of the preventive approach towards workplace improvement. Therefore, the use of a questionnaire fits very well into a participatory approach of ergonomic problems. Experiences with the participatory ergonomics (Haines & Wilson 1998) show that the quality of the process and

the results is enhanced (better ideas and more successful implementation), as it involves workers and other stakeholders.
An additional advantage of the use of a standardized questionnaire is the possibility to create a consolidated database, which can be used as a reference database. This is an important aspect, since reference-data are necessary to interpret findings in a particular worker group as well as to allow comparisons within and across industries (Buckle 1987, Dickinson et al. 1992). In addition, such a database provides the possibility to carry out secondary analyses and explore more general questions on the relation between work related and individual related risk factors and morbidity.

1.4 Study objectives

The objective of this thesis is to describe and apply a questionnaire for the identification of work related musculoskeletal risk factors and morbidity, feasible in daily practice of occupational health services. This questionnaire should:

- Enable quick and easy data collection without violating basic methodological requirements.
- Establish a broad and clear overview of relevant work related and individual related risk factors and symptoms.
- Enable the use of simple concepts, comprehensible for the management and workers.
- Supply a quantitative basis for the setting of priorities.
- Ensure worker participation from the beginning.

Van Dijk et al. (1993) discussed the quality of occupational health services' methods and instruments. First the measurement object and the measurement design have to be named. Next, the quality of instruments for occupational health services can be assessed using four categories of criteria:

(1) Measurement object and design,
(2) Technical quality
(3) Process quality and
(4) Strategic quality.

Measurement object and study design of the DMQ are defined by the instrument's goal, e.g. data collection as the first step in the preventive approach. The object is thus musculoskeletal workload and symptoms, including a wide range of loads and body regions in a standardized, but not workplace specific way. The instrument addresses specific worker groups which are possible at risk. Aggregation of individual data is possible at meso level (task group, department, company) or macro level (branch, occupational group, national), depending on the level of detail required to suite the companies' or branche organisations' preventive strategy.
An instrument's *technical quality* implies aspects like validity, reliability, standardization, and precision. At the start of this study, no instruments were available which could satisfy all of those aspects. The only standardized instrument available was the 'Nordic questionnaire for the analyses of musculoskeletal symptoms' (Kuorinka et al. 1987). However, this instrument measures only musculoskeletal symptoms, not musculoskeletal workload. The Dutch Questionnaire on Work and Health (VAG, De Winter & Gründemann 1991) was available for measurement of workload factors, but this instrument does not address musculoskeletal loads specifically, nor does it contain questions on musculoskeletal symptoms. Neither of the above mentioned instruments contained a task specific part, or allowed worker interaction. Hence, a questionnaire fulfilling the prerequisites formulated above, had to be developed anew, and its technical quality assessed.
The *process quality* of an instrument deals primarily with its acceptability by employees, employers and professionals. Here, the deployment of a questionnaire as a measuring instrument

has its advantages: it is safe, non-invasive, easy to administer and to complete, costs are low, and it does not disturb the production process. In addition, a questionnaire is a well known instrument in daily practice of occupational health services. However, expertise and time are needed, particularly for a professional analysis of the obtained data.

The last criterion involves the *strategic quality* or presumed utility, e.g. the amount to which the instrument is policy orientated. By incorporating the survey in the preventive approach described in 1.4, the instrument will automatically contribute to the decision making process. In addition, it should be possible to aggregate data collected with the questionnaire in surveys in order to explore more general questions on the relation between specific work related factors and musculoskeletal symptoms.

This thesis addresses (1) the technical quality of the instrument, (2) the application of the instrument on macro and meso levels, and (3) the strategic use of the instrument, e.g. the exploration of the role of specific risk factors.

1.5 Content of this thesis

The first part of this thesis (Chapters 2-4) focuses on some aspects of the technical quality of the DMQ. The second part describes the application of the DMQ in selected worker populations to identify risk groups and groups with high morbidity rates at meso and macro levels (Chapters 5-6). The third part describes three analyses of questionnaire data on the role of specific risk factors (Chapters 7-9).

In Chapter 2 the most interesting characteristics of the questionnaire are evaluated, e.g. convergent, divergent and concurrent validity as well as discriminative power. Chapters 3 and 4 describe a tentative, explorative analysis of the criterion validity of self-reported data on musculoskeletal workload and low back symptoms. from a methodological point of view.

Chapter 5 describes a macro level survey in agriculture to identify branches in highest need of intervention. Chapter 6 describes a similar study, at meso –level, of departments and task groups in a large steel company. The aim of this part of the thesis is to explore the possibilities and limitations of the DMQ at different levels of the working population.

In Chapter 7 a secondary analysis of national survey data is explored to pinpoint the relation between work (operationalized as occupation or trade) and low back symptoms. Although this study was not carried out with the DMQ, it involved self-reported data on back symptoms, comparable to the DMQ. In Chapters 8 and 9 the data obtained in a number of surveys with the DMQ are utilized to explore relations between musculoskeletal symptoms and two possible risk factors. Two factors have been chosen which are often associated with musculoskeletal symptoms, but on which little scientific information has been available so far. In Chapter 7, it is explored whether climatic factors (e.g. draught, outdoor work) influence the prevalence rates of low back and neck-shoulder symptoms. In Chapter 8, the question is raised whether physical (in)activity is associated with high prevalence rates of low back and neck-shoulder symptoms. The aim of this part of the thesis is to explore the possibilities and limitations of secondary analyses of the DMQ-database.

Chapter 10 comprises the general discussion, conclusions, and recommendations.

1.6 Point of view

Before proceeding, it is important to emphasize that this research project has been steered primarily from a practical angle, and has been scientifically ‘encapsulated’ in a second stage. This means that the instrument has been developed on the basis of existing knowledge and instruments, and has been tested in practice on different 'levels' before its methodological characteristics were studied in detail. Based on the experience acquired during the field tests and the methodological evaluation, the instrument has been revised to take its final version. In order to facilitate the use of the DMQ in practice, where time constraints are often a major barrier for a systematic preventive approach, software was developed for data input, data analysis, and presentation of results. This software can be seen as a major practical revenue of this thesis, available to practitioners, students and researchers for free, which will enhance acceptability and use of the DMQ by professionals. A beta-version of this software-program (called Loquest) is attached to this thesis on a CD-Rom.

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2. The DMQ: description and basic qualities[1]

1 Submitted as: Hildebrandt VH, Bongers PM, Van Dijk FJH, Kemper HCG, Dul J. The Dutch Musculoskeletal Questionnaire for the measurement of musculoskeletal workload in worker groups: description and basic qualities.

Abstract

Objectives

A questionnaire ('Dutch Musculoskeletal Questionnaire', DMQ) for the analysis of musculoskeletal workload and associated potential hazardous working conditions as well as musculoskeletal symptoms in worker populations is described and its qualities are explored using a database of 1,575 workers in various occupations who completed the questionnaire.

Methods

Assessment of the convergent, divergent and concurrent validity of the questionnaire

Results

63 questions on musculoskeletal workload and associated potentially hazardous working conditions can be categorized to seven indices (force, dynamic and static load, repetitive load, climatic factors, vibration and ergonomical environmental factors). Together with four separate questions on standing, sitting, walking, and uncomfortable postures, the indices constitute a brief overview of the main findings on musculoskeletal workload and associated potentially hazardous working conditions. Homogeneity of the indices has been found to be satisfactory. The divergent validity of the indices is fair compared with an index of psychosocial working conditions and discomfort during exposure to physical loads. Worker groups with contrasting musculoskeletal loads can be differentiated on the basis of the indices and other factors. With respect to the concurrent validity, it appears that most indices and factors show significant associations with low back and/or neck-shoulder symptoms.

Conclusions

This questionnaire can be used as a simple and quick inventory for Occupational Health Services to identify worker groups in which a more thorough ergonomic analysis is indicated.

Keywords: Questionnaire; musculoskeletal workload; musculoskeletal symptoms; validity

2.1 Introduction

In daily practice, Occupational Health and Safety Services and ergonomic consultancies in companies often have to advise management on interventions to reduce musculoskeletal workload and related disorders. Because such interventions can have a great impact on the company, a proper analysis is essential to select the most hazardous situations, which require ergonomic interventions. Time and resources to carry out comprehensive studies are often lacking. Therefore, occupational physicians, nurses, hygienists and ergonomists need simple and quick methods to obtain relevant information on work related factors that contribute to the musculoskeletal workload and related disorders. On the basis of such screening, priorities can be set which worker groups or workplaces should be addressed in a more thorough ergonomic analysis. Since a detailed measurement of musculoskeletal workload (postures, movements and force exertions) by direct methods like observations or inclinometry is complicated and time-consuming when large worker groups are involved and skilled analysts are needed for reliable measurements (Buckle 1987, Kilbom 1994, Winkel et al. 1994, Hagberg 1992), there is a need for simple screening instruments for identifying groups of workers at risk (jobs, departments, tasks etc.), such as checklists (Keyserling et al. 1992), rating of physical job requirements Buchholz et al. 1996), surveys (Bishu 1989) or periodic surveillance (Weel et al. 2000). Although the quantification of the absolute exposure levels has its limitations using these methods, the information gathered can be sufficient to rank groups according to their levels of exposures (Burdorf 1999). Subsequently, a more laborious detailed ergonomic analysis can be restricted to those workers and workplaces, which are identified as potentially hazardous during the first screening. A questionnaire as screening instrument has the great advantage that it yields not only exposure data, but also information on associated health symptoms and on ideas of workers themselves regarding possibilities for improvements. For high symptom rates are also important besides high workload when setting priorities for further analyses and development of solutions. In addition, participation of the workers is ensured and thus the use of such a questionnaire fits very well into a participatory approach to ergonomic problems (Vink et al. 1992).

TNO (Netherlands Institute for Applied Scientific Research) developed a questionnaire (called the 'Dutch Musculoskeletal Questionnaire', DMQ) for measuring of self-reported musculoskeletal workload and other associated hazardous working conditions as well as related symptoms. This article addresses the most important aspects of the validity of this measuring instrument:

- Is the questionnaire able to constitute a clear-cut description of a particular worker population by a limited number of indices for different types of workloads (convergent validity)?
- Do these indices show a relatively low correlation with indices that measure a different adjacent concept, such as psychosocial working conditions and an index of reported discomfort due to musculoskeletal load (divergent validity)?
- Is the questionnaire able to identify worker groups with relative high workload or other unfavourable working conditions (discriminative power)?
- Do the indices show a significant association with musculoskeletal symptoms, indicating that exposure to that load constitutes a risk of symptoms for the exposed workers (concurrent validity)?

The criterion-validity of the questionnaire with respect to the measurement of musculoskeletal workload and symptoms will be addressed elsewhere (Chapter 3 and 4). This paper is restricted to the convergent-, divergent and concurrent validity of the questionnaire.

2.2 Methods and material

2.2.1 The DMQ

The standard version of the questionnaire consists of nine pages with around 25 questions per page, to be filled in by the workers themselves. Completion-time is around 30 minutes. There is also a short version (four pages) and an extended version (14 pages) available. The following sections are distinguished:

- Background variables (e.g. age, gender, education, duration of employment, work history, shift work);
- Tasks (prevalence rates and perceived heaviness of task demands);
- Musculoskeletal workload (postures, forces, movements);
- Work pace and psychosocial working conditions (demands, control and autonomy, work organisation and social support, work satisfaction) since these factors may play an important role for workers with musculoskeletal disorders (Bongers et al. 1993, Hoogendoorn et al., submitted);
- Health, in particular musculoskeletal symptoms; the phrasing of questions on prevalence is comparable with the 'Nordic questionnaire on musculoskeletal disorders (Kuorinka et al. 1987), including the definition of areas of the body pictorially; in addition, the extended version contains more detailed questions on the nature and severity of these symptoms;
- Lifestyle (e.g. sports, smoking) (in the extended version of the questionnaire only);
- Perceived bottlenecks and ideas for improvements suggested by the workers themselves (optional).

To enable experts to work with this questionnaire easily, we developed a software-package (LOQUEST) for data entry, data analysis and auto-report of the main results.

The basic concept behind the questionnaire is a simple representation of the relation between work tasks and musculoskeletal symptoms (Dul et al. 1992, Paul 1994). Work related musculoskeletal symptoms are explained by a high internal physical load, caused by postures, movements and force-exertions needed in the work tasks. Other factors, such as other working conditions, individual factors (gender, age), psychosocial aspects or lifestyle can influence these relationships on different levels. All these elements are measured in the different parts of the questionnaire.

To ensure an optimal content validity of the questionnaire, the choice of variables to be measured was based on available reviews of the epidemiological literature (Hildebrandt 1987, Walsh et al. 1989, Stock 1991, Riihimäki 1991). These reviews identified a large number of potentially harmful postures, movements, force-exertions and other potentially hazardous working conditions, which are still valid at the present time (Bernard 1997, Ariëns 2000, Hoogendoorn 1999).

Musculoskeletal workload (postures, forces, movements) is addressed in 63 questions (see table 2 for the phrasing of the questions). These questions can be categorized into the following six types of potentially hazardous workloads and working conditions:

- Force exertions: lifting, carrying, bearing, pushing, pulling, pinching;
- Dynamic loads: walking, bending and twisting of trunk, neck, wrists, stooping, squatting, reaching;
- Static loads: sitting, standing, prolonged bent or twisted posture of trunk, neck or wrists, working with hands above shoulder level, kneeling or squatting posture;
- Peak loads: sudden, forceful movements, unexpected movements;
- Repetitive loads;
- Ergonomic environmental conditions: (1) climatic factors, (2) vibration, (3) limited working space (4) slipping and falling.

The questions are formulated in such a way that they indicate the presence or absence of exposure and not the amount of discomfort caused by the exposure, which is addressed in a separate part of the questionnaire. The precise formulation is based on several field studies where the preliminary versions of the questionnaire were used. The exposures addressed in the questions were not defined, explained or illustrated to limit the size of the questionnaire and the time need for completing it. No training was given on the completion of the questionnaire. Given the goal of the questionnaire - a quick but comprehensive survey - we decided to use mostly dichotomous answering categories (yes/no). This qualitative approach, without attempts to quantify frequency and duration of variables, was also chosen since the validity of quantitative approaches by questionnaire has been seriously questioned (Kilbom 1994, Winkel et al. 1994, Baty et al. 1987, Rossignol and Baetz 1987, Wiktorin et al. 1993, Viikari-Juntura et al. 1996, Kumar 1993). The completion of the questions as described above does generally not give any problems, even in less educated worker groups.

2.2.2 Study population

A group of 1,575 workers in 24 occupations, who completed the questionnaire during various studies, constitutes the population and database for the analyses. The occupations differ strongly with respect to musculoskeletal workload and associated hazardous working conditions, e.g. nurses (n=237), shipyard workers (n=186), office workers (n=93) and metal workers (n=69). Table 1 shows main descriptives of this worker population and the subgroups mentioned.

Table 1. Descriptive data on the total study population and four selected occupational groups within this population

	All n=1,575	Nurses n=237	Shipyard n=186	Office n=128	Metal n=69
Demographic factors					
Mean age (standard deviation)	35 (9.7)	34 (7.9)	37 (11.2)	37 (9.0)	32 (8.5)
Mean educational level (1=low, 5=high)	3.2	4.0	3.2	3.7	2.4
% male gender	61	12	100	34	80
Work					
% frequent uncomfortable postures	57	52	72	24	28
% frequent sitting at work	33	27	29	76	44
% frequent standing at work	66	63	83	4	78
% frequent walking at work	65	71	57	16	46

2.2.3 Analysis

The convergent validity was assessed by a Principal Component Analysis (PCA), used to construct a limited number of well-defined workload indices for different types of workloads, which enable a clear-cut description of a particular worker population. Varimax rotation was applied to ensure minimal correlation between the indices (see 'construction of indices' in 'results'). Homogeneity of the indices resulting from the PCA was assessed by computing Cronbach's alphas.

To explore the divergent validity of the indices, firstly the intercorrelation was computed between the seven indices and an index of psychosocial working conditions (sum of 35 questions on demands, control and autonomy, organisation and social support, work satisfaction). For a good divergent validity, the indices should show a relatively low correlation with indices, which measure a different adjacent concept, such as psychosocial working conditions. Next, the correlation between the indices of workload and an index of reported discomfort due to musculoskeletal load

was computed. The latter was constructed from 10 questions such as 'are you experiencing discomfort during sitting at work?'. These questions had to be answered regardless of the amount of exposure. The correlation can give an indication whether the reported exposure by the worker is severely biased by possible discomfort experienced by the worker during the exposure to this load.
To analyse whether the seven indices could differentiate occupational groups with contrasting workload, four specific subgroups (nurses, shipyard workers, office workers and metal production workers) were analysed. For a good discrimination, contrasts between these worker groups should be reproduced by differences in the means of the indices. Means and 95% confidence intervals of these indices were computed for each worker group according to a method described by Brand and Radder (1992), specifically developed for indices that consist of dichotomous variables. Differences between worker groups were considered significant ($p<0.05$) when the computed confidence intervals were not overlapping.
The concurrent validity was tested by assessing the relation of the indices (as independent variables) with musculoskeletal symptoms (as dependent variables) in a multiple logistic regression analysis on individual level (see 'concurrent validity' in 'results'). For a good concurrent validity, the indices should show a significant association with musculoskeletal symptoms, indicating that exposure to that load constitutes a risk of symptoms for the exposed workers. For this analysis, all indices were dichotomised into a low-exposure and a high-exposure level, with the cutting-point at 50% of the population analysed. Twelve-month prevalence rates of symptoms (pain, discomfort) of the low back and of the neck-shoulder area were taken as the measure of effect. These were measured with the same questionnaire (‘Have you <u>ever</u> had trouble (ache, pain, discomfort) from your …’). All the independent variables were included simultaneously in the model and were thus adjusted for the others. Age was entered in the model as a possible confounder. Estimated odds ratios (ORs) are presented as the measure of association. OR values greater than one indicate that the index is associated with a higher prevalence rate of symptoms and are considered statistically significant when the 95% confidence intervals do not include 1.

2.3 Results

2.3.1 Construction of indices

Table 2 shows the result of the Principal Components Analysis (PCA). Table 3 shows the tentative descriptions of the content of these factors. A 9 factor-model explained 52% of the total variance. From tables 2 and 3, it can be concluded that the PCA supports the types of workload formulated above upon the literature to a great extent: force exertions (represented mainly by factor 1), dynamic loads (represented mainly by factor 5, 8), static loads (represented mainly by factor 2 and 6), repetitive loads (represented by factor 4) and ergonomical environmental factors (represented by factor 3 and 7) can be distinguished. Only peak loads are not represented by a separate factor: they are represented by factor 5 (sudden, unexpected movements) as well as partly by some parts of factor 1 (sudden, forceful movements). Furthermore, dynamic and static loads are differentiated for trunk (factor 2 and 8) and neck-shoulder-arm (factor 5 and 6). Ergonomic environmental factors are differentiated into two factors (3 and 7), whereas vibration is not identified as a separate factor, but included in factor 6. Since walking, standing, sitting and uncomfortable postures are difficult to assign to one of the above-mentioned factors, it seems logical to consider these factors as four independent factors.
The PCA thus results in seven 'indices of workload and other working conditions' and four separate questions on standing, walking, sitting and uncomfortable postures. Table 3 shows the description,

content and homogeneity (measured with the Cronbach's alpha) of the indices and an overall index of musculoskeletal load (sum of all seven indices).
Six out of seven alpha's are above 0.80, which indicates a satisfactory average inter-item correlation.

2.3.2 Divergent validity

Table 4 shows the intercorrelations between the seven indices of workload and other working conditions, the four separate factors, the overall index of workload, an index of psychosocial working conditions (alpha 0.82), an index of reported discomfort due to musculoskeletal load (alpha 0.85) and age.
The correlation of the indices of workload with the index of psychosocial working conditions varies between 0.21 and 0.33 and is thus in most cases lower than the correlation between the indices of workload themselves, which vary between 0.26 and 0.74. Correlation of the workload indices with the index of reported discomfort due to musculoskeletal loads varies between .19 and .61 and is relatively high for the indices forces, dynamic and static loads. Correlation with age is low (varying between 0.01 and 0.17).
Table 4 also shows that correlations between the indices forces, dynamic and static loads are relatively high (between 0.59 and 0.74).

Table 2. Questions on workload, associated factor loadings and explained variance of 9 factors (principal components analysis with varimax rotation) as measured in the total study population (n=1,575). Only factor loadings above .39 are given in this table; all correlations are significant (p< .05)

Factor	1	2	3	4	5	6	7	8	9
Eigenvalue	15.3	4.9	3.4	2.2	1.7	1.7	1.5	1.5	1.3
Explained variance (%)	23.9	7.7	5.3	3.4	2.7	2.7	2.3	2.3	2.0
Do you in your work often have to:									
1-lift heavy loads (more than 5 kg)?	.76	.	.	.	.	.	.	.	.
2-pull or push heavy loads (more than 5 kg)?	.64	.	.	.	.	.	.	.	.
3-carry heavy loads (more than 5 kg)?	.67	.	.	.	.	.	.	.	.
Do you in your work often have to lift:									
4-in an awkward posture?	.77	.	.	.	.	.	.	.	.
5-with the load far from the body?	.64	.	.	.	.	.	.	.	.
6-with twisted trunk?	.69	.	.	.	.	.	.	.	.
7-with the load above chest-height?	.48	.	.	.	.	.	.	.	.
8-with a load that is hard to hold?	.60	.	.	.	.	.	.	.	.
9-with a very heavy load (more than 20 kg)?	.67	.	.	.	.	.	.	.	.
Do you in your work often have to:									
10-stand for a prolonged time?	.	.	.	.	.	.	.	.	.54
11-sit for a prolonged time?	.	.	.	.	.	.	.	.	-.64
12-walk for a prolonged time?	.	.	.	.	.	.	.	.	.61
13-stoop for a prolonged time?	.	.55	.	.	.	.	.	.	.
Do you in your work often have to:									
14-bent slightly with your trunk?	.	.	.	.	.	.	.	.60	.
15-bent heavily with your trunk?	.46	.42	.	.	.	.	.	.	.
16-twist slightly with your trunk?	.	.	.	.	.	.	.	.72	.
17-twist heavily with your trunk?	.	.52	.	.	.	.	.	.	.
18-bent and twist with your trunk?	.	.44	.	.	.	.	.	.46	.

Table 2 *continued*

Factor	1	2	3	4	5	6	7	8	9
Do you in your work often have to:									
19-work in a slightly bent posture for a prolonged time?	.	.49	.	.	.	.	.	.	.
20-work in a heavily bent posture for a prolonged time?	.	.70	.	.	.	.	.	.	.
21-work in a slightly twisted posture for a prolonged time?	.	.61	.	.	.	.	.	.	.
22-work in a heavily twisted posture for a prolonged time?	.	.74	.	.	.	.	.	.	.
23-work in a bent and twisted posture for a prolonged time?	.	.72	.	.	.			.	.
Do you in your work often have to:									
24-reach with your hands or arms?	.	.	.	.	.	.	.	.	.
25-hold your arm under shoulder-level?	.	.	.	.	.	.	.	.	.
26-hold your arm at or above shoulder-level?	.	.	.	.	.	.47	.	.	.
27-exert force with your hands or arms?	.47	.	.	.	.	.	.	.	.
28-make small movements with hands/fingers at a high workpace?	.	.	.	.44	.	.	.	.	.
Do you in your work often have to:									
29-bent your neck forwards?	.	.	.	.	.62	.	.	.	.
30-bent your neck backwards?	.	.	.	.	.	.54	.	.	.
31-twist your neck?	.	.	.	.	.59	.	.	.	.
32-hold your neck in a forward bent posture for a prolonged time?	.	.	.	.	.58	.	.	.	.
33-hold your neck in a backward bent posture for a prolonged time?	.	.	.	.	.	.59	.	.	.
34-hold your neck in a twisted posture for a prolonged time?	.	.45	.	.	.45	.	.	.	.
Do you in your work often have to:									
35-bent your wrists?	.	.	.	.	.51	.	.	.	.
36-twist your wrists?	.	.	.	.	.49	.	.	.	.
37-hold your wrist bent for a prolonged time?	.	.	.	.	.47	.44	.	.	.
38-hold your wrist twisted for a prolonged time?	.	.	.	.	.44	.45	.	.	.
Do you in your work often have to:									
39-work in uncomfortable postures?	.46.	.	.	.	.	.	.	.	.
40-work in the same postures?	.	.	.	.54	.	.	.	.	.

Table 2 *continued*

Factor	1	2	3	4	5	6	7	8	9
Do you in your work often have to:									
41-always make the same movements with your trunk?	.	.	.	.77	.	.	.	.	.
42-always make the same movements with your arms?	.	.	.	.86	.	.	.	.	.
43-always make the same movements with your wrists?	.	.	.	.85	.	.	.	.	.
44-always make the same movements with your legs?	.	.	.	.73	.	.	.	.	.
Do you in your work often have to:									
45-make sudden, unexpected movements?	.	.	.	.	.45	.	.	.	.
46-perform short, but maximal force-exertions?	.56	.	.	.	.	.	.	.	.
47-exert great force on tools or machinery?	.	.	.	.	.	.	.	.	.
Do you in your work often have:									
48-not enough room around you to perform your work properly?	.	.	.	.	.	.	.66	.	.
49-not enough room above you to perform your work without bending?	.	.	.	.	.	.	.52	.	.
Do you in your work often have:									
50-difficulty in exerting enough force because of uncomfortable postures?	.	.	.	.	.	.	.57	.	.
51-too few facilities to lean on during your work?	.	.	.	.	.	.	.53	.	.
52-trouble in reaching things with your tools?	.	.	.	.	.	.	.51	.	.
53-Do you sometimes slip or fall during your work?	.	.	.46	.	.	.	.	.	.
54-Do you often have to pinch with your hands during your work?	.	.	.	.	.	.	.	.	.
55-Do you in your work experience noticeable mechanical vibrations or	.	.	.	.		.54	.	.	.
shocks?	.	.	.	.	.	.55	.	.	.
56-Do you carry vibrating tools during your work?	.43	.	.57	.	.	.	.	.	.
57-Do you drive vehicles during your work?	.	.	.	.	.	.	.	.	.
58-Is your work physically very taxing?	..	..		.		.		.	
59-Do you in your work experience draughts, wind?	.	.	.74	.	.	.	.	.	.
60-Do you in your work experience cold?	.	.	.81	.	.	.	.	.	.
61-Do you in your work experience warmth?	.	.	.43	.	.	.	.	.	.
62-Do you in your work experience changes of temperature?	.	.	.72	.	.	.	.	.	.
63-Do you in your work experience humid air?	.	.	.69	.	.	.		..	.

Table 3. Name, content, Cronbach's alpha, mean score and standard deviation (SD) of seven indices and four separate questions (n=1,575)

	Name	Content	n*	alpha	mean**	SD
1	Force exertion	Lifting, pushing & pulling, carrying, forceful movements with arms, high physical exertion, lifting in unfavourable postures, lifting with the load away from the body, lifting with twisted trunk, lifting with loads above the chest, lifting with bad grip, lifting with very heavy loads, short force exertions, exerting great force on hands	13	.90	4.8	3.1
2	Dynamic loads	Trunk movements (bending and/or twisting), movements of neck, shoulders or wrists, reaching, make sudden and/or unexpected movements, pinching, working under, at, or above shoulder level	12	.83	5.9	2.7
3	Static loads	Light bent, twisted trunk posture, heavily bent, twisted trunk posture, postures of neck or wrists	11	.87	3.9	2.8
4	Repetitive loads	Working in the same postures, making the same movements with trunk, arms, hands, wrists or legs, making small movements with hands at a high pace	6	.85	4.8	3.4
5	Vibration	Whole-body vibration, vibrating tools, driving	3	.57	1.8	2.7
6	Climate	Cold, draught, changes in temperature, moisture	4	.84	4.8	4.0
7	Ergonomic environment	Available working space, no support, slipping & falling, trouble with reaching things with tools, not enough room above to perform work without bending	6	.78	3.1	3.0
	Sitting	Sitting often at work	1	-	-	-
	Standing	Standing often at work	1	-	-	-
	Walking	Walking often at work	1	-	-	-
8	Uncomfortable postures	Having often to deal with uncomfortable postures at work	1	-	-	-
	Overall-index	Indices 1-7	55	.95	4.5	2.3

* Number of questions. The maximum score equals the number of questions in the index and corresponds to a positive answer to all questions in the index. The higher the score, the higher the self-reported exposure.

** All indices are standardized on a maximum of 10 to enhance comparability.

Table 4. Correlation matrix of seven indices of musculoskeletal workload and associated potential hazardous working conditions (1-7) and four separate factors (8-11), the overall-index (12), psychosocial working conditions (13)[1], reported discomfort on musculoskeletal workload (14) and age (15) computed for the total study-population (n=1,575)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Force	-													
2	Dynamic load	.64	-												
3	Static load	.59	.74	-											
4	Repetitive load	.35	.52	.59	-										
5	Vibrations	.42	.26	.30	.33	-									
6	Climate	.44	.32	.40	.34	.48	-								
7	Ergonomic environment	.60	.48	.54	.37	.42	.47	-							
8	Standing	.39	.37	.43	.31	.13	.23	.29	-						
9	Sitting	-.10	-.06	.02	.14	.12	-.01*	.03*	-.12	-					
10	Walking	.32	.39	.24	.11	.10	.10	.18	.42	-.17	-				
11	Uncomfortable postures	.57	.55	.61	.25	.22	.32	.42	.24	-.06	.18	-			
12	Overall index	.82	.83	.87	.68	.48	.58	.71	.41	.03*	.28	.61	-		
13	Psychosocial working conditions[1]	.33	.27	.31	.29	.24	.21	.33	.12	.21	.05	.23	.41	-	
14	Reported discomfort	.51	.53	.61	.39	.19	.30	.45	.32	.02*	.18	.48	.61	.33	-
15	Age	.02*	.02*	.05	.06	.10	.17	.07	.03*	.08	.03*	.01*	.09	.08	.06

* not significant (P< .05)

[1] cluster of dichotomous questions on psychosocial work aspects; a higher score means more problems

2.3.3 Differentiation of worker groups

Figure 1a and 1b show the means of all indices and factors for the four selected worker groups (nurses, shipyard workers, office workers and metal production workers). No data on the index of repetitive loads for metal production workers

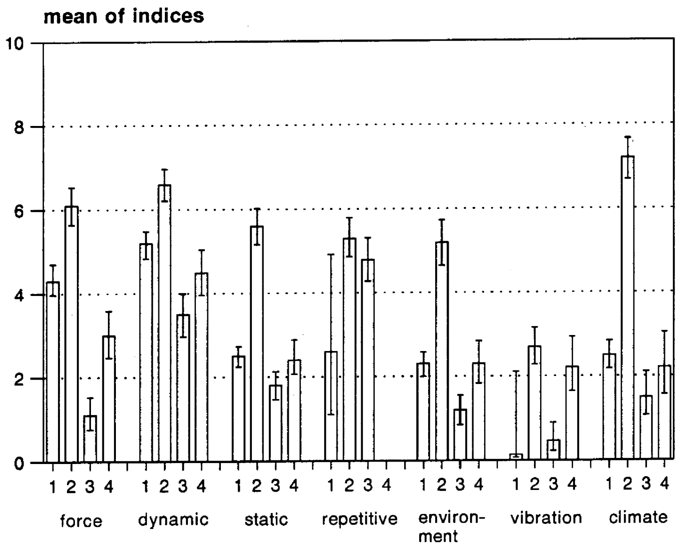

Figure 1a. Rates and 95% confidence intervals of self-reported exposure summarized in seven indices in four occupations (1=nurses, 2=shipyard workers, 3=office workers, 4=metal production workers).

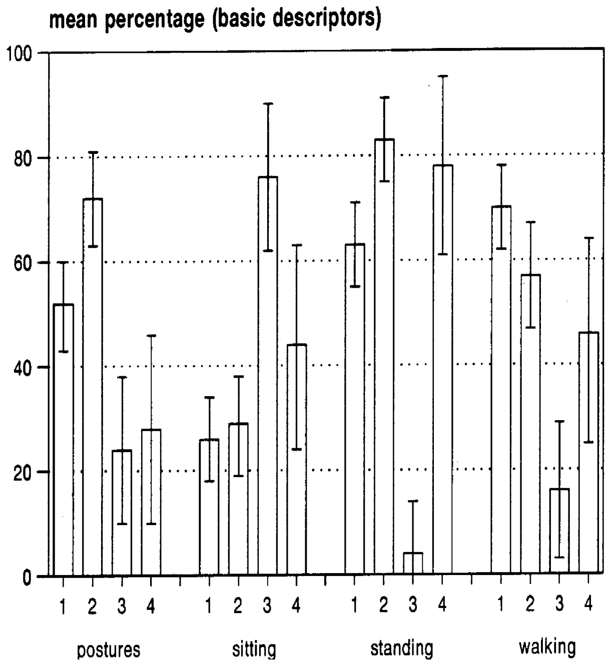

Figure 1b. Rates and 95% confidence intervals of self-reported exposure, to uncomfortable postures, sitting, standing and walking in four occupations (1=nurses, 2=shipyard workers, 3=office workers, 4=metal production workers)

The data show that worker groups can be differentiated: each group can be described specifically. Shipyard workers show the highest means of exposures to most indices and office workers the lowest (except for sitting, walking and repetitive loads).

2.3.4 Concurrent validity

Table 5a and 5b show the results of the multiple logistic regression for symptoms of the low back and neck-shoulder regions.

Table 5a. Estimated odds ratios (OR) and 95% confidence intervals (CI) by multiple logistic regression analysis of seven indices of workload and age on symptoms of low back and neck-shoulder (n=1,575)

	Low back		Neck shoulder	
	OR	95% CI*	OR	95% CI*
Forces	1.54*	1.17-2.02	1.09	0.82-1.43
Dynamic load	1.14	0.85-1.53	1.29	0.97-1.74
Static load	1.33*	1.02-1.76	1.23	0.94-1.62
Repetitive load	1.13	0.87-1.45	1.50*	1.16-1.92
Vibration	0.73*	0.55-0.96	0.72*	0.55-0.96
Adverse climate	0.89	0.68-1.18	1.09	0.83-1.44
Ergonomic environment	1.39*	1.06-1.83	1.17	0.89-1.54
Age	0.79*	0.63-1.01	1.18	0.93-1.48

* p < .05

Table 5b. Estimated odds ratios (OR) and 95% confidence intervals (CI) by multiple logistic regression analysis of uncomfortable postures, sitting, walking and standing and age on symptoms of low back and neck-shoulder (n=1,575)

	Low back		Neck shoulder	
	OR	95% CI*	OR	95% CI*
Uncomfortable postures	2.49*	2.00-3.08	1.95*	1.58-2.42
Standing	1.10	0.86-1.43	1.15	0.89-1.48
Sitting	1.10	0.87-1.40	1.22	0.98-1.52
Walking	1.06	0.84-1.34	.75*	0.57-0.92
Age	-.79*	0.63-0.98	1.23	0.99-1.53

* p<0.05

In particular high force exertion, high static loads, unfavourable ergonomic environmental conditions and uncomfortable postures are significantly associated with low back symptoms. High repetitive loads and uncomfortable postures are associated with neck-shoulder symptoms. Vibration shows again a reversed relationship, as does walking.

2.4 Discussion

2.4.1 Convergent validity

In theory, an instrument to identify risk groups with respect to musculoskeletal disorders with the aim to take effective preventive measures should contain only items, which show a prospective relation with musculoskeletal symptoms or sick leave due to musculoskeletal symptoms. Subsequent interventions in the high-risk groups identified should be effective with respect to the reduction of musculoskeletal morbidity and/or disability. Unfortunately, it appears to be very difficult yet to identify the items which show a prospective relation with musculoskeletal disorders or sick leave due to musculoskeletal disorders; recent reviews and epidemiological studies indicate that there are still many questions on the role – and particularly the quantitative importance - of relevant workload factors and intervening variables in the causation of musculoskeletal symptoms and disability (Kilbom 1994; Feuerstein et al. 1999), that only a small proportion of the total variance is explained (Frank et al. 1995), that there is still little evidence that elimination of ergonomically hazardous work reduces the number of disorders (Bernacki et al. 1999) and that our current knowledge on risk factors is largely based on studies with moderate-to-low quality scores (Viikari-Juntura et al. 1999). Nevertheless, recent systematic reviews do provide strong evidence for manual materials handling, bending and twisting and whole-body vibration and moderate evidence for patient handling and heavy physical work as risk factors for back pain (Hoogendoorn et al., 2000) as well as some evidence for the duration of sitting, twisting or bending of the trunk, neck flexion, arm force, arm posture, hand-arm vibration and workplace design as risk factors for neck pain (Ariens et al., 2000).

Insufficient or invalid exposure measurement may be a major explanation for the remaining gap in our knowledge (Winkel et al. 1994). As a consequence, we incorporated a large number of potentially harmful postures, movements, force-exertions and other potentially hazardous working conditions, which are believed to be important risk factors on the basis of anatomical, physiological, biomechanical, psycho-physiological or ergonomical findings, despite lacking epidemiological evidence. This was also reason to perform an explorative factor analysis, since it would have been difficult to formulate explicitly a fixed number of factors and expected allocation of items. Nevertheless, the factor analysis confirmed to a large extent the concept that formed the basis for the generation of the questions. Force, dynamic and static loads, repetitive movements and ergonomic environmental factors were identified as separate entities. It should be noted that the correlations between most factors stayed rather high, but this could be expected since all factors are based on self reported data and most working situations are characterized by combinations of exposures rather than one homogeneous exposure. Further aggregation of indices with high intercorrelations was considered inappropriate, since it would merge characteristics of the work which are really different from an ergonomically point of view.

Since the factor 'ergonomical environment' contained several, quite different entities, it was decided to distinguish three factors: poor climate, vibration and ergonomic environment *sensu stricto*, the last factor representing in particular space constraints leading to unfavourable postures. Furthermore, some important factors, which describe elementary postures or movements (standing, walking, sitting) or uncomfortable postures, appeared to be quite independent from the other indices and were therefore considered as separate factors. ‘Uncomfortable postures’ measures probably discomfort instead of exposure, which explains its added-value with respect to the indices of physical loads.

2.4.2 Divergent validity

An important question about the usefulness of the DMQ in ergonomic practice is whether the indices measure actual musculoskeletal workload and not other work dimensions, such as psychosocial work factors or reported discomfort. The correlation of the indices with the index of psychosocial working conditions is rather low but significant (around 0.30) and shows thus some degree of association but at the same time also a substantial degree of divergence (a fair divergent validity). The significant correlations (between .19 and .61) of the musculoskeletal workload indices with the index of reported discomfort indicates an association between the report of exposure and the presence of discomfort due to the exposure; this underlines the importance of differentiating as far as possible between self-reported exposures and self-reported discomfort during exposures. Literature is somewhat conflicting on the question whether self-reported exposures are biased by discomfort during these exposures or the presence of musculoskeletal symptoms. Some studies indicate such a relation (Ryan 1989), while others do not (Riihimaki et al. 1989). Given the quite strong correlation between those two dimensions found in this study, the conclusion seems justified that the indices are able to measure exposure to musculoskeletal workload and associated potentially hazardous working conditions only to a certain extent: one has to be aware that the reported exposures may be influenced by reported discomfort, at least at an individual level.

By using PCA with varimax rotation, independence of resulting factors was assured, but this was partly undone by subsequent alterations of the factors to define the ultimate indices: the resulting intercorrelations between the indices are fairly high in some cases, but they show enough unexplained variance to be considered as separate dimensions of musculoskeletal workload and associated potentially hazardous working conditions (a fair convergent validity).

2.4.3 Identifying worker groups at risk

The analysis in the four subgroups with contrasting workloads showed that worker groups with contrasting workloads could be identified. This is an essential feature in accordance with the intended use of the questionnaire: identifying high-risk groups. However, it is obvious that the questionnaire cannot differentiate between worker groups with insufficient contrast in workload. In addition, the differentiation will always be ‘relative’ (ranking groups relative to each other), since no criteria can be formulated as yet to define ‘high’ and ‘low’ exposures on the basis of the qualitative data of a questionnaire.

It is well established that job title is generally a poor proxy for describing exposures to ergonomic risk factors and that variance can be high within a job title (Li & Buckle 1999; Hagberg 1992, Burdorf 1992). Thus the associations found between the indices and other measures are probably an underestimation of risks, since the involvement of really homogeneous worker groups would probably result in a better differentiation.

2.4.4 Concurrent validity

As has been expected on the basis of the literature, most indices show associations with the symptoms, indicating the relevance and predictive validity of the indices in varying worker groups. In particular 'uncomfortable postures' shows relatively high odds ratios, both for low back symptoms and for neck-shoulder symptoms. Since ‘discomfort’ may be regarded as an early manifestation of symptoms or disorders, the high odds ratios could be expected. Nevertheless, in

addition to the independence of this indicator from the other indices, this suggests that this indicator might be a very relevant variable for the differentiation of worker groups.
All associations are in agreement with the literature, with the exception of the negative association between vibration and symptoms for both the low back and neck-shoulder, which is difficult to explain, since whole body vibration is considered as a major risk factor for these symptoms (Bovenzi and Hulshof 1999). Exposure to vibration is limited to a few specific worker groups (e.g. metal workers, shipyard workers) with specific exposures to hand-arm vibration and possibly a (healthy worker) selection effect in these groups should explain at least partly this finding.
The strength of the (cross-sectional) associations found is in agreement with other studies (Hagberg 1992, Riihimäki 1989, Tsai et al. 1992) and is well founded considering the prevalence measure used and the high prevalence rates of symptoms in the unexposed groups.

2.5 Conclusions

The DMQ enables a global assessment of musculoskeletal workload and other potentially hazardous working conditions by seven homogeneous indices (forces, dynamic loads, static loads, repetitive loads, climatic factors, vibration and ergonomic environmental factors) and four separate factors (standing, walking, sitting, uncomfortable postures). With these indices, worker groups with contrasting musculoskeletal workloads and associated potentially hazardous working conditions can be differentiated. Most indices show significant associations with low back and/or neck-shoulder symptoms. These indices can therefore be used as one of the means to identify risk groups and can supply experts in occupational health and safety services and ergonomic consultancies with data for making priorities concerning ergonomic improvements in worker groups.

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3. Validity of self-reported musculoskeletal workload

Abstract

Objectives

Questionnaires are frequently used to study the prevalence rate of musculoskeletal symptoms and associated workload in worker populations. In this paper, we analyse whether it is possible to obtain a valid ranking of worker groups with respect to exposure to workloads on the basis of self-reported data.

Methods

The study population (n=74) consists of four homogeneous worker groups with varying workload exposures (VDU workers, office workers, dispatch workers and assembly workers). Self-reported exposure to movements and postures of the trunk (bending and twisting) is measured by a questionnaire. From observations of videotapes of workers during their main tasks, the frequency and the duration of postures in different trunk flexion and rotation angle-categories were computed for the four groups.

Results

With both methods, the same groups with the highest exposures are identified. Simple qualitative questions seem sufficient. Workers with low back symptoms report higher exposure rates than workers without symptoms doing the same kind of work.

Conclusions

The results suggest that this questionnaire can be used validly to identify high-risk groups for which intervention is most necessary in worker populations when groups are relatively homogeneous and contrasting with respect to musculoskeletal workload. Simple qualitative questions are sufficient. Caution is needed when questionnaires are used to assess individual exposure or dose-response relationships in epidemiological research.

Keywords: Self-reported musculoskeletal workload; validity; posture observation

3.1 Introduction

In occupational health care and ergonomic practice, priorities must often be made in deciding where to start interventions to reduce musculoskeletal loads in a particular company or worker group. A questionnaire (called 'Dutch Musculoskeletal Questionnaire', DMQ) was developed to identify high-risk groups with respect to musculoskeletal load and musculoskeletal symptoms. We carried out a study to explore whether self-reported data from the DMQ on musculoskeletal loads are valid for the identification of high-risk groups among worker populations.

In the past years, several studies have been published on the validity of using self-reported data to assess exposure to workload in epidemiologic studies (e.g. Baty et al. 1986; Rossignol et al. 1987, Jakobsson 1993; Viikari-Juntura et al. 1996; Pope et al. 1998; Neumann et al. 1999). Results seem to be rather contradictory: both under- and overestimation as well as congruity between self-reported and measurement data for different postures and movements are published. Validity seems the best at a dichotomous level and seems worse at a more detailed level involving frequency and duration of exposures (Wiktorin et al. 1993). In all, it seems doubtful whether self-reported exposure data can be used to establish an individual exposure-dose (Winkel et al. 1994; Frank et al. 1995).

Although questionnaires may thus not be very appropriate for quantifying the musculoskeletal load of individual workers, they may be useful on a group level (Burdorf 1999). The DMQ was developed primarily to compare different occupational groups with respect to exposures to musculoskeletal loads. For this particular purpose, it is important whether group findings can be validly used to rank groups with respect to workload. Although estimations of self-reported exposure may display too much variation on the individual level, aggregating such estimations on a group level and comparing them with other groups without paying too much attention to the absolute figures, may give a valid ranking of groups if the contrast between groups with respect to physical loads as well as the size of groups is not too small. This would offer a practical method to identify groups at high risk for which intervention is most necessary.

However, no data are available yet to answer the question whether self-reported data are valid for identifying differences between worker groups with respect to workload. To obtain some indications, a pilot-study was carried out to address three questions. Firstly, we analyse whether it is possible to obtain a valid ranking of groups of workers with respect to physical workload on the basis of the DMQ data by comparing a ranking of worker groups based on questionnaire data with a ranking based on observational data. Since questionnaires should be short and clear-cut in order to be feasible in ergonomic practice, the second question is whether simple, quick and easy to answer questions suffice for ranking worker groups. The third question in this study addresses the potential association between the actual presence of musculoskeletal symptoms and the self-reported exposure by workers. Such an association could influence the ranking between worker groups if symptoms are not equally distributed among those groups.

3.2 Methods and material

We selected four worker groups with contrasting musculoskeletal workload in terms of postures, movements and force exertions:

I. VDU workers, working at VDU's the entire working day (n=32),
II. Office workers, doing all sorts of regular office work (n=22),
III. Dispatch workers, occupied with manual handling (n=20),
IV. Assembly workers, sitting and standing at workbenches (n=20).

Thus two sedentary occupations participated, one with fixed postures performing work at Video Display Units (VDU) (group I) and one with more variable postures performing various office work tasks (group II) and two industrial groups, one with a primarily dynamic workload and force exertions (group III) and one with a more static workload without force exertions (group IV).

These groups were selected from companies affiliated to two occupational health services on the basis of expected high homogeneity of exposure to musculoskeletal loads (within a day and between days); all workers were active in this job for at least 6 months. Group sizes were restricted since it appeared to be very difficult to find groups of workers of sufficient sizes who performed exactly the same kind of work. Homogeneity of the study groups was assessed by the occupational physicians in consultation with the workers themselves and the management.

The exposure of these groups was measured using (1) an extended version of the DMQ and (2) observations of working postures from video images of the tasks.

The DMQ deals with a broad range of factors, which may be related to musculoskeletal problems at the workplace. Questions on exposure to musculoskeletal load include a large range of work related load factors, which have been identified as potential risk factors for low back pain. Out of these, four questions were chosen which represent important trunk movements and postures:

- 'Do you often have to bent your back while working'? (yes/no)
- 'Do you often have to twist your back while working'? (yes/no)
- 'Do you often have to work for a prolonged period with a bent back'? (yes/no)
- 'Do you often have to work for a prolonged period with a twisted back'? (yes/no)

These questions had to be answered by a simple yes or no. To answer the second question of this study, more quantitative questions on frequency and duration of these postures and movements were added to the questionnaire (see table 5).

For the observational data, an analysis was made by two observers of 2D-video images in the sagittal plane of one worker in each group during the conduct of the daily tasks. This worker was selected in consultation with the workers, the management and the occupational physician in such a way that he could be considered 'representative' for the job involved. By observing an additional 1 to 3 workers in each group (the number depending on the variety of tasks) checks were made to verify that the observations of the 'representative' worker differed only slightly from the others.

The worker was observed over a period of 20 minutes, chosen in such a way that an extrapolation of the pictures would result in a valid impression of movements and postures during a whole working day.

The following variables were calculated to characterize trunk movement:

- Frequency of trunk flexion (five categories of flexion angle: less than 10, 11-30, 31-60, 61-90, more than 90 degrees);
- Frequency of trunk rotation of more than 20 degrees.
- All measurements were extrapolated to one hour and next to an eight-hour working day.

To characterize posture the following calculations were made:

- Total duration of trunk flexion in the five categories of flexion angles (% of working day);
- Frequency of trunk flexion in the five categories of flexion angles in three classes of duration: <5 seconds, 5-9 seconds, >9 seconds;
- Total duration of trunk rotation of more than 20 degrees (% of working day);

- Frequency of trunk rotation of more than 20 degrees in three classes of duration: <5 seconds, 5-9 seconds, >9 seconds.

Since the observations were carried out by two observers, a thorough training was given until the interobserver agreement with respect to the frequency and duration of trunk positions was 90% or more. A 3-day training did result in an absolute deviation of observations of trunk inclination from photographs of 5 degrees on average in comparison with very accurate opto-electronic measurements. Pearson correlation coefficient between two observators was 0.98 and between repeated observations 0.98 and 0.99 for both observers. Intra-class reliability coefficient 23 of these observations was 0.98.

In the analysis, we studied whether both methods identified the same group(s) at high risk, both for the simple qualitative questions and for the detailed quantitative questions. For each group mean percentages of affirmative answers were calculated from the questionnaire. From the observational data, frequency of movement and duration of posture were calculated for each group. The five categories of flexion angles were summarized in three categories (0-10, 11-60, >60).

The influence of the presence of low back symptoms on self-reported exposure to back loads has been assessed by stratification of the cross-tabulations and tested for significance by a chi-square test. A p-value of 0.05 was taken as acceptable level of significance (two-sided). Given the aim of the pilot-study (explorative) and the limited number of workers in each group, no other statistical tests were carried out.

3.3 Results

The response rate to the questionnaire was 75%. On the basis of the task descriptions reported by the workers, respondents with other tasks than those observed were excluded (n=20). Mean age of the remaining workers in all four groups was around 31 years (ranging from 29 to 33 years). 74% of the VDU workers and 59% of the office workers were females; dispatch and assembly workers were all males. Prevalence rate of low back symptoms during the past 12 months was 53% (VDU workers), 47% (office workers), 77% (dispatch workers) and 55% (assembly workers).

3.3.1 Comparison of observational and questionnaire data

Table 1 shows the results of the questionnaire data on bending the trunk and table 2 shows the results of the video analysis with respect to trunk flexion.

Table 1. Results of questionnaire in four occupational groups with respect to trunk bending and bent posture

	VDU (n=31)	Office (n=17)	Dispatch (n=14)	Assembly (n=12)
• 'Often' bending	3	12	79	33
• 'Often' stooped posture	0	6	54	33
• 'Often' bent posture	52	35	23	25

Table 2. Results of observations in four occupational groups with respect to trunk flexion: frequencies and duration of changes of posture in the sagittal plane

	VDU	Office	Dispatch	Assembly
Frequency of bending (number of movements per hour and percentage of all movements per group)				
All movements	178(100)	243(100)	370(100)	380(100)
0-10 degrees	41 (23)	96 (40)	152 (41)	148 (39)
11-60 degrees	137 (77)	142 (59)	160 (43)	227 (60)
>60 degrees	0 (0)	5 (0)	58 (16)	5 (1)
Duration of bent posture (percentage of working day)				
0-10 degrees	6	39	70	42
11-60 degrees	95	60	15	57
>60 degrees	0	1	16	1
Frequency of static bent posture (>10 degrees) (number of movements per hour and percentage of all movements per group)				
All movements	137(100)	137(100)	212(100)	233(100)
<5 seconds	91 (66)	53 (39)	144 (68)	135 (58)
5-9 seconds	10 (7)	22 (15)	56 (26)	52 (22)
>9 seconds	36 (26)	62 (45)	12 (6)	46 (20)

The following conclusions can be drawn with respect to the ranking of the four groups:
Dispatch workers rank first according to the questionnaire-data with respect to bending the trunk and stooping postures, assembly workers rank second; this is reflected by the results of the observations: dispatch and assembly workers show the highest frequencies of posture changes, dispatch workers in the extreme categories (0-10, > 60 degrees), assembly workers in the mid category (10-60 degrees). However, the substantial difference between dispatch workers and assembly workers in the questionnaire was not observed.
Dispatch workers rank first with respect to stooped postures in the questionnaire; the observations show also that bends of more than 60 degrees are only found among the dispatch workers, who spend a relatively high percentage of the working time in these postures;
VDU workers rank first with respect to bent postures of the trunk in the questionnaire, which is observed too: VDU workers spend a relatively high proportion of the working day in a bent (>10 degree) position. Prevalence rate of static bent postures of more than 9 seconds is relatively high among office workers; dispatch workers show relatively few static bent postures of more than 9 seconds.
Table 3 shows the results of the questionnaire data on twisting the trunk and table 4 shows the results of the video-analysis with respect to trunk rotation.

Table 3. Results of questionnaire in four occupational groups with respect to trunk rotation and rotated posture

	VDU (N=31)	Office (n=17)	Dispatch (n=14)	Assembly (n=12)
• 'Often' rotation	45	18	69	27
• 'Often' rotated posture	13	0	33	9

Table 4. Results of observations in four occupational groups with respect to trunk rotation: frequencies and duration of changes of posture in the frontal plane

	VDU	Office	Dispatch	Assembly
Frequency of rotation (number of movements per hour); all movements	24	53	120	54
Duration of rotated posture (percentage of working day)	3	10	17	9
Frequency of static rotated posture (>20 degrees) (number of movements per hour and percentage of all movements per group)				
All movements	24 (100)	50 (100)	120(100)	54 (100)
<5 seconds	18 (75)	28 (56)	93 (78)	38 (70)
5-9 seconds	4 (17)	9 (13)	24 (20)	12 (22)
>9 seconds	2 (8)	13 (26)	3 (3)	4 (7)

The following conclusions can be drawn with respect to the ranking of the four groups:
Dispatch workers rank first in reporting rotating and rotated postures, which is reflected by the observations: dispatch workers rank first with respect to the frequency and duration of rotations.
VDU workers rank second with respect to rotation of the trunk in the questionnaire, which is not reflected by the observations: VDU workers rank last with respect to the frequency and duration of rotations; prevalence rates of static rotated postures of more than 9 seconds are relatively high among office workers.

3.3.2 Qualitative versus quantitative questions

Table 5 shows the results of the various kinds of questions on trunk flexion.

Table 5. Results of quantitative questions on trunk flexion in four occupational groups (percentages)

	VDU (n=31)	Office (n=17)	Dispatch (n=14)	Assembly (n=12)
Frequency of bending				
<10 times a day	97	77	0	10
10-25 times a day	0	24	29	42
25-50 times a day	0	0	21	8
>50 times a day	3	0	50	8
Tasks which require bending				
<2 hours a day	97	100	21	83
2-4 hours a day	0	0	14	5
4-6 hours a day	0	0	21	0
>6 hours a day	3	0	43	17
'Often' bending	3	12	79	33
Mean number of hours bending	0.1	0.2	4.9	2.2

From table 5, it appears that detailed questions on the frequency and duration of movements and postures result in approximately the same ranking of groups as simple qualitative questions, thus constituting no added value in differentiating worker groups. Comparing these data with the data of table 2, it appears that the association of the self-reported quantitative data with the observational data is in general rather small.

3.3.3 Influence of symptoms on the self reporting of workloads

A significant relation was found between the prevalence rates of low back symptoms and prevalence rates of self-reported bending and twisting movements as well as bent and twisted postures. Figure 1 shows self-reported bending (figure 1a) and rotating (figure 1b) of the trunk in each occupational group, stratified by low back symptoms.

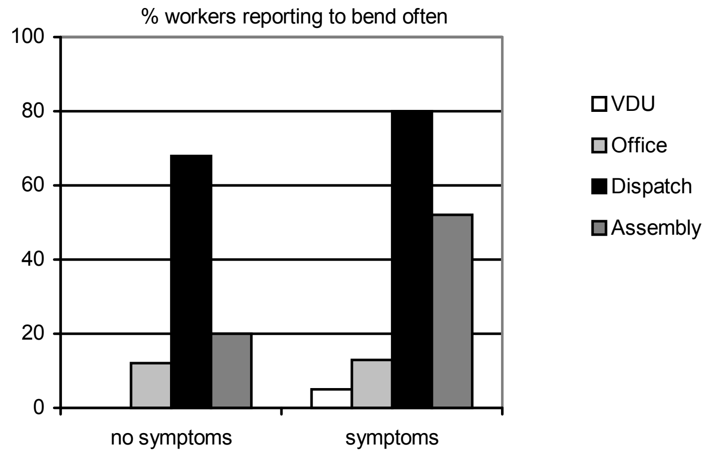

Figure 1. Self-reported bending of the trunk in four occupational groups, stratified by low back symptoms; percentages of workers reporting frequent performance of the movement

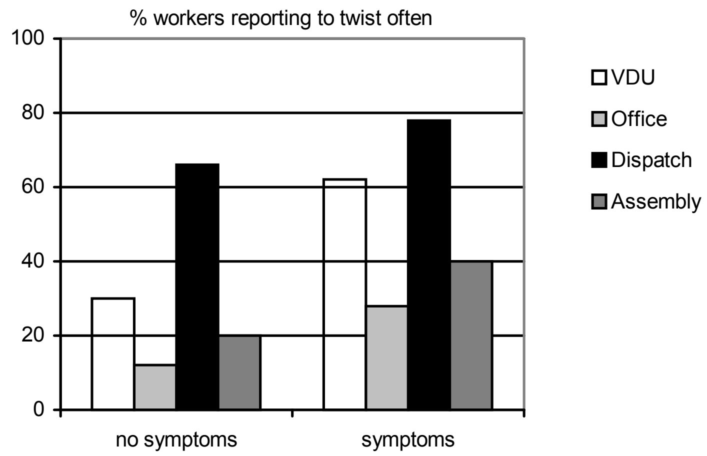

Figure 2. Self-reported bending of the trunk in four occupational groups, stratified by low back symptoms; percentages of workers reporting frequent performance of the movement.

Workers with back symptoms report more bending and rotating than workers without back symptoms; within each stratum worker groups with highest (and lowest) rates are the same.

3.4 Discussion

3.4.1 Methodological issues

In this study, observations from video images of movements and postures were used as the reference method. Reliability and validity of observations of postures and movement in the sagittal plane have indeed been shown to be satisfactory in the laboratory (Douwes et al. 1990 1991, Paul et al. 1993), but direct observations in work situations with more complex and three-dimensional movements appear to be troublesome (Karhu 1977; De Looze 1994). In particular twisting and side bending of the trunk have been found difficult to classify accurately by observation (Kilbom 1994). We opted for indirect observations from video images to make it possible to review troublesome dynamic tasks again and again and even consult another observer in case of doubt. Although far from ideal, the use of this method as a reference was considered appropriate in the absence of a real 'golden standard'.

The study design chosen depended heavily on finding worker groups that were homogeneous enough to carry out the observations with a worker who could be considered 'representative' for all workers of the group. Only a thorough search by several occupational physicians resulted in four homogeneous worker groups of minimal size with divergent workload between groups. It is thus surprising that variation in answers to questions within the non-sedentary groups is still very large (Table 5). This could indicate major differences between individual workers in interpretation of the questions, concerning phrasing (e.g. 'often') and movements/postures (what 'bending' is). However, one has also to realise that both methods are only comparable to a certain degree: the observations concern only one particular working task on one particular (although 'representative') day, whereas the questionnaire measures an estimation of average (and cumulative) exposure during the normal execution of daily tasks. In addition, the phrasing of the questions in a questionnaire has to be quite qualitative, since more quantitative questions take a lot of space and are time-consuming for the respondent, which conflicts with the necessity of keeping the number of pages of the questionnaire as low as possible to enhance the response rate. In contrast, the observations concern clearly defined and quantitative notions like changes of position in the sagittal plane between 10 and 20 degrees. The comparability of the observational data and the questionnaire data is thus limited, since both methods are measuring rather different parameters and have their own advantages and disadvantages.

The study design required four contrasting worker groups. Unfortunately, differences between groups with respect to movements and postures turned out to be less than desired, which resulted in less possibilities of differentiating between the worker groups. Workload was assessed by experts visiting the workplaces. The results of the observations show that the assembly workers have more dynamic work than was expected by the experts. It seems thus risky to classify worker groups by workload merely on the opinion of expert opinions.

Finally, this study was limited to bending and twisting movements and bent and twisted postures. Strictly speaking, our conclusions should therefore be limited to only these aspects of musculoskeletal load. Other studies have shown already that the accuracy of the estimations may depend on the kind of posture or movement involved (Baty et al. 1986; Kumar 1993, Kilbom 1994). However, there is no reason to expect that the validity of the ranking of the worker groups is dependent on the specific postures or movements involved. Therefore, the qualitative approach presented in this paper aimed at ranking worker groups may well be valid for most other movements and postures.

In all, the methodological aspects reviewed and the small scale of this pilot-study imply that the results are only indicative.

3.4.2 Interpretation of the results

Results of this study indicate that the questionnaire seems able to identify the group with the highest exposure for all movements involved. Some discrepancies deserve further comments. A high percentage of VDU workers report in a high percentage that they often have to twist while this

is not reflected by the observations. This is possibly due to the fact that only rotations of more than 20 degrees were observed, while the workers may report rotations of less than 20 degrees as well.
Another discrepancy seems to be the interpretation of the word 'bending': the data suggest that workers interpret this notion particularly as firm bending (stooping), for the self-reported prevalence rates among VDU and office workers were low while the observations indicate that these groups also bent often more than 10 degrees. By contrast, VDU workers do report their slightly bent posture accurately. Separate questions on light and stiff bending movements and bent postures might improve the discriminating power of these questions to some extent.

3.4.3 Qualitative versus quantitative questions

Results of this study show that it does not seem necessary to put forward complex quantifying questions on physical loads when the goal is only the identification of high-risk groups. Furthermore, the results of the detailed questions on frequency of movements and duration of postures hardly reflect the observational data, confirming the difficulty met by others in obtaining valid worker ratings of quantitative musculoskeletal workload factors. Although - as already mentioned before - it is difficult to compare the observational data and questionnaire data directly, it seems that both frequency and duration of movements and postures are underestimated, as was found in other studies (Rossignol et al. 1987; Burdorf 1992). Some questions do not differentiate at all between the worker groups, despite contrasting observational data. From our data, it seems again that workers cannot report frequency and duration of their movements and postures accurately. This means that the absolute percentages or means calculated from these self-reported data are of little value and have to be interpreted only relatively to the data of other groups.

3.4.4 Influence of symptoms on the self reporting of workloads

Workers with back symptoms may recall their back loading tasks better and thus report those tasks more often (Walsh et al. 1989). Also, workers with symptoms may adjust their postural behaviour to prevent further symptoms (Punnett et al. 1987). Other studies did not show a relationship between symptoms and self-reported exposures (Kuorinka and Kilbom 1990, Wiktorin et al. 1999), or showed a differential bias for some exposures (Wiktorin et al. 1993, Viikari-Juntura 1996). Our study shows a significant relation between the presence of symptoms and the level of self-reported exposure to postures and movements. Similar results were found by Wiktorin et al. (1993), who showed that workers with symptoms of the low back as well as neck or shoulder symptoms tend to overestimate exposure to some variables concerning manual handling, but not to variables concerning postures or movements. Since it is unlikely that workers with symptoms were actually doing different work, the tentative explanation is that either workers with symptoms have a different working method (Punnett et al. 1991) or are more aware of movements and postures, which constitute a load for their back and thus report their exposure either more accurately or with some 'exaggeration'.
These findings indicate that an analysis of the relation between self-reported individual exposure data and health symptoms may be biased due to the possible overestimation of exposure by those with symptoms or underestimation of exposure by those without symptoms. These results pled against the use of self-reported individual exposure data in epidemiological studies aiming to establish dose-response relationships. The ranking of occupational groups will be influenced too. Given the relatively high prevalence rates of symptoms, the resulting misclassification might facilitate the desired contrast between groups.

Finally, it has to be stressed that the question remains which method (questionnaire or exposure-assessments) can predict future musculoskeletal symptoms or disability the best. Prospective studies will be needed to answer that question.

3.5 Conclusions

The results of this study indicate that the DMQ can identify worker groups with the highest exposure to musculoskeletal workload relative to other groups, when groups are relatively homogeneous and contrasting with respect to musculoskeletal workload. Simple qualitative questions are sufficient to reach this goal. Workers with low back symptoms report higher exposure rates than workers without symptoms doing the same kind of work. This finding suggests that caution is needed when self-reported data from questionnaires are used to assess dose-response relationships in epidemiological research.

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4. Validity of self-reported low back pain

Abstract

Objectives

The aim of this study was to evaluate the validity of the DMQ for identifying worker groups with relatively high prevalence rates of low back pain. The sensitivity, specificity and predictive value of the questionnaire in comparison with a more detailed physical examination were also assessed.

Methods

Four homogeneous worker groups with divergent workload (VDU workers, office workers, vehicle drivers and printers) were studied (n=92). In the questionnaire, frequency, duration and severity of the low back symptoms were measured, including prevalence of symptom rates during lifetime, the last twelve months and the last seven days and prevalence rates of radiating pain. A physiotherapist carried out a standardized physical examination and classified the workers into one of four possible 'diagnoses' (insufficientia dorsi, lumbago, sciatica or lumbago-sciatica). Workers were considered 'positive' when reporting symptoms in the questionnaire or being classified into one of the four possible diagnoses by the physical examination.

Results

Results indicate that the questionnaire is able to identify the same worker groups with high prevalence rates as the reference method. The type of measure (life time prevalence, one-year prevalence, seven-day prevalence or radiating pain) does not influence the ranking substantially. Self-reported radiating pain in the questionnaire corresponds best with the 'diagnoses' lumbago-sciatica and sciatica in the physical examination. The nature and severity of the symptoms show a substantial variation between occupational groups, possibly indicating specific work related morbidity. Seven-day prevalence rates are preferable when high specificity is desired, while lifetime prevalence rates result in the best sensitivity. Overall, the one-year prevalence rates constitute an attractive intermediate choice and seem the most appropriate measure to involve in a survey.

Conclusions

The questionnaire can be used to identify groups with relatively high prevalence rates of low back symptoms.

Keywords: Questionnaire; musculoskeletal symptoms; physical examination

4.1 Introduction

The great impact of musculoskeletal disorders on the working population is well known. In the Netherlands, approximately one fifth of long-term sickness absence and one third of permanent disability are diagnosed as 'musculoskeletal disorders' (CBS 1994; GMD 1993). Two-thirds of the workers disabled by musculoskeletal disorders, claim that their disorder is partly or completely caused by their work and one third report that disability could have been prevented if work adjustments had been made available earlier (Gründemann et al. 1991). To identify high-risk populations, which ought to receive priority for preventive actions (like ergonomic interventions), information on prevalence rates of symptoms in specific worker populations is necessary as well as data on workload. Comparable data on other populations are needed to interpret these findings, since normative data on the variables involved are hard to establish. Musculoskeletal disorders are difficult to diagnose and methods for detecting these disorders are still imperfect, both in a clinical and in an epidemiological setting (Andersson 1991). In worker populations, disorders are mostly in the beginning stages and often the assessment of possible anatomical-physiological substrates is difficult. Symptoms are thus an important parameter. Symptoms can be measured by a simple questionnaire. It is a relatively easy measuring instrument, both for the worker, patient and the physician. In addition, it is relatively easy to administer and to standardise. However, data on the validity of such questionnaires for the identification of worker groups with relatively high prevalence rates of symptoms are still difficult to obtain. The aim of this study was to evaluate the validity of the 'medical' part of a questionnaire developed by TNO (the 'Dutch Musculoskeletal Questionnaire’, DMQ) with respect to the following questions:

- Is the questionnaire able to identify worker groups with relatively high rates of musculoskeletal symptoms?
- What are the sensitivity, specificity and predictive value of the questionnaire in comparison with a detailed physical examination?

Since low back symptoms constitute the major problem, the study was focused on symptoms of that particular region.

4.2 Methods and material

Four worker groups were selected with contrasting musculoskeletal workloads: VDU workers, office workers, vehicle drivers and printers. Groups were selected in such a way that all workers within each group performed the same tasks. However, it was difficult to find such groups: it appears that nowadays substantially sized groups of workers all doing the same kind of work can hardly be found any more. Thus, the numbers of study-participants in each occupational group are relatively small. All workers in the groups were asked to participate, regardless of the presence of symptoms. Table 1 presents some descriptive data on these groups.

Table 1. Descriptive data on study groups (between brackets: standard deviation)

	VDU-workers	Printers	Office-workers	Drivers
Number	20	20	23	29
Mean age (years)	40 (9)	36 (9)	46 (7)	39 (8)
Mean duration of employment (years)	14 (7)	12 (10)	8 (8)	11 (6)
Gender (percentage males)	20	100	80	100
Educational level (1=low, 3=high)	1.8 (.5)	2.0 (0)	2.0 (.7)	1.9 (.4)

Symptoms were measured by the DMQ-questionnaire with items on frequency, duration and severity of low back symptoms. The phrasing of the main questions on prevalence rates (life time, 12 month and 7-day prevalence rates) was comparable with the 'Nordic questionnaire' (Kuorinka et al. 1987). In addition, questions were asked on the prevalence rate of radiating low back pain during the past 12 months and frequency of symptoms during the past 6 months.
Since a 'golden standard' for the identification of low back cases is still lacking, a standardized physical examination was chosen as a reference method for identifying musculoskeletal disorders. In 1982, Nachemson and Andersson published a system of classifying low back disorders suitable for use in epidemiologic surveys, based on the patients description of symptoms and a verification by simple clinical findings (Nachemson et al. 1982). This classification was taken as the reference for the questionnaire data.
All variables needed to classify the workers were measured during a physical examination. These variables included anamnestic data (prevalence of complaints), posture (lordosis, kyphosis), mobility (flexion, extension, lateroflexion and rotation of the trunk), strength (quadriceps, tibialis anterior, extensor hallucis longus, sit-up), pain during movements of the trunk, pressure pain, muscle tension and straight leg raising. These variables were measured according to a highly standardized protocol. One physiotherapist, who was not informed about the results of the questionnaire completed by the worker earlier, carried it out. On the basis of the results of this examination, workers were classified according to the classification of Nachemson and Andersson6 and considered 'positive' when having one of four 'diagnoses', which are mutually exclusive (for details, see Nachemson and Andersson 1982):

- Insufficientia dorsi: tiredness, discomfort or lumbar pain, provoked by repeated or forceful movements, stiff or weak back; rarely pain on palpation, no increased muscle tension, no or little increase in pain during lumbar motion, no neurological symptoms;
- Lumbago: ache and pain, sometimes radiating down to the gluteal, hip or inguinal region. Pain increase by motion in the acute stage; pain on palpation, increased muscular tension, loss of motion, pain on motion, no neurological symptoms;
- Sciatica: radiating pain in one or both legs, increased by motion, acute onset, often numbness, paraesthesia, feeling of weakness in one or both legs; pain on palpation lumbar region and/or legs, no increased lumbar tension, limited lumbar movement, straight leg raising test is positive, neurological findings may be present;
- Lumbago-sciatica: symptoms and signs as for both lumbago and sciatica, one of the two can dominate.

Two analyses are performed. First, the four worker groups are ranked according to the prevalence rates of symptoms and signs and whether both methods agree with respect to the occupational group with the highest prevalence rate of low back symptoms is checked. Next, the agreement between questionnaire and clinical examination on the level of the individual worker is evaluated by computing sensitivity, specificity, positive predictive value and kappa-statistic. Given the aim of the study (explorative) and the limited number of workers in each group, no other statistical tests were carried out.

4.3 Results

Table 2 presents the main results of the questionnaire and the physical examination. Also the ranking of occupational groups achieved with both methods is indicated.

Table 2. Prevalence (%) of low back symptoms and results of the physical examination in four occupations; rank numbers from low (1) to high (4) between brackets

	VDU-workers (n=20)		Printers (n=20)		Office-workers (n=23)		Drivers (n=29)	
questionnaire								
Life time prevalence	55	(2)	70	(4)	52	(1)	68	(3)
1 year prevalence	55	(3)	68	(4)	50	(1)	52	(2)
Last 6 months > 0 time	45	(2)	63	(4)	41	(1)	48	(3)
Last 6 months > 4 times	35	(2)	37	(3)	23	(1)	36	(2)
Radiating symptoms	35	(2)	37	(3)	22	(1)	46	(4)
7 day prevalence	40	(3)	47	(4)	29	(1)	36	(2)
Prevalence rates of clinical findings								
Positive findings (one of the four diagnoses)	50	(2)	74	(4)	43	(1)	65	(3)
Separate diagnoses:								
Insufficientia dorsi	10	(1)	32	(3)	17	(2)	45	(4)
Lumbago	25	(3)	26	(4)	22	(2)	3	(1)
Sciatica	15	(4)	11	(3)	4	(1)	10	(2)
Lumbago-sciatica	0	(1)	5	(3)	0	(1)	7	(4)
Sciatica + lumbago-sciatica	15	(2)	16	(3)	4	(1)	17	(4)

Differences between groups are rather small, which hampers the ranking of groups. However, it appears that the questionnaire is at least able to identify the extremes in agreement with the physical examination: the groups with the highest (printers) and lowest levels of symptoms (office workers). The type of measure (life time, 1-year or 7-day or frequency) does not influence the ranking very much. The ranking of self-reported radiating pain corresponds best with the ranking of the 'diagnosis' sciatica and lumbago-sciatica in the physical examination.

Table 3 presents the sensitivity, specificity and positive predictive value of the questionnaire (self-reported presence of symptoms or not) in comparison with the results of the physical examination (one of the four diagnoses or none) for all workers. Also the kappa-statistic is given as a measure of agreement between both methods.

Table 3. Sensitivity, specificity, positive predictive value and kappa-statistic of the questionnaire in comparison with the physical examination (all workers, n=92)

	Sensitivity	Specificity	Predictive value	Kappa
Life time prevalence	96	87	91	.78
1-year prevalence	86	86	89	.69
Prevalence of radiating symptoms	58	97	97	.56
7-day prevalence	64	100	100	.65

When the recall period becomes larger and the prevalence rate increases, the sensitivity of the questionnaire increases: more persons with a low back disorder diagnosis also report symptoms. However, the specificity decreases: more persons without a low back disorder diagnosis report symptoms in the questionnaire. Sensitivity to radiating pain is rather low, but specificity is high. The positive predictive value is rather high for all prevalence measures. Kappa's are all near or above 0.60, indicating good agreement.

4.4 Discussion

4.4.1 Study design and methods

The design of this study depended heavily on the availability of contrasting, homogeneous worker groups. Since it was difficult to find such groups, the numbers of study-participants in each occupational group are relatively small, which reduces the statistical power of this study. This implies that this study can give indications, but no definitive answers on some of the issues raised. The lack of a 'golden standard' also hampered a proper study design. The physical examination was considered a suitable 'substitute' but the relation of the four diagnostic categories with anatomical-physiological substrates is unclear and the classification still lacks any biometric parameters. Also, the classification involves anamnestic data, in addition to signs recorded during the examination, also and thus overlaps to a certain extent with the questionnaire. However, this could be an advantage as well; a study that focused on physical findings alone did not find any correspondence between the physical findings and questionnaire data (Törner et al. 1990), possibly indicating that the parameters commonly measured (e.g. restricted movement) do not sufficiently reflect the underlying disorder, even during the most acute phase (Törnet et al. 1990, Vällfors 1985). The evaluation of all the symptoms and signs in the Nachemson and Andersson classification could thus be more appropriate. As long as it is impossible to make firm clinical diagnosis of most disorders, it would seen preferable to identify symptoms and signs of possible musculoskeletal disorders using a strictly standardised examination and classification scheme.

4.4.2 Sensitivity, specificity and predictive value of the questionnaire

Since no data are available on the validity of the reference method used, the data presented on sensitivity, specificity and predictive value of the questionnaire must be interpreted with caution. The conclusions of this study are based on the assumption that the reference method is actually able to identify workers with low back trouble. The comparison of both methods indicates that the results of the questionnaire and the physical examination are closely related, with characteristic differences between the prevalence measures involved. It seems that the 7-day prevalence rate is to be preferred when high specificity is desired, while the lifetime prevalence rate results in the best sensitivity.

The results are in agreement with other studies indicating a satisfactory correspondence between questionnaire findings and clinical examination (Kuorinka et al. 1987; Holmström et al. 1991), although in a study by Undeutsch et al. (1982) a much lower specificity (31%) was reported for symptoms reported during an interview.

4.4.3 Choice of prevalence measure

The choice of the correct measure of effect is important since the use of different prevalence measures is reported to result in different correlations with risk factors (Buckle et al. 1986). In this study, the type of prevalence measure (life time, 1-year, 7-day prevalence rate, radiating pain) seems to be of little importance. First, our study indicates that the choice of measure is less important for a correct ranking of occupational groups: all measures seem to differentiate well between occupational groups. Next, it is striking that the life time prevalence rate and the 12-month prevalence rate seem to relate better to the findings of the clinical examination than the 7-day prevalence rate. One would expect that the relationship between the 7-day prevalence rate and clinical examination would be the strongest, since the recall period is closest to the examination time. However, the 7-day prevalence rate could place too much emphasis on the results of a random point in time when dealing with such a fluctuating and recurrent disorder as low back pain (Svensson et al. 1982), whereas the clinical examination classified the workers not only on the basis of current symptoms, but also on the basis of the symptom-history. A great disadvantage of the lifetime prevalence rate is its high rate (up to 90% in some occupations), which questions the relevance of such a measure and may threaten the face validity of a survey in the eyes of a critical company management. Furthermore, its relation to working conditions is more difficult to establish. Overall, the one-year prevalence rate constitutes an attractive intermediate choice and seems the most appropriate measure to employ in a survey. In addition, the internationally widespread use of the one-year prevalence rate in epidemiologic studies would indicate its use to enhance possibilities of comparisons between worker groups and comparisons of associated risk factors.

4.4.4 Ranking of occupational groups

Since questionnaires are often used to identify worker groups with high prevalence rates of musculoskeletal symptoms, it is important to assess the validity of this usage. This study indicates that the agreement between the questionnaire and a standardized physical examination is good on a group level; with the questionnaire the same group with the highest prevalence rate of musculoskeletal trouble was identified as with the physical examination. No indications were obtained in this study that the frequency of symptoms (in the past six months) is an important variable when identifying worker groups with relatively high prevalence rates of symptoms. Radiating pain corresponds best to the 'diagnosis' lumbago-ischias and ischias and could possibly be considered as an indication of nerve root involvement. However, radiating pain does not differentiate groups better than the other prevalence measures involved.

4.4.5 Specific morbidity related to specific workload

Table 3 indicates that the kind of clinical findings is different for each occupational group: vehicle drivers are characterised in particular by insufficientia dorsi, while VDU workers and office-workers are characterized by lumbago. Sciatica is less prevalent in office-workers.

It is difficult to interpret these results, since the number of groups is small. Furthermore, the fact that the four diagnoses are mutually exclusive, which implies that a worker cannot have more than one diagnosis, might have unknown confounding effects. Earlier, Wickström (1987) as well as Jegaden et al. (1985) reported the possibility that the nature of the physical findings could be related to the nature of workload in a certain occupational group. The finding of Wickström (1987) that radiating pain correlates best with the presence of clinical signs could not be reproduced. The same can be said about the findings of Jegaden et al. (1985) and Riihimaki (1985) that sciatica does differentiate between tasks and lumbago does not. This study indicates that it seems inappropriate to focus on radiating and/or sciatic pains, since it would possibly emphasize one type of problem found in certain occupations and perhaps neglect other problems characteristic to other occupations. However, as stated earlier, radiating pain could be a measure of more serious low back trouble, since it corresponds best with the 'diagnosis' lumbago-sciatica and sciatica. It seems justified to direct further research to this topic, since it could give more insight into the question whether specific workload also causes specific problems (lesions). At this moment, no empirical research can substantiate such a hypothesis.

4.5 Conclusions

This study indicates that the identification of high-risk groups by measuring self-reported symptoms seems possible and appropriate as long as other, more specific methods are lacking. Apart from a period prevalence rate of symptoms, it seems relevant to gather information on the nature and severity of the symptoms, since these can show a substantial variation between occupational groups and could give indications on specific workload related morbidity.

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5. Musculoskeletal symptoms and workload in 12 branches of Dutch agriculture[1]

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Abstract

Objectives

Identification of high risk branches with respect to musculoskeletal symptoms and workload in Dutch agriculture.

Methods

Postal questionnaire survey. The study population comprised a sample of 2,580 male employees and employers, with a response rate of 49%.

Results

A total of 75% of the employees and 71% of the employers reported musculoskeletal symptoms during the past 12 months. Low back pain was most prevalent (1-year prevalence rate of 51% among employees, 47% among employers), followed by symptoms of the neck-shoulder (1-year prevalence rate of 35% among employees, 30% among employers) and knees (1-year prevalence rate of 22% among employees, 17% among employers). There were marked differences between specific branches in size and nature of musculoskeletal morbidity as well as in self-reported musculoskeletal workload. In particular protective vegetables growing and arboriculture showed both relatively high rates of symptoms and relatively high exposure levels.

Conclusions

Musculoskeletal morbidity is high in most branches of Dutch agriculture. Several branches show specific patterns of symptoms and exposures to physical workload and other working conditions. The results of this study were used to decide which agricultural branches and workload factors should have priority in the ergonomic interventions that followed.

Keywords: Musculoskeletal symptoms; Physical workload; Agriculture.

5.1 Introduction

In the Dutch agriculture (which includes cattle breeding and horticulture) 43% of the disability cases is due to musculoskeletal disorders (GUO 1992). This fact urged the 'Dutch Foundation for Occupational Health Care in the Agricultural Branches' (STIGAS) to initiate a programme for the prevention of these disorders. However, data on their size and nature and related working conditions were not available. An epidemiological and ergonomic investigation was carried out to identify high-risk groups that should get priority attention. This paper reports the results of the epidemiological study. The ergonomic study has been reported elsewhere (Van Dieën 1989a; Van Dieën and Hildebrandt 1991). The questions to be addressed in this study are:

- What are the size and nature of musculoskeletal symptoms and workload in Dutch agriculture in its entirety?
- Which specific agricultural branches are at particular risk concerning musculoskeletal symptoms and workload?

5.2 Methods and material

5.2.1 Questionnaire

The Dutch Musculoskeletal Questionnaire (DMQ) was used (Hildebrandt and Bongers 1991; Hildebrandt 1992). This instrument contains questions on general background data (e.g. age, gender, years of employment, educational level, shift work), health (in particular musculoskeletal symptoms), tasks, workload and other hazardous working conditions (in particular exposure to unfavourable postures, movements and force exertions, psychosocial workload, poor climate and vibration). The main questions on musculoskeletal symptoms are comparable with the Nordic-questionnaire on musculoskeletal disorders (Kuorinka et al. 1987).

5.2.2 Study population

The questionnaire was sent by post to 4,621 employees and 2,728 employers in 15 branches of the Dutch agriculture. Employers (including self employed workers) were included in the study since they constitute the majority of the workforce in the Dutch agriculture. The sample was drawn from two existing databases of agricultural employers and employees and stratified on branch, age (data only available for employees) and farm size (data only available for employers).

5.2.3 Analysis and statistical methods

First, findings on symptoms and workload of the total study population were analysed. Prevalence rates of musculoskeletal symptoms were computed and directly standardized for age. Questions on workload and other working conditions are grouped into 4 indices and mean scores were computed for each of these indices. Homogeneity of all indices, as expressed by the Cronbach's alphas was satisfactory (Table 1).

Table 1. Name, content, range, Cronbach's alpha, mean score and standard deviation (SD) of four indices of workload and other working conditions, as measured in the study population (n=2,580)

Name and content	Alpha	Mean*	SD
(1) Physical workload (14 questions)	0.79	4.5	2.3
Physical exertion, postures, movements, forces (high exertion, often lifting, bending and/or twisting movements, often bent, twisted and/or kneeled posture), often standing and/or walking, peak loads (often unexpected movements, sudden forceful movements, pushing/pulling and/or slipping/falling)			
(2) Psychosocial workload (employees only**) (35 questions)	0.86	2.8	1.5
Working pace (high working pace, time pressure, hurry at work, should work more calmly), mental load (high mental exertion, looking with strenuousness, listen sharply, having to remember a lot, high concentration, high accuracy demands), control and autonomy (not enough autonomy, insufficient possibilities to organize the work, to influence working pace, to interrupt work), organisation/social support (poor work organisation, poor support by colleagues, poor management, poor safety, adverse influence of work to private life), work satisfaction (boring work, work without variation, too simple work, no pleasure at work, poor prospects, not being appreciated sufficiently, poor salary, low overall satisfaction with the work)			
(3) Poor climate (4 questions)	0.71	6.3	3.4
Draught, cold, hot, humid air, changes of temperature			
(4) Vibrations (1 question)	-	3.0	4.6
Any mechanical vibrations			

* Means are standardised on a maximum of 10; the higher the score, the higher the self-reported exposure

** Since these questions are applicable to employees only, data on those factors are restricted to employees.

To interpret the data, a comparison was made with a reference population of non-sedentary workers also exposed to high levels of physical loads: 436 male maintenance-workers in the basic metal industry (mean age 38 years), 186 male production workers of a shipyard (mean age 37 years) and 69 production workers in a metal industry (mean age 32 years).

Most variables are categorical or dichotomous, hence differences between the groups concerning musculoskeletal symptoms were analysed by applying a loglinear model ('logit-model', SPSS-X statistical software package). Age was included in the model to allow for a possible confounding effect. Symptoms of the neck, shoulder and upper back (called neck-shoulder-symptoms) and of the elbows and wrists/hands were taken together and presented for the agricultural employees only to reduce the amount of data to be shown.

Differences between groups concerning musculoskeletal workload were analysed by computing the means and corresponding 95% confidence intervals of the four indices of workload and other working conditions for each agricultural branch according to a method described by Brand and Radder (1992), specially developed for indices consisting of dichotomous variables. Differences between branches are significant ($p < 0.05$) by approximation when the computed confidence intervals were not overlapping. In high-risk branches, separate questions on physical workload were compared with the remainder of the study population and tested on significance by chi-square tests.

A significance level of $p<0.05$ (two-tailed) was applied in all analyses.

5.3 Results

The response rate was 49% (range over branches: 39-59%). Older employees and employers from smaller farms responded relatively more frequently than younger employees and employers from larger farms. Three branches (sheep breeding, beef production and outdoor vegetable farming) and respondents with missing data on branch were excluded (n=152) as well as women (n=69), because of small sample sizes. Also excluded were respondents who did not belong to the defined study population (Dutch agricultural workers): workers with a foreign nationality (n=106), respondents who were not working anymore because of protracted sickness (n=196), disablement (n=397), retirement (n=35) or who were working for less than 50% of their working time in agricultural production (n=43).

5.3.1 Descriptive data on the study population

The distribution of the samples among the various agricultural branches is given in table 2.

Table 2. Distribution of respondents among the various agricultural branches

		Employees	Employers
1.	Dairy farming	199	112
2.	Poultry farming	82	40
3.	Agriculture SS (sensu strictu)	343	138
4.	Mushroom production	56	73
5.	Pig farming	53	38
6.	Protective vegetable growing	167	237
7.	Cut flower growing	197	58
8.	Pot plant growing	137	51
9.	Bulb growing	91	46
10.	Fruit farming	35	73
11.	Arboriculture	98	40
12.	Agriculture contract work	176	40
All branches		1634	946

On average, employers are slightly older than employees (42 versus 40 year). In arboriculture and agricultural contract work, the number of weeks worked per year is relatively low for employees, indicating that seasonal work is relatively common in these branches. The mean number of working hours per week is considerably higher for employers (58 h) than for employees (43 h). Educational level is relatively low for employees. The mean number of employees per farm (an indication of the size of the farms) varies considerably between branches. Mushroom production farms, bulb growing and arboriculture are the largest, dairy farming and agriculture sensu strictu are the smallest.

5.3.2 Symptoms and exposures in the total samples

Musculoskeletal symptoms

In all, 71% of the employers and 75% of the employees report symptoms for one or more parts of their musculoskeletal system. Figure 1 shows the prevalence rate of symptoms of the main areas of the musculoskeletal system during the past 12 months for the total study population and for the reference population.

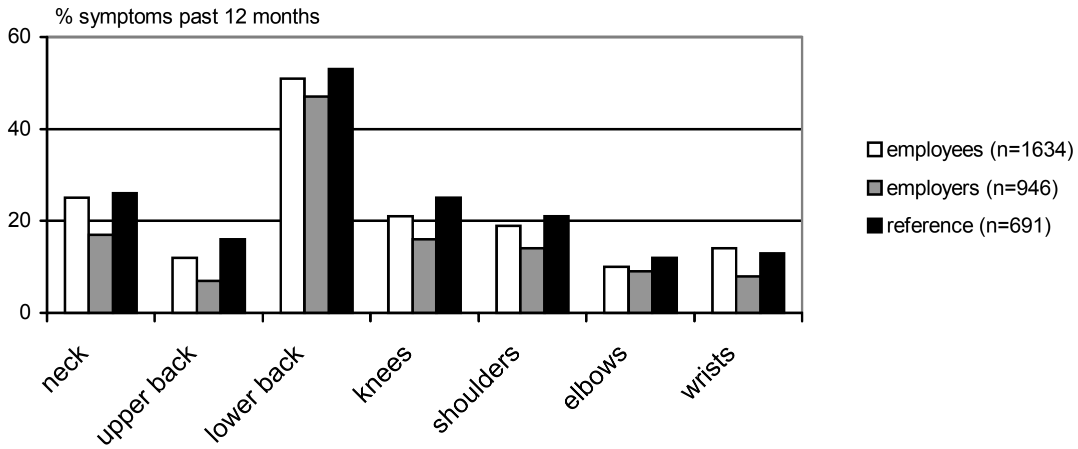

Figure 1. Prevalence rate of symptoms (%, age standardized) of the main areas of the musculoskeletal system during the past 12 months for employers (n=946) and employees (n=1,634) and the reference-population (n=691)

Low back symptoms are far more prevalent than symptoms of other regions. Symptoms of other body parts are less common. Employers report significantly less symptoms than both the employees and the reference population for most areas, except the elbows. Employees report significantly less symptoms of upper back and knees in comparison with the reference-population. However, all differences are relatively small. No marked differences between left and right body parts are present (not shown).

Self-reported workload and working conditions

Figure 2 shows the mean score of the four indices for the total study population and for the reference population.

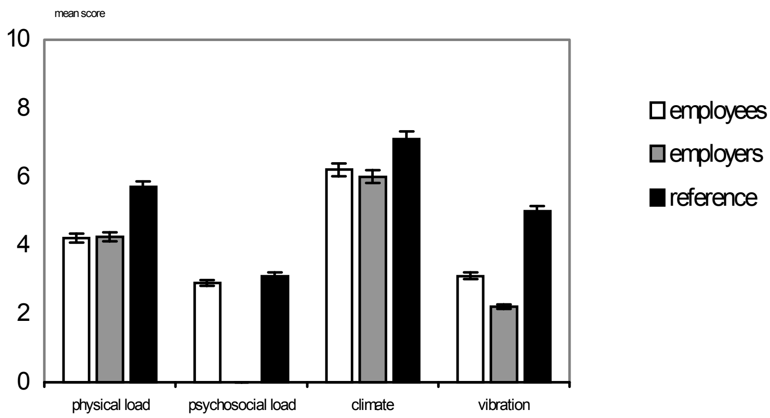

Figure 2. Self-reported exposure to musculoskeletal workload by employees (1) and employers (2) as indicated by 4 indices of workload and other working conditions in comparison with the reference population (3). No data on psychosocial load of employers.

Figure 2 shows only small differences between employees and employers with respect to physical workload and poor climate; employees report more exposure to vibration. Compared to the reference population, exposure to physical and psychosocial workload, poor climatic conditions and vibration is lower in agriculture.

5.3.3 Symptoms and exposures in twelve branches of Dutch agriculture

Musculoskeletal symptoms

Figures 3 (a) – (d) show the symptoms of the most important areas (low back, neck-shoulders, elbow-wrists and knees, respectively) in the 12 branches involved, restricted to data for employees.

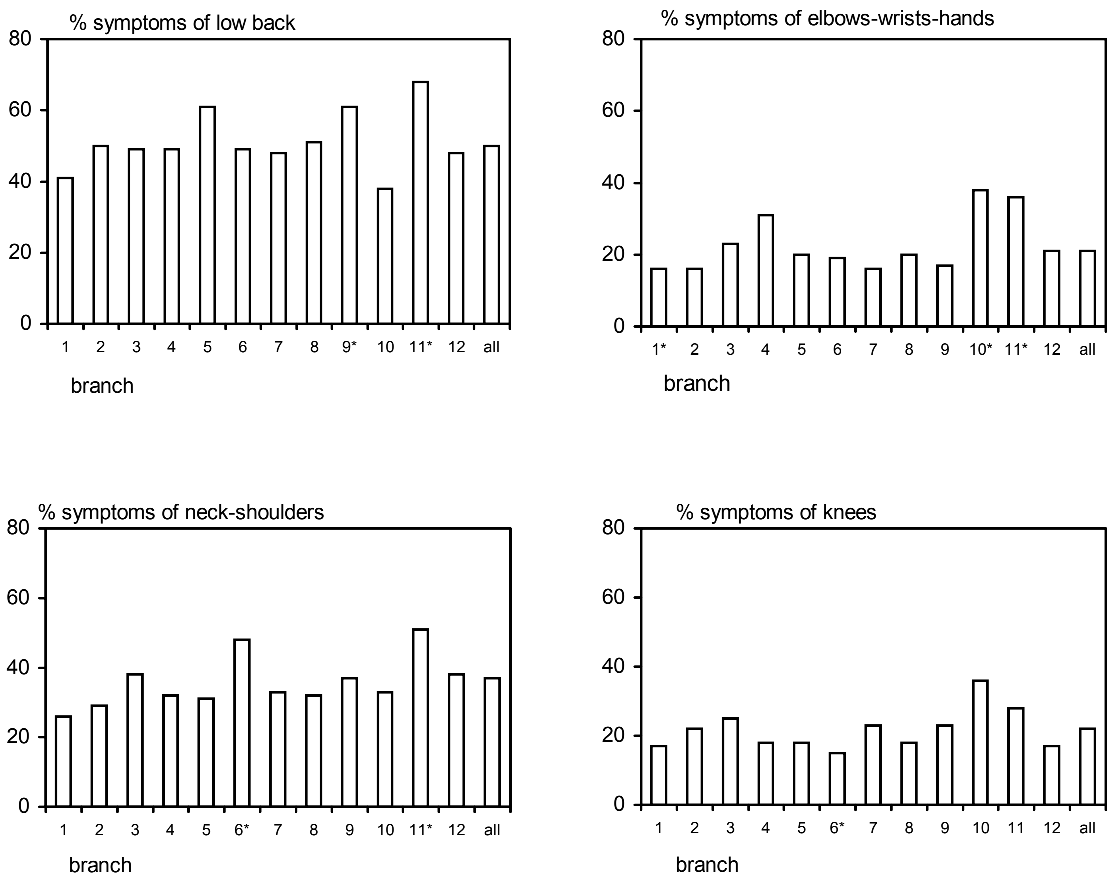

Figure 3. Prevalence rates of symptoms (%, age standardized) of low back (3a), neck-shoulders (3b), elbow, wrist & hand (3c) and knees (3d) during the past 12 months for employees in 12 agricultural branches.

1=dairy farming, 2=poultry farming, 3=agriculture SS, 4=mushroom production, 5=pig farming, 6=protective vegetable growing, 7=cut flower growing, 8=pot plant growing, 9=bulb growing, 10=fruit farming, 11=arboriculture, 12=agricultural contract work, All=all employees.

* An asterics near the branch number indicates a significant difference between the branch and the mean of the whole sample ($p<0.05$)

Prevalence rates of symptoms are significantly differing between branches for all areas. Symptoms of the low back are more prevalent in bulb growing and in arboriculture. Neck-shoulder symptoms are relatively high in protective vegetable growing and in arboriculture. Symptoms of the elbows and wrists/hands are more prevalent in fruit farming and arboriculture. None of the branches shows significant high symptom-rates of the knees.

Analysis of left-right differences (not shown) indicated that all the problems were localized in particular in the right (dominant) body parts, indicating asymmetrical exposure to loads on arms and hands.

Self-reported workload and working conditions

Figures 4 (a) – (d) show the means of the indices of physical workload, psychosocial workload, poor climate and vibration respectively for the 12 branches separately.

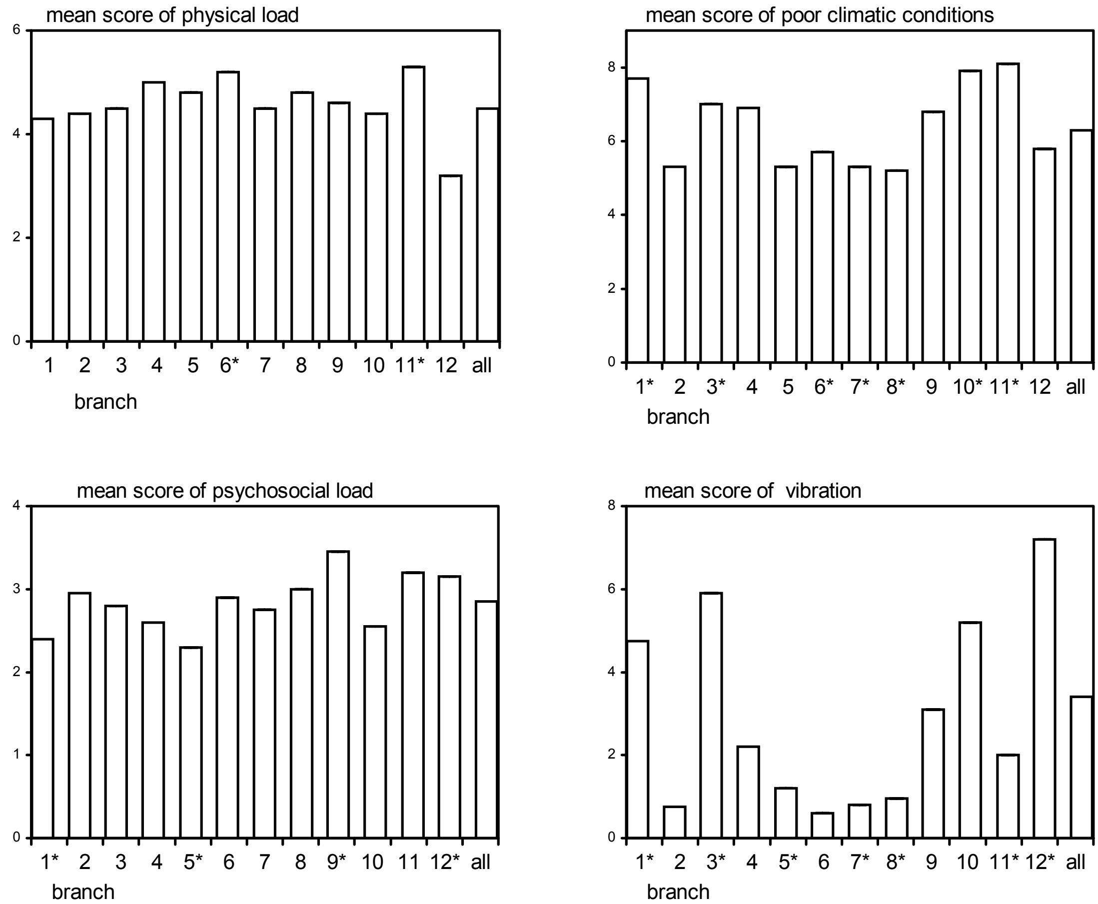

Figure 4. Self-reported exposure to musculoskeletal workload by employees working in 12 agricultural branches, as indicated by 4 indices of workload and other working conditions: physical workload (4a), psychosocial workload (4b), poor climatic conditions (4c) and vibration (4d).

1=dairy farming, 2=poultry farming, 3=agriculture SS, 4=mushroom production, 5=pig farming, 6=protective vegetable growing, 7=cut flower growing, 8=pot plant growing, 9=bulb growing, 10=fruit farming, 11=arboriculture, 12=agricultural contract work, All=all employees.

* The exposure of this branch is significantly ($p>0.05$) higher or lower than the mean of all employees

Several branches show specific significant deviations from the mean of the whole sample, indicating specific workload problems. High physical workload is relatively common in protective vegetable growing and arboriculture. Table 3 presents some details on the high physical exposures of these two branches.

Table 3. Percentages of employees in protective vegetable growing and arboriculture reporting exposure to musculoskeletal workloads often, regularly or daily (in comparison with all agricultural employees)

	Protective Vegetable growing	Arboriculture	All other agricultural workers
High physical exertion	69*	79*	59
Forces:			
• Lifting	82*	65	67
• Pushing/pulling	38*	23	30
Back movements:			
• Bending	87*	93*	75
• Twisting	79	74	74
Back postures:			
• Bent	63*	81*	49
• Twisted	36*	37	30
Prolonged			
• Standing	93*	87	80
• Sitting	36*	23*	53
• Kneeling	42	74*	37
• Walking	90*	77	81
Elevated arms			
• Under shoulder level	69*	47	42
• Above shoulder level	68*	13	18

* $p<0.05$

Employees in protective vegetable growing are exposed to a wide range of unfavourable postures, in particular to lifting, bending, bent postures and work with hands under or above shoulder level. Employees in arboriculture report particular exposures to bending and bent postures as well as kneeled postures. Prolonged sitting is less common in both branches.

5.4 Discussion

5.4.1 Selection of the study population

The response rate in this study was rather low. This is probably owing to the fact that the questionnaire was sent by post to the respondents by a relatively unknown authority (Occupational Health Care in Agriculture was still in a developmental stage). Furthermore, the questionnaire was sent in the spring, which is a very busy season in some agricultural branches.

The non-response analysis indicated that older employees and employers from smaller farms did respond relatively more than younger employees and employers from larger farms. However, differences between branches concerning farm size and mean age were relatively small and further analysis showed little or no relation between age or farm size and musculoskeletal symptoms. Therefore, it is unlikely that this selective response has influenced the comparison between branches to a substantial extent.

Recently, Dickinson et al. (1992) reported severe overestimation of prevalence rates of morbidity with low response rates, but others (Biering-Sørensen 1984; Frymoyer 1983) did not found such an effect, or reported the opposite: responders had lower sickness absence rates (Svensson and Andersson 1982). Besides, even if absolute prevalence rates have been biased owing to a selective response, it is not likely that this has influenced the main goal of this study - the comparison

between branches (which showed generally no major differences in response rates) - to a large extent.
Owing to the cross-sectional character of this survey, respondents are those who have shown to be able to survive high workloads. This means that the absolute prevalence rates found probably underestimate considerably work related morbidity. Since a differential selection between branches is not very likely, the influence on the comparison of branches will again be small.

5.4.2 Results in general

It is difficult to compare the results of this study with findings in other countries, since no studies are available on morbidity and workload in such a broad variety of agricultural branches. However, studies confined to specific agricultural branches (Klaukka 1980; Maeda et al. 1980; Thelin 1980; Auquier et al. 1983; Eckholm 1985) showed also high musculoskeletal morbidity levels, with large variations between branches and the low back as the most important area.
Although some differences between employers and employees were observed, on the whole findings in both groups are remarkably comparable. This is in agreement with the fact that farms are often small and employers often carry out the same kind of work as their employees. This is also confirmed by the answers on the questions on exposures, which were in general quite equal for employers and employees. However, employers appeared to have a considerably higher duration of exposure (see table 1) which should result in higher morbidity levels among employers. Instead, employers show slightly lower prevalence rates. A possible explanation could be that the decision latitude of employers is higher which implies that they can influence their working conditions to a larger extent than employees can, e.g. by assigning really monotonous or heavy tasks to their employees.

5.4.3 Results in the branches separately

The analysis of musculoskeletal symptoms between branches showed marked differences in specific morbidity of, for example, elbows and wrists (figure 2), including a preference for the dominant body area. These differences were not detected in the comparison of symptoms in agriculture as a whole in comparison with the reference group (figure 1). This underlines the necessity to stratify occupational populations on separate occupations and tasks when the aim is the identification of work related morbidity. It can be expected that even more specific bottlenecks will be revealed when specific subpopulations within a particular branch are studied, e.g. tomato growing within the branch of protective vegetable growing.
Some of the findings seem to be interpreted easily: in agriculture SS and agricultural contract work, the exposure to vibration points to the use of tractors, the high symptom rates of the upper extremities in fruit farming could be (partly) associated with the use of pneumatic cutting equipment and the neck and shoulder symptoms seen in protective vegetable growing may be associated with working above shoulder level. However, all these findings need further (ergonomic) investigations at the workplace to trace the specific (causal) tasks.

5.4.4 Setting priorities

The data on morbidity and self-reported workload gathered in this study has been used to focus the detailed ergonomic analysis on the most urgent problems. Thus, the study provides starting points for preventive actions concerning branches with particularly high levels of morbidity and/or unfavourable exposures and shows body parts at risk. The choice of the 'most urgent' problems is the responsibility of the industrial branch itself. In this case, priority has been given to the protective vegetable growing branch. Subsequently, a new, more detailed analysis of symptoms and workload was carried out, which was entirely focused on this branch (Van Dieën 1989b). Possible solutions were gathered (Van der Schilden 1989; Berndsen et al. 1991) and a pilot study is ongoing on how to implement these solutions with maximal success (Hildebrandt et al. 1991).

5.5 Conclusions

Musculoskeletal morbidity is high in most branches of Dutch agriculture. Several branches show specific patterns of symptoms and exposures to physical workload and other working conditions.
Symptoms of the low back are more prevalent in bulb growing and in arboriculture. Neck-shoulder symptoms are relatively high in protective vegetable growing and in arboriculture. Symptoms of the elbows and wrists/hands are more prevalent in fruit farming and arboriculture. None of the branches shows significant high symptom-rates of the knees.
High physical workload is relatively common in protective vegetable growing and arboriculture. Psychosocial workload is relatively high in bulb growing and agricultural contract work. Poor climatic conditions are encountered in dairy farming, agriculture SS, fruit farming and arboriculture. Vibration is encountered in particular in dairy farming, fruit farming and agricultural contract work.
In particular protective vegetables growing and arboriculture show both a relatively high morbidity and relatively high exposures to work related risk factors. These branches should get priority in preventive ergonomic actions.

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6. Identification of high risk groups among maintenance workers in a steel company[1]

[1] Published as Hildebrandt VH, Bongers PM, Dul J, Van Dijk FJH, Kemper HCG Identification of high-risk groups among maintenance workers in a steel company with respect to musculoskeletal symptoms and workload. Ergonomics 39 (1996) 2, p. 232-242

Abstract

Objectives

To determine priorities for ergonomic improvements in five maintenance departments of a steel company, a study was carried out to identify groups with a high prevalence of musculoskeletal problems or a high exposure to unfavourable musculoskeletal workload.

Methods

All workers were asked to complete a standardized questionnaire on musculoskeletal symptoms and musculoskeletal workload. Response rates in the five departments varied between 60 and 80% (n=436).

Results

Symptoms of low back and neck-shoulder (12-month prevalence rates of 53% and 36%) were most common, but not higher in comparison with a reference group of 396 non-sedentary workers. Self-reported exposure rates to physical and psychosocial loads as well as poor climatic conditions were comparable with the reference group; only exposure to vibration was higher.
Significant differences were seen between the five departments as well as between task groups within the departments. Several task groups with relatively high symptom rates and high exposure levels could be identified.

Conclusions

A questionnaire survey can constitute a valuable contribution to the selection of high-risk task groups that need ergonomic intervention.

Keywords: Maintenance workers, steel industry, musculoskeletal symptoms, physical workload

6.1 Introduction

Prevalence rates of musculoskeletal disorders, low back pain in particular, are high in the Dutch working population (Hildebrandt 1994). No industrial branch escapes this problem and there is a strong need for primary prevention, e.g. ergonomic improvements. In a steel company, a programme was initiated to develop guidelines to reduce musculoskeletal disorders in the group of maintenance workers. It was decided to develop these guidelines specifically for 'high risk' tasks, which involved a considerable number of workers. High-risk tasks were defined as tasks associated with a relatively high prevalence rate of musculoskeletal disorders and/or with a relatively high exposure of workers to hazardous working conditions. The goal of this study was to identify these high-risk tasks.

6.2 Methods and material

A cross-sectional questionnaire survey was carried out to collect data on health (musculoskeletal symptoms) and work (musculoskeletal workload and other working conditions known to be unfavourable for the musculoskeletal system).

6.2.1 Questionnaire

The Dutch Musculoskeletal questionnaire (DMQ) was used (Hildebrandt and Bongers 1991; Hildebrandt 1992). This instrument contains questions on general background data (e.g. age, gender, years of employment, educational level, shift work), health (in particular musculoskeletal symptoms), tasks, workload and other hazardous working conditions (in particular exposure to unfavourable postures, movements and force exertions, psychosocial workload, poor climate and vibration). The main questions on musculoskeletal symptoms are comparable with the Nordic-questionnaire on musculoskeletal disorders (Kuorinka et al. 1987).

6.2.2 Study population

Five departments participated in the survey: Roll Maintenance (n=46), Furnace Building (n=103), Electro technical Service (n=34), Mobile Craftsmen Unit (n=125) and Central Workshop (n=128). Questionnaires were filled in by the workers at the departments during working time. Those who were ill or absent, completed the questionnaire later. Response rates varied between 60 and 80%.

6.2.3 Analysis and statistical methods

The questionnaire data were analysed on three levels:

1. The total study population, to obtain an overview of the magnitude of symptoms and workloads in this population relative to other worker populations;
2. The five departments involved, to identify high risk departments;
3. Task groups, to identify high-risk tasks.

Detailed ergonomic analyses and interventions are more easily carried out at the level of specific tasks than at the level of departments with a broad variety of jobs and tasks, hence the third level was considered to be most important. Since no information on the specific tasks performed by the workers involved was available on an individual level beforehand, workers were asked to rate frequency and duration of their (precoded) main tasks and the perceived heaviness of these tasks in the questionnaire. Results indicated that most workers carried out many tasks with varying frequency and duration, which made it impossible to compose homogeneous groups of workers performing a fixed set of tasks. Therefore, worker groups who performed a specific task often or predominantly were compared. This implied that workers could be part of different task groups when they performed different tasks regularly. Table 1 shows a short description of these tasks, restricted to groups with a minimum of 15 workers.

Table 1. Description of main task groups within three* departments of maintenance workers

Department		n	Description
Furnace unit	a	20	Various activities A**
	b	22	Various activities B**
	c	22	Maintenance of tiles
	d	24	Spouting distributing box
Mobile Craftsmen Unit	e	30	Maintenance fitting A**
	f	19	Melting shop
	g	26	Maintenance fitting B**
	h	28	Activities shop Mobile Craftsmen Unit
	i	30	General tube manufacture RCV
	j	16	Maintenance fitting C**
	k	15	Maintenance pumps/engines
Central Workshop	l	60	Machine fitting
	m	27	Marking off
	n	20	Directing
	o	39	General construction fitting
	p	30	Heavy construction fitting
	q	33	Welding shop
	r	18	Construction fitting carriages

* No task groups of sufficient size were present within the Electrotechnical Service and Roll Maintenance Unit

** These task groups have more or less the same work, but at other sites in the company.

Prevalence rates of musculoskeletal symptoms were presented as the percentage of workers having had symptoms during the last 12 months and adjusted for age differences between groups by direct standardization. Symptoms of the neck, shoulder and upper back were taken together (called neck-shoulder-symptoms), because of the close relation between symptoms of these areas.

To analyse the prevalence rates of musculoskeletal symptoms in the total study population, results were compared with a reference group (mean age 37 years) also exposed to high levels of workloads: 142 maintenance workers of a transport company, 186 production workers of a shipyard and 68 production workers in a metal industry. The ideal reference group would be a group of workers who are not exposed to any potential harmful musculoskeletal loads at all (Occhipinti et al. 1993). However, such a population is hard to find: most occupational groups are exposed to some kinds of physical loads: sedentary workers have to deal with prolonged static loads, non-sedentary workers with dynamic loads and force-exertions. Therefore, a reference group was composed that was characterized by rather high levels of exposure to adverse physical working conditions, equalling that of the study population. This means that even prevalence rates in the study population, which equal the rates of the reference group, point to high physical loads and thus deserve (ergonomical) attention.

To identify high-risk departments and task groups, symptom rates of a specific department or task group were compared with the rates of all workers and all other groups respectively.

A loglinear model was applied for the statistical analysis of differences between departments concerning musculoskeletal morbidity ('logit-model', SPSS-X statistical software package), since most variables were categorical or dichotomous. Age was included in the model as possible confounder. Differences between task groups and the remaining of the study population (including all workers with other tasks not involved in this analysis due to low numbers) were tested by Chi-square (for 2x2 tables) or a Mann-Whitney statistic for means. Since most task groups were very small and overlapping, and the aim was to identify groups with high risks, a significance level of $p<0.25$ (two-tailed) was allowed (Broersen et al. 1992). For all other analyses a significance level of $p<0.05$ (two-tailed) was applied.

Questions on working conditions were grouped into 4 indices (physical workload, psycho-social workload, poor climate and vibration). Homogeneity of these indices, as expressed by Cronbach alpha, was satisfactory (table 2).

Table 2. Name, content, range, Cronbach's alpha, mean score and standard deviation (SD) of four indices of workload and working conditions, as measured in the study population (n=436)

Name and content	Alpha	Mean*	SD
(1) Physical workload (14 questions)	0.85	6.4	2.6
Physical exertion, postures, movements, forces (high exertion, often lifting, bending and/or twisting movements, often bent, twisted and/or kneeled posture), often standing and/or walking, peak loads (often unexpected movements, sudden forceful movements, pushing/pulling and/or slipping/falling)			
(2) Psychosocial workload (35 questions)	0.85	3.5	1.8
Working pace (high working pace, time pressure, hurry at work, should work more calmly), mental load (high mental exertion, looking with strenuousness, listen sharply, having to remember a lot, high concentration, high accuracy demands), control and autonomy (not enough autonomy, insufficient possibilities to organize the work, to influence working pace, to interrupt work), organisation/social support (poor work organisation, poor support by colleagues, poor management, poor safety, adverse influence of work to private life), work satisfaction (boring work, work without variation, too simple work, no pleasure at work, poor prospects, not being appreciated sufficiently, poor salary, low overall satisfaction with the work)			
(3) Poor climate (4 questions)	0.81	7.8	3.2
Draught, cold, heat, changes of temperature			
(4) Vibrations (1 question)	-	5.5	5.0
Any mechanical vibrations			

* Means are standardized on a maximum of 10; the higher the score, the higher the self-reported exposure

Means and 95% confidence intervals of these indices were computed for each department according to a method described by Brand & Radder (1992), specially developed for indices consisting of dichotomous variables. Differences between departments were significant ($p< 0.05$) by approximation when the computed confidence intervals were not overlapping.

In the high-risk department, separate questions on physical workload were compared with the remainder of the study population and tested on significance by chi-square tests.

6.3 Results

6.3.1 Descriptive data on the study population

The study population includes 436 male workers with a mean age of 36 years and a mean of 14 years of employment at the firm; differences between departments are within a range of five years. Shift work is frequent in Roll Maintenance, Furnace Building and the Central Workshop. Educational level is comparable between the various departments; Electro technical Service has the highest percentage workers with only primary school (15%).

6.3.2 Symptoms and exposures in all workers in give departments

Musculoskeletal symptoms

Figure 1 shows the size and nature of the main musculoskeletal symptoms (low back, neck-shoulders and knees) in the study population and the reference group. Prevalence rates of symptoms of elbows, wrists/hands, hips and ankles/feet are low (≤15%, not shown) and comparable with the reference group.

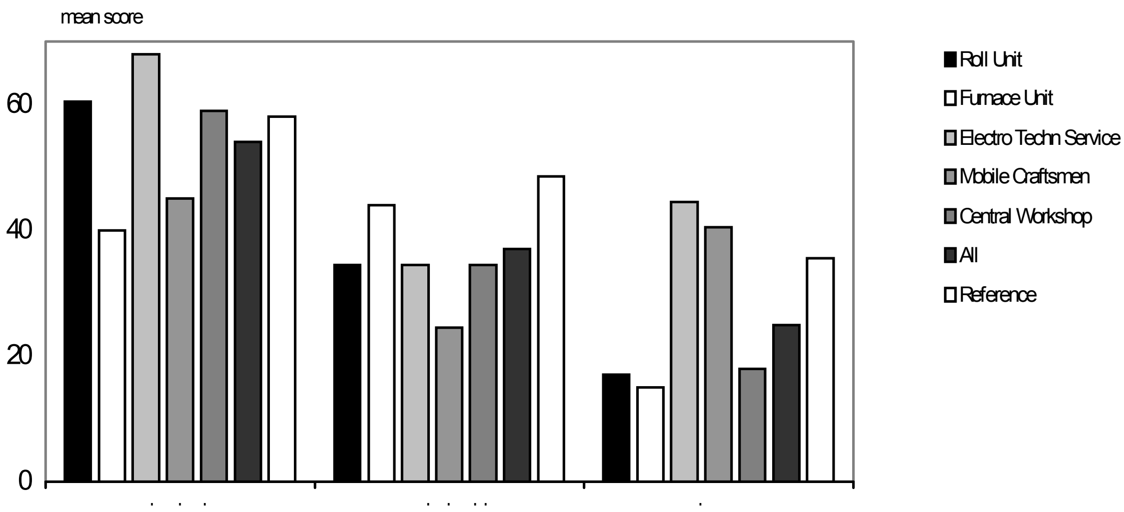

Figure 1. Age standardized prevalence rates (%) of musculoskeletal symptoms during the past 12 months of maintenance workers in five departments of a steel company (n=436) and a reference group of non-sedentary workers (n=396).

The absolute level of, in particular, low back symptoms (and - to a lesser extent - neck-shoulder symptoms) is high; knee symptoms are significantly lower than other groups with high workloads as represented by the reference group. Furthermore, there are significant differences between departments, indicating specific problems related to specific departments: Electro technical Service has a relatively high prevalence rate of low back and knee symptoms, the Furnace Building a relatively low prevalence of low back symptoms and the Mobile Craftsmen Unit shows a relatively high prevalence rate of knee symptoms.

Self-reported workload and other working conditions

Figure 2 shows the mean score of the four indices in the study population and the reference group.

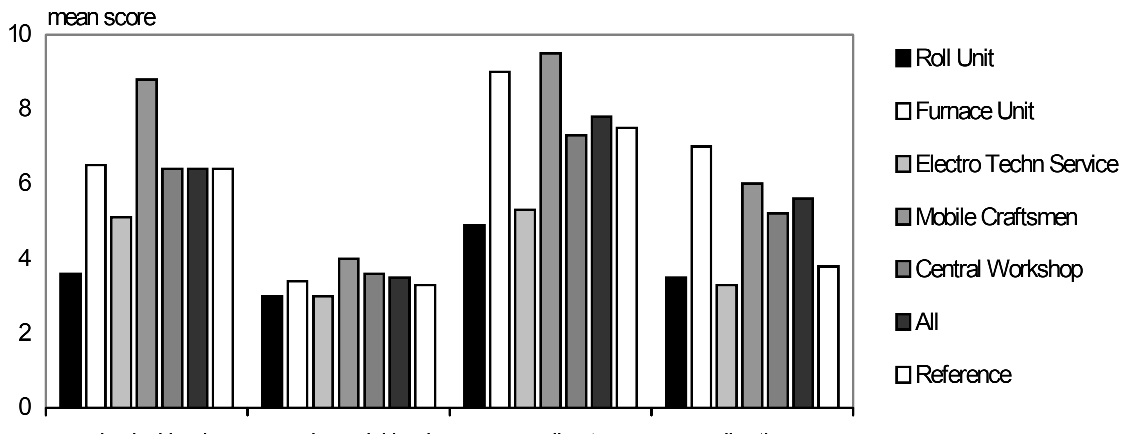

Figure 2. Mean scores of 4 indices of workload and working conditions reported by maintenance workers in five departments of a steel company (n=436) and a reference group of non-sedentary workers (n=396).

Figure 2 shows that specific problems can be identified between departments also with respect to workload and hazardous working conditions: Roll Maintenance and Electro technical Service show relatively low exposures, significantly for physical loads and poor climate. The Mobile Craftsmen Unit shows significantly high exposures to physical and poor climatic conditions. Furnace Building reports significantly high exposures to poor climatic conditions and vibration. Differences between groups with respect to psychosocial workload are small, only Roll Unit reports a significantly lower exposure. Means of all maintenance workers are comparable with the reference group, with the exception of vibration, which differs significantly.

Table 3 shows some additional details on the high physical exposures of the Mobile Craftsmen. All specific exposure variables show relatively high rates in this department, which indicates no specific bottlenecks, but a general high exposure level.

Table 3. Percentages of Mobile Craftsmen reporting exposure to musculoskeletal workloads often, regularly or daily (in comparison with all other maintenance workers)

Workload	Mobile Craftsmen	All other workers
High physical exertion	79*	63
Forces:		
• Lifting	84*	72
• Pushing/pulling	72*	49
Back movements:		
• Bending	94*	83
• Twisting	92*	85
Back postures:		
• Bent	86*	71
• Twisted	58*	44
Prolonged:		
• Standing	98*	91
• Sitting	28	30
• Kneeling	86*	56
• Walking	85*	75
Elevated arms		
• Under shoulder level	73*	56
• Above shoulder level	60*	24

* The difference between Mobile Craftsmen Unit and the remainder of the study population is significant ($p<0.05$)

6.3.3 Symptoms and exposures in 18 task groups

Musculoskeletal symptoms

Figure 3 shows the prevalence rates of symptoms of the low back (figure 3a), the neck-shoulder (figure 3b) and the knees (figure 3c) for the 18 task groups within the departments Furnace Building, Mobile Craftsmen Unit and Central Workshop.

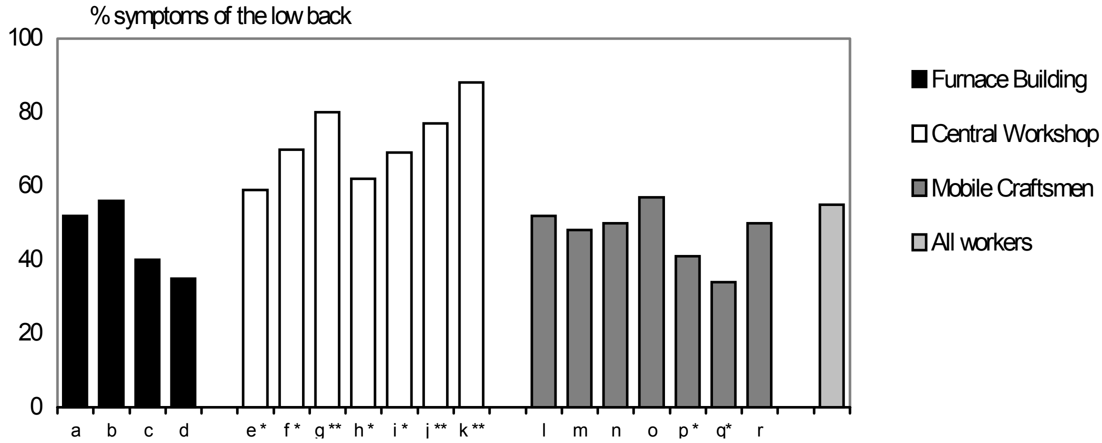

Figure 3a. Age standardized prevalence rates (%) of low back symptoms during the past 12 months of 18 task groups within maintenance workers.
* significantly different from mean of all workers, *p<0.25; ** p<0.05.

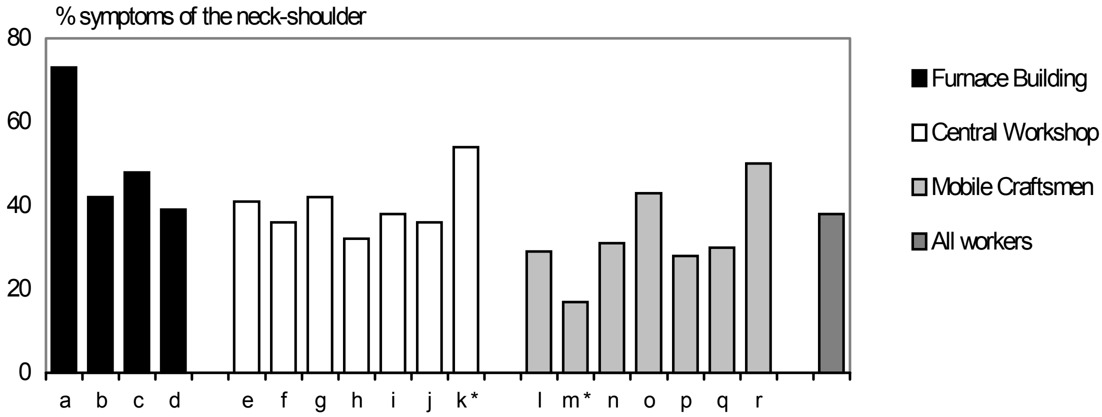

Figure 3b. Age standardized prevalence rates (%) of neck-shoulder symptoms during the past 12 months of 18 task groups within maintenance workers.
* significantly different from mean of all workers * p<0.25; ** p<0.05.

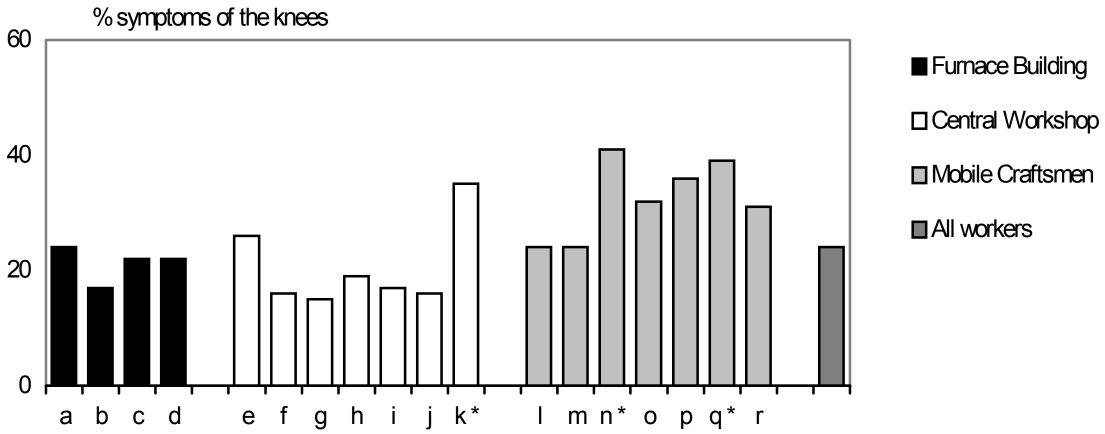

Figure 3c. Age standardized prevalence rates (%) of knee symptoms during the past 12 months of 18 task groups within maintenance workers.
* significantly different from mean of all workers * p<0.25; ** p<0.05.

A high level of symptoms is seen in particular within the Central Workshop (task groups g, j, k) with respect to the low back. Symptoms of the neck-shoulder and knees are relatively high in task group k. Most tasks of Mobile Craftsmen Unit tend to show higher rates of knee symptoms.

Self-reported workload and other working conditions

Table 4 shows the means of the four indices of workload and other working conditions.

Table 4. Mean scores of four indices of workload and working conditions of 18 task groups within three maintenance departments

Department and task group	Physical index	Psychosocial index	Climate index	Vibration
Furnace Building				
Various activities A	7.1	3.6	9.2*	6.8
Various activities B	7.4*	4.1	9.1	7.0
Maintenance of tiles	6.9	3.4	9.2*	7.3*
Spouting distributing-box	6.9	3.2	8.9	7.2**
Mobile Craftsmen Unit				
Maintenance fitting A*	7.9*	3.8	9.7*	6.6
Melting shop	7.1	4.1	8.4	6.0
Maintenance fitting B*	8.0*	4.0	9.2**	6.9
Activities shop	7.3	4.3**	9.1**	5.2
General tube manufacture RCV	7.7*	4.2**	9.8*	5.6
Maintenance fitting C*	8.1*	4.3	9.7*	6.7
Maintenance pumps/engines	7.9*	3.9	9.7*	7.1
Central Workshop				
Machine fitting	6.7	3.5	7.1	6.2
Marking off	7.7*	4.2	7.8	7.0
Directing	7.7**	4.6**	7.3	7.0
General construction fitting	7.2**	4.1**	7.4	5.9
Heavy construction fitting	7.5**	4.4**	6.8	7.3**
Welding shop	7.3**	4.1**	8.2	5.5
Construction fitting carriages	8.7*	5.1*	8.1	8.3*
Mean of total study population	6.4	3.5	7.8	5.5

* The difference between the task group and mean of total study population is significant (* p<0.05, ** p < .25).

Levels of exposures are in general above the mean of the total study population for most task groups, in particular with respect to physical loads and (less pronounced) psychosocial loads. Poor climate is reported often in particular task groups of Furnace Building and Mobile Craftsmen Unit. Exposure to vibration appears to be particularly high in particular task groups within Furnace Building and Central Workshop.

6.4 Discussion

6.4.1 General remarks

The aim of this study was not only to determine size and nature of the musculoskeletal problems and working conditions of maintenance workers, but also to generate data, which could play a role in setting priorities for ergonomic interventions in this group. Given the multitude of jobs and tasks of this group of maintenance workers, these priorities were necessary. High prevalence rates of symptoms and high exposure to adverse working conditions were among the criteria used in this decision making process: for a reduction of exposure and associated symptoms will have its greatest impact on, for example, costs when it is focused on high risk groups (Mairiaux 1991). Other criteria were involved too, such as the number of workers in a particular task group, data on absenteeism and disability, existing ergonomic data on workplaces and feasibility of ergonomic improvements.

6.4.2 Results concerning the total study population and the five departments

Attention for the prevention of musculoskeletal symptoms in this population as a whole seems warranted owing to a prevalence rate of back problems during the past 12 months of 50% of workers. In many of the specific task groups within the departments, rates were considerably higher. These results correspond with findings of Lenshoek et al. (1989) who reported high prevalence rates of musculoskeletal disorders among maintenance workers in the same firm. In addition, Van Dijk et al. (1987) found a three- to fivefold risk of disability due to musculoskeletal disorders among maintenance workers in comparison with office workers within the same industry. In that study, production workers showed even higher risks.

For maintenance workers, several high-risk departments could be identified (the Mobile Craftsmen Unit and the Central Workshop for low back and knee symptoms, respectively). Also Daniel et al. (1980) identified high-risk groups among departments of a steel company (coatings, mechanical and civil engineering, hot mill and melting shop).

6.4.3 Results concerning the 18 work tasks

The necessity to confine the analysis to groups of sufficient size and to accept a certain overlap between task groups owing to the multitude of tasks performed by a particular worker has its implications. First, less prevalent high-risk tasks were not involved. However, this was hardly a disadvantage, since the prevalence rate of the task was one of the criteria for choosing tasks in the following ergonomic analysis. Second, the overlap between task groups constitutes a risk of a misclassification of workers. In addition some high risk groups could have been missed due to a health based selection inherent to the cross-sectional nature of this study. Measurements were taken from surviving workers, which will weaken the relations found. However, the use of a fairly 'soft'

measure of effect (symptoms during the past 12 months) will partly counteract this (workers will not yet have dropped out when symptoms are still mild).
Both the overlapping groups and the possible health based selection will have weakened the ability to identify high-risk tasks. Nevertheless, the results of this analysis show that it is still possible to identify at least some of these tasks. In particular the Mobile Craftsmen Unit (task groups g, j and k) shows both high prevalence rates of low back symptoms and high exposures to unfavourable working conditions, which are important data to involve in a priority setting process.
In addition, the similarity of findings on health and workloads in the high-risk task groups involved (in general, workload in task groups with a high level of symptoms appears to be above the mean of the whole study population) suggests a relation between reported health problems and a high musculoskeletal workload.
Finally, some striking divergent findings must be mentioned with respect to the analysis on the level of departments and on the level of task groups: knee symptoms are relatively low in the Central Workshop as a whole (figure 1), whereas the separate task groups within this department show just the opposite (high rates). The same is seen for the Mobile Craftsmen Unit for low back symptoms. This again indicates the necessity to analyse results also at task group level, in particular since an ergonomic intervention will most probably take place at that level.
On the basis of the results of this analysis as well as other ergonomic data on the work tasks involved, three working tasks were chosen. For these tasks, ergonomic guidelines were developed and reported elsewhere (Dul et al. 1991).

6.5 Conclusions

At the department level, the Electro technical Service and the Mobile Craftsmen Unit were identified as high risk groups concerning musculoskeletal symptoms. At the level of specific tasks, identification of high-risk groups was more difficult, in particular due to small number of workers per task and the variety of tasks performed by one worker. Nevertheless, this analysis supplied additional information for choosing the workplaces for the following ergonomic intervention.
A questionnaire survey can be considered to be a valuable instrument in the first phase of the selection of ergonomic interventions in those workplaces, which constitute the highest risks for the workers.

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7. Back pain in the working population: prevalence rates in Dutch trades and professions[1]

[1] Published as: Hildebrandt VH. Back pain in the working population: prevalence rates in Dutch trades and professions. Ergonomics 1995;38:1283-98.

Abstract

Objectives

Identification of Dutch trades and professions with relatively high and low prevalence rates of back pain.

Methods

An analysis of three health surveys in the Dutch working population. The sample was representative of the working population in the Netherlands and consisted of 5,840 man and 2,908 women. The analysis included 33 trades and 34 professions with at least 50 respondents for each.

Results

A total of 26.6% of the workers reported back pain quite often. Almost 2% reported absence from work in the last 2 months, and 4% considered their back pain to be a chronic disabling disease. There was a substantial variation in prevalence rate of low back pain between trades and professions, ranging from 12 to 41%. Trades with relatively high prevalence rates were found to be the building materials industry, the construction industry and road transportation, and the wholesale industry. Trades with relatively low prevalence rates were found to be banking, public administration and commercial services. Workers in the construction industry and supervisory production workers, plumbers, drivers and cleaners had a relatively high prevalence rate of back pain. Chemists, scientists, bookkeepers, secretaries and administrative professions had a relatively low prevalence rate of back pain.

Conclusions

It is concluded that high prevalence rates of back pain are found in particular in non-sedentary professions. Priorities in prevention of back pain should be directed towards the groups with relatively high prevalence rates identified above.

Keywords: Back pain; Work related disease; Trades; Professions

7.1 Introduction

Back pain is one of the most prevalent health symptoms in the general population. More than half of the general population reports having had back pain at some time in their lives (Haanen et al. 1984). In the Netherlands, 21% of sick leave days (CBS 1985) and 32% of permanent disability (GMD 1985) is diagnosed as 'musculoskeletal disorders'. Within this category, back pain constitutes the largest part (Verbeek 1991).
Despite the magnitude of the problem, there is still limited knowledge on prevalence rates of back pain in specific trades and professions. Indeed, many studies are available on back pain in specific worker populations, but the data from these studies are often not comparable due to a large variation in the applied methods. This makes it difficult to obtain a valid overall picture of the differences in prevalence rate of back pain in different trades and professions. Knowledge of relative prevalence rates in trades and professions is of interest, first, to indicate priorities concerning trades and professions most needing preventive action. Second, hypotheses can derived from such data on the underlying work related risk factors from which specific studies aimed at dose-response relationships can be carried out. Such studies can supply the necessary data to formulate effective preventive action.
In the Netherlands, few sources provide representative, comprehensive and comparable data on health status of different trades and professions. In this paper, data are analysed from a yearly health survey of the Dutch working population by the Dutch Central Statistics Office (CBS). This survey consists of a random sample of 10,000 persons of the general population. The sample accurately reflects the general Dutch population on a number of background variables (e.g. age, sex, civil status, size of household) (Sonsbeek and Stronckhorst 1983) and may thus be considered to be a representative sample of the working population in the Netherlands. In the survey a few questions are asked on work and back pain, which are used to describe the prevalence rate of back pain in the Dutch working population, stratified by trade and profession. The central question of the analysis is: “Which trades and professions are associated with a relatively high and low prevalence rate of back pain?"

7.2 Methods and material

To obtain a large sample, respondents with an officially paid job were selected from three CBS surveys on successive years (1983, 1984, 1985), constituting a database of 8,748 Dutch workers.
The variables involved were a written question on back pain ("Do you have trouble from your back quite often") and oral questions on the kind of daily work undertaken ("What are you doing precisely in your work" and "In what kind of firm or institution are you working"). The answers to these oral questions were coded according to a Dutch classification of trades and professions (CBS 1984). In this classification, 9 trading branches and 7 professional branches were distinguished. Each branch was subdivided into classes; 55 trade classes and 85 professional classes were defined. Obviously, there is a relation between trade and profession: within a trade, several professions will be present and vice versa. Hence, the sample was categorized in two separate, but completely overlapping ways:

- A distinction into trade branches, subdivided into trade classes and
- A distinction into professional branches, subdivided into professional classes.

The question on back pain was part of a larger validated questionnaire on psychosomatic health symptoms (Dirken 1967), which was an integral part of the survey questionnaire. In another part of the survey questionnaire, respondents were asked about sick leave and chronic diseases or handicaps, from which additional data could be derived on sick leave due to back pain in the last two months and chronic disabling back pain. However, in the analysis, only the question on the presence of back pain quite often was used since prevalence rates of sick leave and chronic conditions were too low to allow cross tabulation with trades and professions. In the following, prevalence rate of back pain is defined as the percentage of respondents who answered positively to the question concerning 'having back pain quite often'.
For a first insight into the relation between the back symptoms and the kind of work done, professions defined by relatively light, sedentary work were classified as sedentary (most professions in professional branches 0 to 4 in table 2) and professions defined by more heavy, dynamical work were classified as non-sedentary (most professions in professional branches 5 to 9 in table 2) and cross tabulated with back pain, gender and age.
Next, prevalence rates were computed for each trade and professional branch and class. Since all four exposure variables (trade branch, trade class, professional branch and professional class) were categorical and the effect variable (presence or absence of back pain quite often) was dichotomic, a loglinear model was chosen for the statistical analysis ('logit-model', SPSS-X statistical software package). Such a model allows an efficient and systematic evaluation of relations without having to produce an immense set of cross tables for each combination of variables with associated statistics. By specifying age in this model as a categorical covariate of back pain (three age classes), allowance was made for the possible confounding effect of age on the relation between exposure categories and back pain due to possible age differences between exposure groups and the age dependence of back pain. The influence of gender was controlled by stratification. In the tables, it is indicated if the risk of back pain in a particular branch or class compared to the risk of having no back pain is significantly smaller or greater than could be expected on the basis of the model formulated. An alpha of 0.10 (two-tailed) has been accepted, given the exploratory nature of the study.

7.3 Results

7.3.1 Descriptive data of the sample

The sample consists of 8,748 workers (age range 16-79), 33% female (n=2,908), mean age 38 years and 67% male (n=5,840), mean age 34 years. The distribution of the sample over the various trades (table 1) and professions (table 2) is given separately for men and women and compared with corresponding data from an official Labour Force Census (CBS 1983).
Branches and classes with less than 50 respondents were excluded from the analysis. This meant that seven out of nine trade branches, all nine professional branches, 33 of the 55 trade classes and 34 of the 85 professional classes were included in the analyses.

Table 1. Distribution of the sample over the various trades (branches and classes), stratified for gender, excluding all branches and classes with less than 50 respondents. Right column: corresponding data from an official Labour Force Census (CBS 1984).

		Men n=5,840		Women n=2,908		Total n=8,748		Census data
Trades: branches (bold) and classes		n	%	n	%	n	%	%
1	agriculture	378	6.5	52	1.8	449	5.1	5.0
2/3	industry	1,453	24.9	280	9.6	1,733	19.8	19.7
20/21	food, drink, catering	114	3.7	58	2.0			
25	wood, furniture industry	57	1.0	-	-			
27	publishers	121	2.1	-	-			
29	chemistry	114	2.0	-	-			
32	building materials et al.	50	0.9	-	-			
33	basic metal industry	65	1.1	-	-			
34	metal products	147	2.5	-	-			
35	machines	129	2.2	-	-			
36	electrical industry	190	3.3	-	-			
37	transportation	96	1.6	-	-			
39	other industry	86	1.5	-	-			
4	public utility	72	1.2	-	-	80	0.9	0.9
5	construction, installation	658	11.3	-	-	683	7.8	8.3
51	construction	512	8.8	-	-			
52	building installation	146	2.5	-	-			
6	trade, hotel and catering	907	15.5	612	21.0	1,519	17.4	17.5
61/62	wholesale	358	6.1	100	3.5			
65/66	retail	364	6.3	436	15.0			
67	hotels, catering	85	1.5	68	2.3			
68	repair utensils	100	1.7	-	-			
7	transportation, storage, communication	485	8.3	80	2.8	565	6.5	6.3
71	railways	50	0.9	-	-			
72	road transportation	187	3.2	-	-			
73	navigation	52	0.9	-	-			
77	communication	139	2.4	-	-			
8	banking, insurance, commercial service	498	8.5	266	9.1	764	8.7	7.4
81	banking	116	2.0	101	3.5			
82	insurance	80	1.4	-	-			
84	commercial service	260	4.5	119	4.1			
9	remaining service	1,372	23.5	1,583	54.4	2,955	33.8	33.1
90	public administration, defence	527	9.0	129	4.4			
92	education							
93	health care and veterinary services	374	6.4	332	11.4			
94	social services	169	2.9	433	14.9			
95	social-cultural institutions	73	1.3	419	14.4			
97	social organisations, research institutes	63	1.1	81	2.8			
98	other services	53	0.9	-	-			
		62	1.1	121	4.2			

Table 2. Distribution of the sample over the various professions (branches and classes), stratified for gender, excluding all branches and classes with less than 50 respondents. Right column: corresponding data from an official Labour Force Census (CBS 1984).

Professions: branches (bold) and classes		Men n=5,840		Women n=2,908		Total n=8,748		Census data
		n	%	n	%	n	%	%
0/1	scientists, specialists	1,277	21.9	744	25.5	2,018	23.1	20.8
1	chemists, physicists et al.	57	1.0	-	-			
2/3	architects, engineers, drawers	379	6.5	-	-			
6/7	doctors, dentists, veterinarians, nurses	130	2.2	319	10.9			
8	statisticians, mathematicians, system analysts et al.	85	1.5	-	-			
13	teachers	271	4.6	234	8.0			
19	scientists, other specialists	147	2.5	102	3.5			
2	management	216	3.7	-	-	236	2.7	4.2
21	managers	205	3.5	-	-			
3	administrative functions	856	14.7	804	27.6	1,660	19.0	18.6
32	secretaries, typists	-	-	194	6.7			
33	bookkeepers, cashiers et al.	275	4.7	146	5.0			
37	post and distribution	58	1.0	-	-			
39	civil servants	408	7.0	425	14.6			
4	commercial functions	575	9.8	376	12.9	951	10.9	12.6
43	shopkeepers	110	1.9	-	-			
45	managing commercial personnel	53	0.9	-	-			
46	agents	79	1.4	-	-			
47	insurance agents et al.	54	0.9	-	-			
48	shop assistants, salesmen	171	2.9	326	11.2			
5	service functions	322	5.5	759	26.1	1,081	12.4	11.6
53	cooks, waiters, barmen et al.	72	1.2	107	3.7			
54	domestic services	-	-	341	11.7			
55	housekeeping, cleaning	55	0.9	186	6.4			
58	firemen, police, guards	105	1.8	-	-			
59	other services	-	-	53	1.8			
6	agriculture	388	6.6	52	1.8			
61	self employed	204	3.5	-	-	440	5.0	5.5
62	workman	163	2.8	-	-			
7/8/9	craftsmen, industry, transportation	2,206	37.8	156	5.4	2,362	27.0	24.9
70	supervisory production personnel	144	2.5	-	5.4			
77	preparing food, drinks	93	1.6	-	-			
83	tool makers, machine fitters,	67	1.1	-	-			
84	instrument makers et al.	289	4.9	-				
85	electrical fitters et al.	167	2.9		-			
87	plumbers, pipe fitters, welders,			-	-			
	sheet metal workers	89	3.2					
92	printers	76	1.3	-	-			
93	painters	76	1.3	-	-			
95	construction workers	316	5.4	-	-			
97	loading/unloading,			-	-			
	crane drivers et al.	197	3.4					
98	drivers, sailors,	370	6.3	-	-			
	train drivers et al.			-	-			

Most trades and professions are well represented in the sample. Gender ratios in the different branches and classes vary greatly; especially in industry, women are relatively scarce. Comparison of the distribution of the sample over the various trade and professional branches with data from the national Labour Force Census (CBS 1984) indicates that the representative ness of the sample is adequate: as is shown in table 1 and table 2, the distribution of workers over the various trades and professions in the sample is closely reflected by the census data (within 2%). The same was seen for age and gender.

7.3.2 Prevalence rate of back pain in the total sample

In table 3, the prevalence rate of back pain is shown for the total sample. In addition, data are shown on the percentage of respondents, which were absent from work during the last two months due to back pain, and the percentage with chronic disabling back pain. These data are stratified for gender and age (three classes).

Table 3. Prevalence rate of back pain, sick leave due to back pain, and chronic disabling back pain (%) in the total sample, stratified for age and gender.

	n	Back pain quite often	Sick leave due to back pain (last 2 months)	Chronic disabling back pain
gender				
males	5840	25,3	1,7	4,8
females	2908	28,9	1,3	3,7
age (years)				
16-34	4096	21,8	1,2	2,5
35-49	3180	30,2	1,8	6,1
≥ 50	1472	31,9	1,9	6,6
total population	8748	26,6	1,5	4,5

differences between males and females as well between age categories are all significant ($p< .05$)

More than a quarter of the respondents reported having back pain quite often (26.5%); 1.5% had been absent from work during the past two months due to back pain (that is 5% of the respondents who complained about having quite often back pain); 4.5% reported having chronic disabling back pain (that is 16% of the respondents who complained about having quite often back pain). Women have more symptoms than men and prevalence rate is increasing with age in men as well as women. Figure 1 presents some detail on the relation between back pain and age.

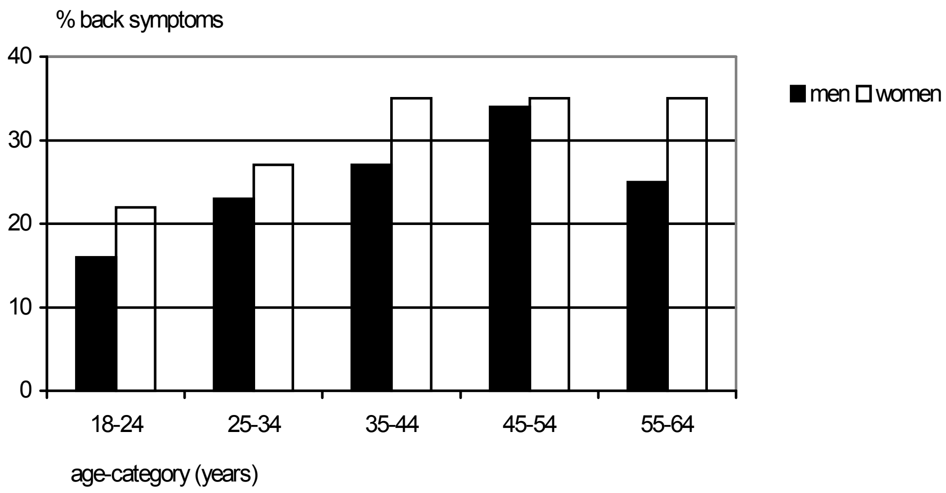

Figure 1. Relation of back pain with age and gender.

In men, prevalence rate increases until the fifth decade and decreases from 55 years onwards; in women, this decrease is not seen. To evaluate whether this relation is dependent on the kind of work, data were stratified for sedentary and non-sedentary work.

In table 4, first the prevalence rate of back pain is shown for sedentary and non-sedentary workers.

Table 4. Prevalence rate of back pain, sick leave due to back pain, and chronic disabling back pain (%) in sedentary (SED) and non-sedentary professions (NON-SED), stratified for age and gender.

	n	Back pain quite often	Sick leave due to back pain (last 2 months)	Chronic disabling back pain
Non-sedentary	3883	29,6	2,1	5,7
males	2916	28,9	2,3	5,9
females	967	32,7	1,8	5,0
sedentary	4865	23,9	1,0	3,5
males	2924	21,6	1,0	3,8
females	1941	27,4	1,1	3,0
total population	8748	26,6	1,5	4,5

differences between non-sedentary and sedentary workers and subgroups are all significant (p< .05)

From table 4, it is concluded that in non-sedentary work, both men and women have higher prevalence rates of back pain than in sedentary work. Figure 2 shows the relation between back pain and age for both sedentary and non-sedentary workers for males and females.

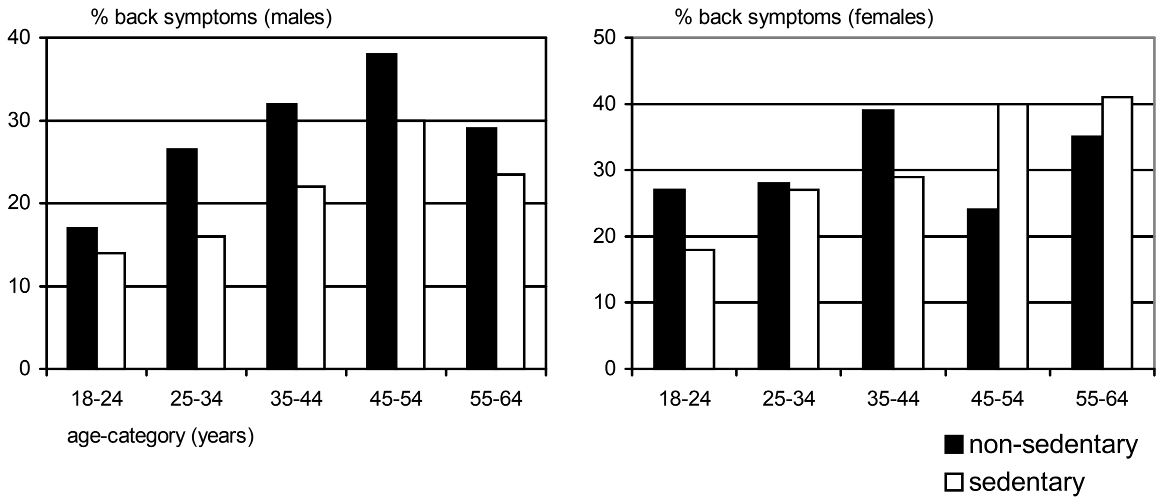

Figure 2. Relation of back pain with age in sedentary and non-sedentary work in males and females.

In both non-sedentary workers and sedentary workers, prevalence rates decrease in the older age categories in male workers; this trend is not seen in the female group.

7.3.3 Prevalence rate of back pain in trade and professional branches

Figure 3 shows the prevalence rate of back pain in the various trades and professional branches, for men and women separately.

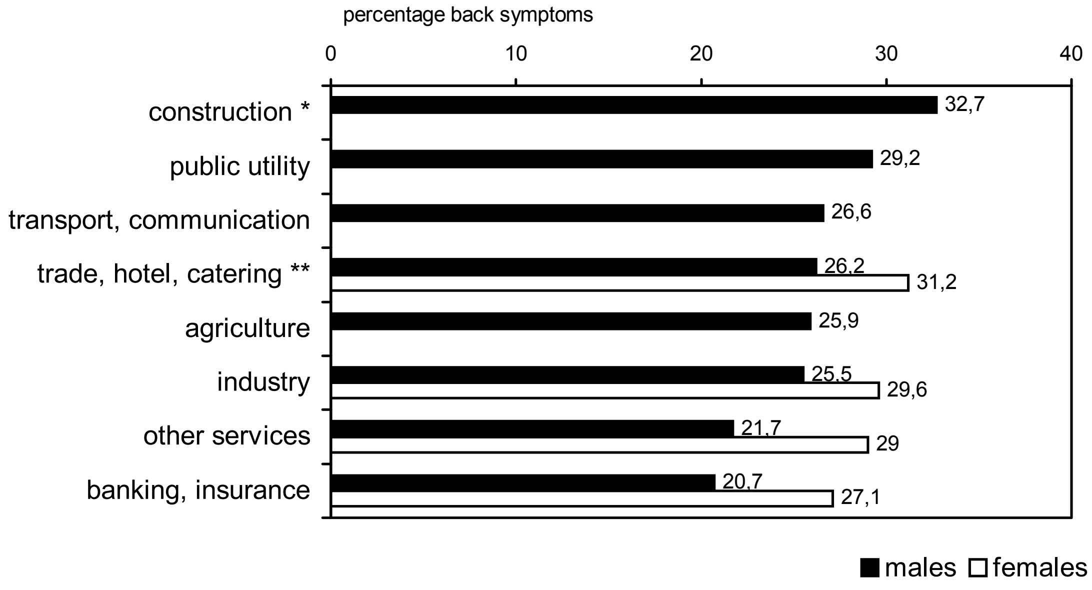

Figure 3a. Prevalence rate (%) of back pain in the various trade, for men and women; */** prevalence rate is significant (p<.10) higher or lower than expected in males/females, after allowance for age-differences between groups. No data are available for females in construction, public utility, transport/communication and agriculture and in agriculture and management.

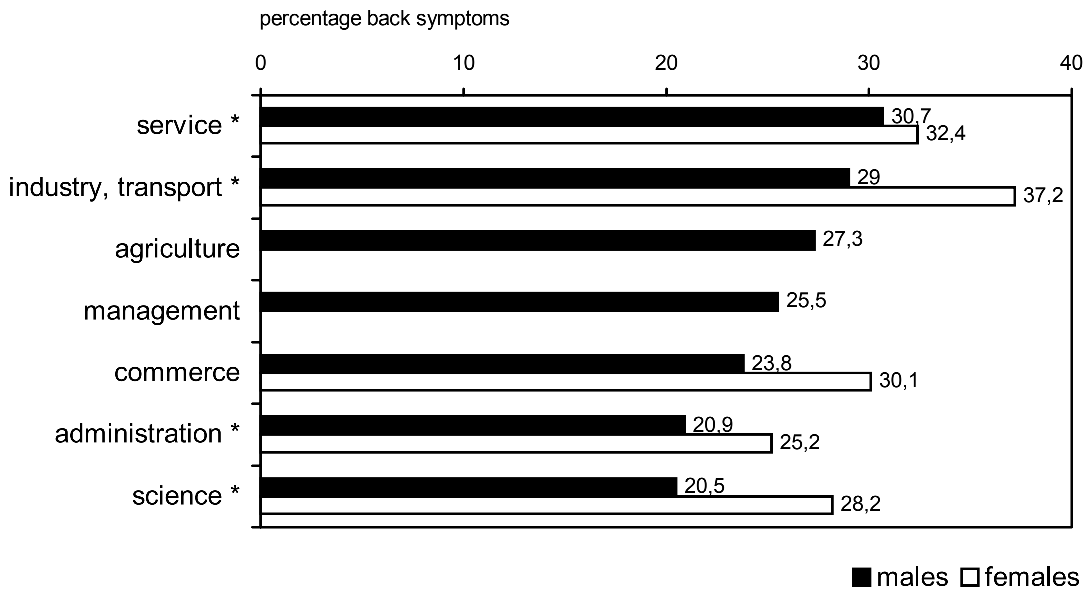

Figure 3. Prevalence rate (%) of back pain in the various professional branches, for males and females; * prevalence rate is significantly (p<.10) higher or lower than expected in males, after allowance for age-differences between groups. No data are available for females in construction, public utility, transport/communication and agriculture and in agriculture and management.

7.3.4 Prevalence rate of back pain in trade and professional classes

Figures 5 (a) and (b) show the prevalence rate of back pain for men and women in the various trade classes. Figures 6 (a) and (b) show the prevalence rate of back pain in the various professional classes.

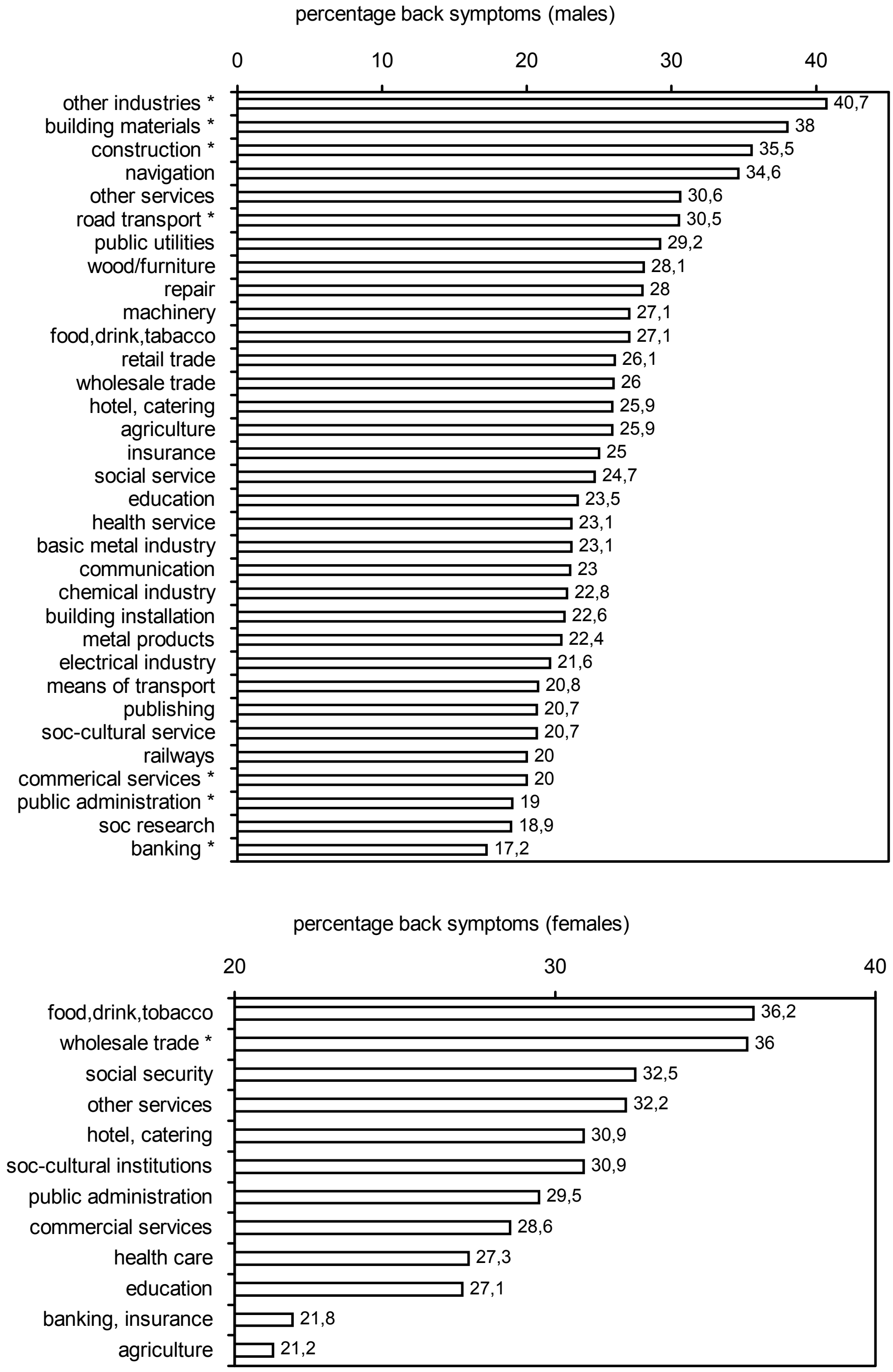

Figure 5. Prevalence rate (%) of back pain in the various trade classes for males and females; * prevalence rate is significantly (p<.10) higher/lower than expected, after allowance for age-differences between groups.

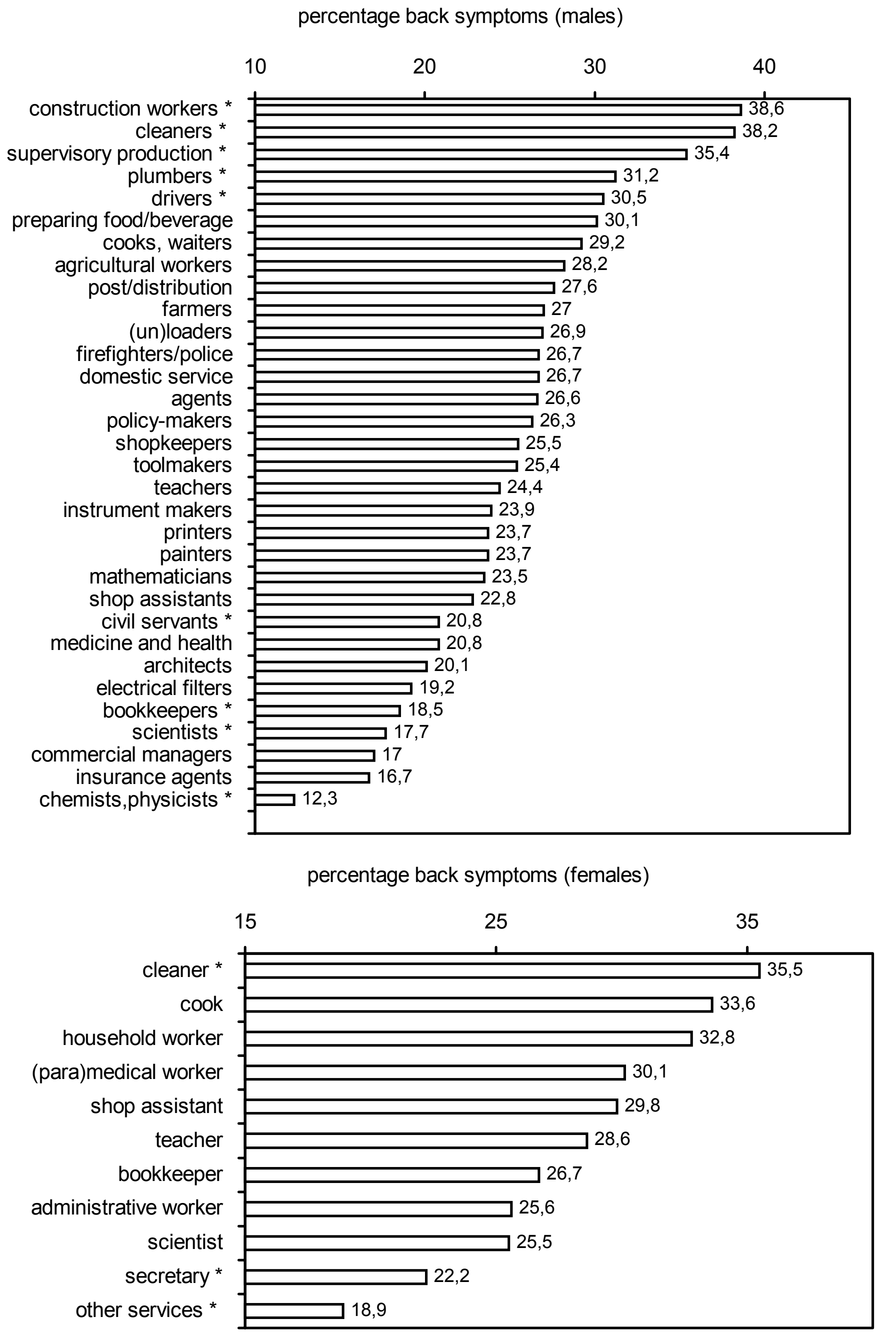

Figure 6. Prevalence rate (%) of back pain in the various professional classes for males and females; * prevalence rate is significantly (p<.10) higher/lower than expected, after allowance for age-differences between groups.

All figures indicate a substantial variation of prevalence rates of back pain for the various categories (range from 12% to 41%). Professional classes seem to differentiate best. Significant findings from figures 3 to 6 are summarized in table 5.

Table 5. Summary of main findings (only trades and professions that showed significant deviation from the mean).

Branch/class	Gender	High prevalence rate	Low prevalence rate
Branches			
Trade	Men	Construction	Bank, insurance
	Women	Trade, catering	
Professions	Men	Services	Scientists
		Industry - transport	Administration
Classes			
Trade	Men	Other industries	Banking
		Building materials	Public administration
		Construction	Commercial services
		Road transport	
	Women	Wholesale	
Professions	Men	Construction workers	Chemists
		Cleaners	Scientists
		Supervisory production workers	Bookkeepers
		Plumbers	Civil Servants
		Drivers	
	Women	Cleaners	Secretaries
			Others services

Table 5 identifies several branches and classes characterized by relatively high or low prevalence rates of back pain. It seems that high prevalence rates of back pain are found in particular in non-sedentary professions.

7.4 Discussion

The aim of this analysis was primarily to obtain some basic data on the prevalence rate of back pain in the working population. Considering the representativeness of the sample, it is likely that all Dutch trades and professions of substantial size indeed have been involved in the analysis. Nevertheless, smaller groups are still under-represented, which means that more risk groups will be identified when larger samples are available. This is particularly important in the case of women, who are less well represented in several trades and professions. Furthermore, housewives and househusbands were not included in the sample, since it was restricted to workers with officially paid jobs.

7.4.1 Methodological notes

For interpretation of the results of the analysis, it is important to evaluate the data used. They were originally collected for screening of health and medical consumption, which has disadvantages but also advantages. A disadvantage is that the work and health measures used were not specifically directed to the research objective, resulting in less specific variables than would have been desirable, in particular with respect to the exposure variables. Apart from the classification of the work in professions and trades, no additional information was available on the size and nature of the (musculoskeletal) workload of the respondents. This makes it difficult to interpret findings in terms of workload factors, since trades and - to a somewhat lesser extent - professions are very heterogeneous concerning physical workload.

The measure of effect, self-reported back symptoms, is also rather crude and could cause misclassification of respondents. However, back pain is difficult to assess objectively and to classify into clinical syndromes (Frymoyer et al. 1983; Biering-Sørensen 1983). Furthermore, it has been shown conclusively that it is possible to differentiate groups with diverse musculoskeletal workload and health on the basis of questionnaire findings (e.g., Biering-Sørensen 1985)

An advantage of the use of this database was its size and representativeness. Another advantage concerns the absence of information bias, since respondents were completely unaware of the aim of this analysis and thus not biased towards a supposed relationship between their job and the presence of back pain. The survey was cross-sectional, which means all drawbacks of this design have to be kept in mind when interpreting the results. In particular, the healthy worker effect has to be mentioned. Workers having severe back pain in combination with a high physical workload, will fall-out (by sickness absence, disability) or change their work from a physically heavy to a physically lighter job. A cross-sectional survey measures the survivors, those who stay in their work, and thus apparently can cope with the high demands of their work. This may result in a major underestimation of work related morbidity, in particular in the older age groups and professions with heavy working conditions and with respect to the more severe stages of low back pain (although the prevalence measure used will involve also less severe stages). The age-related prevalence figures found, can support this phenomenon in the population involved. After an increase of back pain (which is to be expected since older workers, in general, display more adverse health symptoms, see Smulders and Bloemhoff 1991), prevalence rate decreases in the male sample in the oldest age category. This could indicate a selection process, in which less healthy and older workers leave their work and workers with the relatively light jobs survive. As a result, the working population becomes healthier. In this respect it is surprising that the decline of back pain in the older age groups of men was seen for both non-sedentary and sedentary workers, as it is to be expected that non-sedentary workers would be subject to selection to a much greater extent than sedentary workers. In women, other factors probably counteract this mechanism independent of work (e.g., hormonal changes, osteoporosis).

7.4.2 Interpretation of results

Literature on large population samples with regard to low back pain in trades and professions is scarce. However, the results of this study do match the literature well; professions, which are mentioned often in literature having high prevalence rates of back pain (e.g., construction workers), do show high prevalence rates in this analysis. They are also in agreement with the data from periodic examinations in occupational health care in the Netherlands (Broersenn et al. 1992), which are summarized in table 6.

Table 6. Summary of main findings of studies of Broersenn et al. 1991.

Gender	High prevalence rate (>10% above average)	Low prevalence rate (>10% beneath average)
Men	road maker	head internal administration
	plasterer	head technical department
	bricklayer	engineer
	trade or industry occupation	engineer boiler house
	teacher in physical education	head of transport
	machine operator	higher mechanical engineer
	carpenter	assistant bookkeeper
	metal worker	secondary administrative employee
	builder's labourer	supervisor maintenance production
	gardener's assistant	bookkeeper
Women	hospital nurse	juvenile educator
	packer	household staff
	assistant bookkeeper	primary administrative employee
	cleaner	administrative functions
	administrative clerk	controller products

In these data, in particular male construction workers and female nurses show the highest prevalence rates.

This broad analysis, as well as the study of Broersenn et al. (1992) and many studies in other countries (e.g., Magora 1970; Nagi et al. 1973; Pelisson and Chaouat 1979; Svensson and Andersson 1982; Biering-Sørensen 1985; Naliboff et al. 1985), again supports the viewpoint that, in particular, non-sedentary work is associated with high prevalence rates of back pain in both men and women. The same was seen in respect to musculoskeletal diseases in general (Hellgren 1970; Takala et al. 1982; Hettinger 1985; Metzler 1985). Nevertheless, a review of isolated studies on individual professions indicated that professions characterised by light (more static) work can show high prevalence rates of back pain too (Hildebrandt 1988).

The question remains as to whether the differences between branches and classes are caused by specific exposures to (or combinations of) workloads in these groups. In this respect, findings in the professional classes are most interesting, since these are likely to be more homogeneous concerning the kind of workload than the trade's classes. In a recent study (Gründemann et al. 1991) data have been gathered on self-reported workload in a number of professions in the Netherlands, using the same classification. This makes it possible to generate at least some hypotheses on the relation between back pain and workload in the professions involved here. This study involved a questionnaire survey among more than 8,000 workers who had been off work for approximate one year because of health problems. Among others, questions were asked on exposure to postures, movements and force exertions derived from the 'Dutch Musculoskeletal Questionnaire'. These data could give at least an indication of the size and nature of the workload in the professions involved, although this information is derived from a very selected population (workers being off work for a long time because of health problems) and workers may overestimate harmful exposures. This is not necessary a problem, since it will at most emphasize to some extent differences in workload in the different professions, which is only helpful for the desired qualitative characterization of professions.

In table 7 the results of these questions are shown, stratified for professions. Only those professions which were analysed in both studies and which are relatively well defined by their titles, are involved in this analysis. In the table, it has been indicated when a particular workload variable scored particularly high or low (+/- 15% of average) in a particular profession. Also, the prevalence rate found in the present study is shown for each profession. Professions with intermediate prevalence rates are omitted to obtain a sharp distinction between professions.

Table 7. Self-reported exposure to workload variables by workers with one year of sickness absence in a selection of 14 professions (data from Gründemann et al. 1991) and prevalence rate of back pain (males and females) in these professions (data from the present study); exposure is indicated by the percentage workers reporting to be exposed often to that particular workload factor. Percentages printed in bold: scores are at least 15% higher than average (percentage self-reported exposure to workload for all disabled workers)

Workload variable	mean	Profession													
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
high physical load	62	64	56	76	**78**	**78**	73	**87**	**83**	70	68	17	14	16	58
high mental load	49	31	55	20	44	40	**67**	39	42	39	36	58	**74**	**77**	45
time pressure	60	59	61	55	51	63	73	67	60	53	54	66	65	**75**	62
often lifting	54	**84**	44	66	**69**	**6**	56	**83**	**81**	64	65	03	07	07	46
often push/pulling	37	**58**	39	**56**	40	32	42	**64**	**62**	**55**	**59**	01	03	04	45
often sitting	29	06	19	02	04	03	**76**	18	31	21	12	**92**	**85**	**59**	20
often standing	55	**75**	59	51	51	87	22	**74**	**71**	**79**	**76**	07	07	30	69
often walking	52	**68**	58	**86**	**77**	**82**	29	61	64	40	55	09	06	16	61
% back pain	27	39	36	36	33	32	31	31	29	24	22	21	21	21	19

1 construction; 2 supervisors production; 3 cleaners; 4 domestic servants; 5 cooks; 6 drivers; 7 plumbers; 8 loading/unloading; 9 metal workers; 10 fitters; 11 secretaries; 12 bookkeepers; 13 scientists; 14 electrical engineers.

Although table 7 has to be interpreted with great care, taking into consideration the severe limitations of the data source mentioned above, the data seem to support the conclusions drawn before: professions with a high prevalence rate of back pain are on average characterised by physically demanding work with dynamical components (e.g., lifting, pushing/pulling and walking in the construction industry). Professions with low prevalence rates show a tendency towards light work with or without static components (e.g., sitting). However, exceptions have to mentioned too (e.g., supervisory production workers, metal workers, fitters). Therefore, keeping in mind the multicausal aetiology of back pain and the paucity of data on many relevant variables, any statements on underlying causal relations on the basis of the data presented here must remain speculative.

To obtain clues for prevention, more knowledge on workload factors, which constitute increased risks of back pain and corresponding dose-response relationships, is needed. Prospective studies on the relation between exposure to workload and the onset or aggravation of back pain on workers are therefore a prerequisite. Only with such a longitudinal design can exposure to workload and subsequent changes in time be quantified in a valid way, while in the meantime keeping track of the various selection processes.

7.5 Conclusions

Prevalence rates of back pain in the most important trades and professions in the Netherlands appear to vary greatly, ranging from 12% to 41%, with a mean prevalence rate of 27%.
Interpretation of the findings is difficult since data on relevant workload factors in the various trades and professions studied are very scarce. It seems though that workers in professions exposed to physically heavy (non-sedentary) work (e.g., construction workers) are at greater risk than workers in professions exposed to physically lighter (sedentary) work (e.g., bank employees). Nevertheless, more quantitative (dose-response) data on work related and personal risk factors of back pain are needed for a valid assessment of priorities concerning preventive actions, which should reduce musculoskeletal morbidity in the working population.

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8. The influence of climatic factors on aspecific back and neck-shoulder disease[1]

[1] Submitted as Hildebrandt VH, Bongers PM, Dul J, Van Dijk, FJH,Kemper HCG The influence of climatic factors on a specific back and neck-shoulder disease.

Abstract

Objectives

An epidemiological study was carried out to explore the relation between climatic factors and aspecific low back and neck-shoulder symptoms in working populations.

Methods

A literature review was carried out and questionnaire data on musculoskeletal symptoms, workload and climatic conditions of 2030 workers in 24 different occupations were analysed multivariate.

Results

On the basis of the scanty findings of non-specific studies, it can be concluded that a relation between climatic factors and musculoskeletal symptoms is considered at least plausible by both researchers, workers and patients, but the epidemiological evidence appearing from literature is - in contrast - very weak.

In the analysis of the questionnaire data about a quarter of the workers related symptoms of the low back and neck-shoulders to climatic factors. They perceived climatic factors in most cases as aggravating factors for their symptoms. No seasonal influence on prevalence rates of low back and neck-shoulder symptoms was reported. Both for low back and neck-shoulder symptoms, and sick leave due to neck-shoulder symptoms, an association was found with climatic factors, in particular with respect to draughts in relation to neck-shoulder symptoms. In addition, neck-shoulder symptoms were negatively related to frequent outdoor work.

Conclusions

The findings suggest a relationship between climatic factors and musculoskeletal symptoms and call for further detailed investigations.

Keywords: Musculoskeletal risk factors, working conditions, outdoors work, draught, weather, season

8.1 Introduction

A relation between climatic conditions at work and the prevalence of low back symptoms is commonly assumed. Workers often associate symptoms such as low back pain or muscular pain with draughts and cold. In the literature, many examples of those self-reported associations are found: Hult 1954, Wagenhäuser 1969, Heino et al. 1978, Backman 1983, Biering-Sørensen 1983a. Authors themselves also mention the possibility of an association between climatic factors and low back symptoms (Hult 1954, Isomaki 1983, Wagenhäuser 1969, Backman 1983, Heino et al. 1978), although others doubt that climate has any effect on musculoskeletal disease (Riihimäki 1985). Several authors describe the 'sensitivity' of patients with a specific arthritis to climatic factors: Kellgren et al. (1953), Hult (1954), Brown & Lingg (1961) and Folkerts (1984). Tauber (1970) states "a generation-old observation has been that changes in the weather influence musculoskeletal aches quite significantly and quite definitely".

Kellgren et al. (1953) concludes on the basis of clinical experience that there is a sensitivity of patients with disc pathology or generalized osteoarthritis to climatic factors: patients with disc pathology in particular to coldness and dampness, patients with osteoarthritis in particular to dampness. Wilson & Wilson (1955) postulated that acute attacks of low back pain often take place in the first hours of a cold, damp working day, whereas chronic symptoms deteriorate in that part of the day. St John Dixon et al. (1972) describes a 'cold-sensitive', a specific, low back pain as a subgroup within a specific low back pain, in addition to a subgroup of posture-related problems, though combinations of the two are also present. This syndrome is characterized by symptoms that are sensitive to cold, in particular at night. Troup et al. (1981) distinguishes three types of recurrent low back pain: a type related to posture, another type characterized by regular attacks often related to the season with symptom-free intervals in between and a mixed type. Biering-Sørenson (1983b) considers that weather sensitivity contributes in particular to back symptoms of muscular origin. Coste et al. (1992) tried to identify clinical subtypes of a specific low back pain and reported a subtype 'psychological pain', which was (among others) characterized by an aggravation of pain related to changes in climate. Wickström (1978) concludes in a literature review on the effect of work on degenerative back disease that 'wet and cold work conditions may awake or aggravate rheumatic symptoms, while heat may reduce them. It seems however, that climatic conditions as such do not affect the degenerative process in the spine'.

The question thus may be raised whether this phenomenon of 'weather sensitivity' really exists, or whether it involves only anecdotes, superficial case-studies and personal, not factually based opinions (Latman 1987) or 'old wives tale' (Hollander 1985).

In this paper, firstly the literature is analysed to describe the epidemiological data available on the relation between climatic factors and a specific musculoskeletal disorders. Secondly, an analysis of this relation is reported using a database of 2030 workers who filled in a questionnaire on musculoskeletal symptoms and workload as well as on climatic factors.

8.2 Research question

The basic question addressed in the literature survey was whether climatic factors, such as draught, and changes of temperature, are related to musculoskeletal symptoms, in particular low back and neck-shoulder symptoms.

The data-analysis addressed the following questions:

- Do workers themselves experience more symptoms in particular seasons in comparison with other seasons?
- Do workers themselves relate their symptoms to particular climatic factors? Do they feel that climatic factors aggravate or relieve their symptoms?
- Are self-reported climatic factors (cold, draught, dampness and changes of temperature) and outdoor work positively related to symptoms?

8.3 Methods and material

A literature search was carried in the Emhealth and Cisdoc databases using “climate”, “weather” and “musculoskeletal symptoms” as main keywords. Only literature in English from 1975 onwards was included. In addition, epidemiological studies on low back and neck-shoulder symptoms, which were not indexed on these keywords, were manually screened and included when climate was addressed in the analysis in relation to musculoskeletal symptoms.

The database used for the empirical study consisted of 2,030 workers who completed the Dutch Musculoskeletal Questionnaire (DMQ). The database represents a large variety of occupations in industry (shipyard, metal, transport), services (cleaners, child care), health care (nurses) and offices. This questionnaire measures self-reported musculoskeletal symptoms and exposure to physically demanding working conditions and has a short and an extended version. It contains questions on exposures to cold, draught, dampness and changes of temperature. The extended version of the DMQ also includes questions on the seasons in which symptoms of low back and neck-shoulder most often appear and asks workers whether they think climatic factors are related to their symptoms. The questions on prevalence rates of musculoskeletal symptoms are comparable to the 'Nordic-questionnaire on musculoskeletal disorders' (Kuorinka et al. 1987). Completion of the questionnaires was distributed randomly throughout the year.

The first and second research question was answered by analysing data from a subgroup of workers (n=834) who filled in the extended version of the questionnaire. The third question was answered by analysing the total database of 2030 workers. An index of poor climatic working conditions was operationalized and computed on the basis of 4 questions on exposure to cold, draught, dampness and changes of temperature. Reliability expressed by Cronbach's alpha was satisfactory (0.82). Furthermore, a dichotomous variable (yes/no) for outdoor work (as a surrogate measure for adverse climatic working conditions) was available.

Since the influence of climatic factors could be stronger in more severe cases of musculoskeletal disorders, the analyses were carried out on self-reported health symptoms (yes/no) as well as on self-reported sick leave due to symptoms (yes/no). The analyses were restricted to the areas showing the highest prevalence rates in working populations: (1) the lower back region, (2) the neck-shoulder-upper back region. 12-month prevalence rates were taken as indicators of musculoskeletal morbidity.

A logistic regression was carried out to assess multivariate the influence of climatic factors on symptoms and sick leave. Physical working conditions as well as age and gender were included in the model, as they could influence any effect of climate on symptoms or sick leave. An index of physical working conditions was computed on the basis of 31 questions on self-reported exposures to postures, movements and force exertions (see chapter 2). Reliability expressed by Cronbach's alpha was satisfactory (0.93). Adjusted odds ratios of 12-month prevalence rates of symptoms and sick leave due to symptoms were computed for each climatic factor separately, for the index of

poor climatic working conditions as well as for outdoor work. Interaction between climatic factors and age, gender or physical working conditions was tested by examining significant differences between models with or without interaction.
A p-value of 0.05 was taken as an acceptable level of significance (two-sided).

8.4 Results

8.4.1 Literature review

Several authors point to the fact that 'climate' is not a discrete variable, but a gathering of many factors and that it is unclear which of these (combinations of) factors is really relevant (Sibley 1985, Tauber 1970, Lawrence 1977). Problems in defining and measuring these ever changing factors and their combinations, make it difficult to construct valid variables (Johansson & Sullivan 1975). The definition of 'climate' thus differs strongly between studies. Furthermore, it is likely that some climatic factors have not been studied at all (Tauber 1970).
Table 1 summarizes the available studies (all cross-sectional). In all, 27 studies were found, none of them addressing the subject specifically. Three main approaches can be identified in the literature concerning the influence of climatic factors on prevalence rates of musculoskeletal symptoms:
- The influence of the 'season' or particular months of the year (8.2.1)
- The influence of outdoor in contrast to indoor work (8.2.2)
- The influence of distinct climatic factors (8.2.3)

Influence of the seasons

An indirect method of discovering the possible role of climatic factors, is to assess the influence of the season. In autumn and winter, climatic conditions in outdoor work are less pleasant, which could influence symptom prevalence rates.
In a Danish population survey no relation was found between the prevalence of low back symptoms and the seasons (Biering-Sørenson 1982).
Ward et al. (1968) studied the distribution of visits for low back pain over the months of the year in an English primary care practice. Most visits took place in autumn and the start of winter. In a Dutch primary care practice, only small differences between seasons were present in respect of visits for low back symptoms (diagnosis lumbago and ischialgia). Patients with ischialgia came in particular in autumn and winter (Hoekstra 1983).
Most studies that addressed the influence of the seasons were carried out in working populations. Wilson & Wilson (1955) described a decrease in cases of low back symptoms reported to the medical service of a large company between April and September, which was not explained by holidays. Wilson attributed this finding to climatic factors ('the first hour at work on a cold and wet morning is often the time when acute attacks occur'). An analysis of visits to the medical service of the Edison Company in New York for 'rheumatic' (musculoskeletal) symptoms showed a rise in winter and a drop in summer (Brown & Lingg 1961). Tauber (1970) studied work related low back symptoms in the US in the year's 1964-1967. He regularly found a rise in the incidence of symptoms in the warm months, chiefly September. Duration of cases was highest in September, and lowest in April and November.

Table 1. Cross-sectional studies with reference to climatic factors as risk factors for musculoskeletal disorders

Reference	Study population	n *	Operationalization of climate	Outcomes	Multivar. analysis	Results
Anderson & Duthie 1963	Dockyard workers	1422 men	indoors-outdoors	rheumatic complaints absence due to rheumatic diseases	age	no increase in complaints rate or absence for outdoor or cold conditions
Biering-Sørenson 1982, 1983a,b	general Danish population	920	seasonal variation	one year incidence and recurrence-rate (self-reported)	no	no relation
Biering-Sørenson 1985	Danish working population		exposure to cold	prevalence of back pain	no	association of back pain with cold surroundings
Bjelle et al. 1981	adult Swedish population	45000	indoors-outdoors self-reported trouble from heat, cold or draught	self-reported rheumatic disorders	no	high prevalence rates of osteoarthritis in areas with a high frequency of complaints of climatic factors
Brown & Lingg 1961	energy company	24157	indoors-outdoors mean monthly temperature	doctor's visit because of rheumatic complaints diagnosed disc disorders	gender	no difference in visits or disc disorders for indoor-outdoor, drop during summer, peak during winter
Clemmer et al.(1991)	offshore petroleum drilling company	4765	weather indicators at the time of the injury	lost time because of work related low back injuries	no	no association
Gilad & Kirschenbaum, 1986	five production and four service-orientated worksites	250	month of the year climatic conditions at work	self-reported back pain attacks	no	highest prevalence rates in winter months and humid conditions
Hoek 1971	Dutch Telecom	1246	outdoor-indoor technicians	registered sick leave > 14 days off due to back pain	no	outdoor workers > 50 year relative high mean sick leave due to back pain

Table 1 *continued*

Reference	Study population	n *	Operationalization of climate	Outcomes	Multivar. analysis	Results
Hoekstra 1983	primary care patients	380	season	low back-diagnoses (all, lumbago, sciatica)	no	highest incidence of low back symptoms in autumn, lowest in summer; highest incidence of sciatica winter, lowest in spring; lumbago: no clear seasonal influence
Kellgren & Lawrence 1952	underground coal miners (aged 41-50)	84	exposure to damp	radiographic signs of disc degeneration	no	no association
Kellgren et al. 1953	urban English population	3515	self-reported unusual exposure to cold or wet; living in damp houses	rheumatic complaints	gender	association with cold and wet work conditions and damp housing
Kelsey 1975	patients with acute herniated lumbar discs	223 C=494	season	acute herniated lumbar intervertebral discs	age and gender	
Knave et al. 1985	VDU operators	395	indoor tempe-rature, air pressure & humidity and air velocity	self-reported musculoskeletal pain or discomfort	no	negative correlation with air pressure, no association with temperature, air humidity, air velocity
Lawrence 1955	coal face miners (aged 41-50)	171	exposure to wet working conditions	rheumatic symptoms, signs, sick leave and radiological changes	no	positive association with symptom prevalence rate, sick leave, clinical signs, radiographic changes; no association with disability

Table 1 *continued*

Reference	Study population	n *	Operationalization of climate	Outcomes	Multivar. analysis	Results
Lawrence 1961	cotton operatives	172	exposure to humid, warm working conditions	rheumatic symptoms, signs, sick leave and radiological changes	no	negative association with symptoms, sick leave, clinical signs and radiographic changes of the dorsal and lumbar spine
Lawrence et al. 1966	foundry workers (aged 35-74 years)	299	exposure to radiant heat	radiographic evidence of lumbar disc degeneration; clinical examination on rheumatic symptoms and signs	no	association with lumbar disc degeneration
Metzler 1985	industrial workers in Luxembourg	11800 0	season	reported occupational accidents affecting the low back	no	highest prevalence rates in autumn
Nicholson et al. 1981	telecommunicat ions engineers	23 risk groups	exposure to wet and cold working conditions	back injury rate	no	positive association
Perlik et al. 1981	chemical workers	557	season	number of lost days and total lost days for acute back pain	no	highest prevalence rates in winter
Sibley 1985	patients with rheumatoid arthritis or osteoarthritis	70	13 combinations of weather features	severity of rheumatic symptoms (self-reported)	no	no correlation

Table 1 *continued*

Reference	Study population	n *	Operationalization of climate	Outcomes	Multivar. analysis	Results
Simons & Mirabile 1972	workers with back injuries in the American processing industry;	684	month of the year	medical 'incidents'	no	highest prevalence rates in March and April; lowest in January and February.
Takala et al. 1992	female workers with light sedentary work.	316	season	self-reported neck and shoulder symptoms during previous three months	yes	highest prevalence rates in autumn.
Tauber 1970	steel workers	11549	month of the year	work related backache cases	no	highest prevalence rates in warm months, chiefly September; duration highest in September
Wagenhäuser 1969	Swiss villagers		exposure to cold and dampness	prevalence rate of rheumatic symptoms	no	association with combination of cold and dampness, but not with cold alone
Ward et al. 1968	patients from 16 general practices	826	month of the year	visit for low back symptoms	sex	highest prevalence rates in autumn and the start of winter
Wilson & Wilson 1955	workers in a UK iron foundry	1163	month of the year	low back symptoms reported to the medical service	no	highest prevalence rates between October and March

* M=males, F=females, C=controls

Simons & Mirabile (1972) studied medical 'incidents' in the American processing industry; they also found that back injuries occurred more than the annual average in spring and summer and less in winter. However, this pattern was not specific for back injuries: all injuries showed a similar pattern. Kelsey (1975) described a tendency towards a start of symptoms of hernia nuclei pulposi in spring and autumn. In a chemical plant in former Czechoslovakia, sick leave due to low back symptoms was highest during the winter months (Perlik et al. 1981). An analysis of occupational injuries affecting the low back in Luxembourg showed a rise from winter till autumn (Metzler 1985). Gilad & Kirschenbaum (1986) reported that back attacks were most frequent during winter in Israeli workers. Takala et al. (1992, 1994) reported seasonal variations in neck and shoulder symptoms in women in light sedentary work. Symptom rates decreased from autumn and winter towards spring. Interestingly, a similar pattern was seen for stress and headache.

In summary, findings are rather inconsistent: injuries and sick leave due to back symptoms as well as visits to family physicians or occupational health physicians due to low back problems seem to occur more often in autumn and winter, but there are also several studies which report highest prevalence rates in spring and summer; some studies found a similar pattern for other symptoms or diagnoses. Most authors assume a relation between these seasonal variations and variations of climatic variables.

Indoor versus outdoor work

The comparison between indoor and outdoor work could provide interesting indications of a relation between climatic factors and symptoms, since outdoor workers are more exposed to unfavourable weather conditions than indoor workers.

A general population study in Sweden showed no difference between prevalence rates of back symptoms and working mainly outdoor (Bjelle et al. 1981). In Great Britain, prevalence rates of outdoor workers did not differ from other occupations for disc disorders (Kellgren et al. 1953). An analysis of visits to the medical department of a gas- and electricity company in New York due to 'rheumatic' symptoms showed no differences in the prevalence rates of disc disorders between indoor and outdoor workers, irrespective of the heaviness of work (Brown & Lingg 1961). Shipyard workers working in a sheltered work place did not have less 'rheumatic' symptoms or sick leave than shipyard workers working outdoors in cold surroundings (Anderson & Duthie 1963). However, in British Telecom the majority of occupational tasks associated with relatively high frequencies of back injuries were performed outdoors, exposed to cold and dampness (Nicholson et al. 1981). Stubbs (1981) also reported higher frequencies of back injuries among workers in the field staff of British Telecom, but he attributed this to the less 'controlled' working conditions of the field-staff and not to climatic conditions. In the Netherlands, Hoek (1971) studied back symptoms and sick leave at Dutch Telecom. Tasks with relative high sick leave frequencies due to back pain were technicians in outdoor service, involving possibly cold, draught and dampness.

In summary, differences in climatic conditions as reflected by indoor and outdoor work do sometimes result in differences in the prevalence rates of symptoms. However, it remains disputable whether these differences can simply be related to the climatic differences of indoor and outdoor work. In particular, outdoors work is often associated with more heavy (Wagenhäuser 1969) or less controlled (Stubbs 1981) musculoskeletal workload and this was not controlled in any of the studies reviewed.

Influence of distinct climatic factors

Low temperatures and a high degree of dampness are mostly studied as separate meteorological factors. Only a few studies addressed a broader range of climatic factors: Bjelle et al. (1981) found no relation between back pain and self-reported complaints of heat, cold or draughty working conditions in Sweden. Sibley (1985) followed Canadian patients with rheumatic arthritis or osteoarthritis for one month and found no relation between the severity of symptoms and thirteen specified climatic variables. Clemmer et al. (1991) found no relation between 'weather indicators' and lost time for low back injuries in US-heavy industry.

In the general population, Kellgren (1953) found a relation between unusual cold or damp working conditions and back symptoms in Great Britain. He found no relation between back symptoms and living in damp houses. The prevalence rate of 'rheumatic' symptoms among Swiss villagers was elevated by the combination of cold and dampness, but not by cold alone (Wagenhäuser 1969).

More data are available concerning the working population. Kellgren & Lawrence (1952) found no relation between discus degeneration (radiographic signs) and a history of exposure to damp in a study among miners. Lawrence (1955) analysed the relation between 'rheumatic' symptoms, radiological changes and work in a wet or dry collieries. Workers who worked more than 5 years in wet conditions showed a prevalence rate twice as high as those who had worked in dry conditions. Sick leave was even three times higher. Disability however showed no clear-cut relationship. The prevalence rate of clinical signs was higher too. Although the frequency of radiographic changes was higher too, they were unlikely to be severe. The number of affected discs did not differ (Lawrence 1955). A study in a cotton-weaving mill showed that weavers working in relatively chilly conditions reported more symptoms than other weavers (Lawrence 1961). In the Danish working population, back pain was associated (among other things) with cold surroundings (Biering-Sørenson 1985). Knave et al. (1985) studied musculoskeletal symptoms among VDU-workers and studied a number of indoor climatic factors. He found no association with either temperature or air dampness. Finally, a study of Israeli workers showed that back pain attacks were most frequent in wet periods (Gilad & Kirschenbaum 1986).

In summary, it seems that available data on the influence of cold and dampness are rather contradictory. Cold and dampness and possibly a combination of both may be associated with higher prevalence rates of back pain or radiographic, mostly degenerative, changes.

There are little data on the influence of heat. In a Swedish population study Bjelle et al. (1981) found no relation between back symptoms and self-reported hot working conditions. Lawrence (1961) reported in a study of cotton-weavers an association between a damp but very warm atmosphere and lower prevalence rates of 'rheumatic' symptoms. In a study on foundry-workers Lawrence & Molyneux (1966) found a discrepancy between a (high) degree of disc degeneration and osteoarthritis (radiological signs) and (low) symptoms rates. He attributed this discrepancy to exposure to radiating heat (Lawrence 1977). Such a discrepancy was also found in textile workers, possibly explained by a warm and damp working environment (Lawrence 1977). As reported already, Knave et al. (1985) found no correlation of musculoskeletal symptoms with indoor temperature in a study on VDU-workers.

Chiefly those with musculoskeletal symptoms mention draughts, wind or changes in temperature. Patients report in particular changes of weather conditions as deteriorating factors (Hill 1966, Hollander 1985). Lawrence (1977) and Latman (1981) emphasize the importance of these changes in weather and the speed of these changes: the faster the changes, the greater the effect. Empirical studies again provide scant information on those factors. In Sweden, Bjelle et al. (1981) found no relation between back pain and self-reported draughty working conditions. Knave et al. (1985) found no relation between musculoskeletal symptoms and the indoor air speed in a study on VDU-workers. A quarter of the participants in a Danish population study claimed that their back symptoms were aggravated by changes in weather or cloudy or rainy weather (Biering-Sørenson 1983b).

Knave et al. (1985) found a negative correlation between the indoor air pressure and musculoskeletal symptoms among VDU-workers.

Conclusion of the literature review

The influence of climatic conditions has been assessed mainly by studying the relation between prevalence rates of symptoms and season, by comparing indoor and outdoor workers and by studying the influence of particular climatic factors. Almost no studies were found which address this subject specifically, measuring the distinct climatic factors objectively and using multivariate analysing methods. On the basis of the scanty findings of a specific studies, it can be concluded that a relation between climatic factors and musculoskeletal symptoms is considered at least plausible by both researchers, workers and patients, but that the epidemiological evidence is - in contrast - very weak. Some patients with back pain seem 'sensitive' to climatic factors, which means they experience a relation between certain climatic factors (in particular cold, dampness, draught and changes of temperature) and the appearance or aggravation of their symptoms.

8.4.2 Empirical study

Descriptive data on the various worker groups and exposure to climatic factors

Main characteristics the population studied, including the reported exposures to climatic factors and symptoms of low back and neck-shoulder, are given in table 2. About half of the workers reported exposure to adverse climate conditions as well as low back symptoms (60%) and neck-shoulder symptoms (43%).

Table 2. Descriptive data on the population studied (n=2030)

	%	mean	(standard deviation)
Mean age		33.2	(9.6)
Mean educational level (1=primary school, 5=academic)		3.4	(1.6)
% male gender	43		
% working often in open air	19		
% of workers reporting frequent exposure to:			
draught, wind	43		
cold	35		
changes of temperature	51		
dampness	24		
Mean of index poor climatic working conditions (min=0, max=4)		1.52	(1.5)
% of workers having (last 12 months) symptoms of the:			
low back	60		
neck-shoulder	44		
% of workers having (last 12 months) sick leave due to the:			
low back	48		
neck-shoulder	34		

Self-reported influence of climatic factors on symptoms

Table 3 shows the degree to which workers themselves related their symptoms to 'climate' (not specified any further in the questionnaire) and the perceived influence of the season on symptoms.

Table 3. Poor climatic working conditions as cause or aggravating or relieving factor and seasons in which symptoms occur the most, according to workers themselves. Percentages of positive answers of workers with symptoms of the low back or neck-shoulder (n=834); workers were allowed to indicate more than one factor.

	symptoms of the low back	symptoms of the neck-shoulder
climate is a:		
causal factor	21	27
aggravating factor	15	22
relieving factor	5	5
symptoms occur in particular in:		
spring	57	65
summer	53	59
autumn	60	61
winter	60	63

A rather high proportion of workers (21-27%) related their symptoms to climatic factors. Most of them (15-22%) perceived climatic factors as an aggravating factor and only 5% as a relieving factor. Differences between prevalence rates for the four seasons were small.

Statistical associations between climatic factors and symptoms and sick leave due to symptoms

Table 4 shows the odds ratio of symptoms and sick leave due to symptoms for the low back and the neck-shoulder for the specific climatic factors, the index of poor climatic working conditions and outdoor work, adjusted for age, gender and physical working conditions.

Table 4. Result of logistic regression for symptoms and sick leave due to symptoms: odds ratios (OR) and 95% confidence intervals (95% CI) for poor climatic working conditions after adjustment for age, gender and physical working conditions (n=2030).

	low back symptoms OR 95%CI	low back sick leave OR 95%CI	neck-shoulder symptoms OR 95%CI	neck-shoulder sick leave OR 95%CI
draught, wind	1.12 (0.89-1.43)	1.02 (0.82-1.27)	1.45 (1.14-1.83)*	1.46 (1.16-1.85)*
cold	1.09 (0.85-1.41)	1.16 (0.92-1.47)	1.03 (0.80-1.33)	1.07 (0.83-1.38)
changes of temperature	1.07 (0.86-1.32)	1.08 (0.87-1.34)	1.03 (0.83-1.28)	1.08 (0.87-1.34)
dampness	0.98 (0.74-1.29)	0.99 (0.77-1.28)	0.87 (0.66-1.40)	0.86 (0.64-1.15)
climate index**	1.26 (1.01-1.56)*	1.19 (0.97-1.49)	1.42 (1.14-1.76)*	1.42 (1.13-1.81)*
outdoor work	0.94 (0.70-1.26)	1.06 (0.80-1.38)	0.64 (0.48-0.86)*	0.69 (0.50-0.95)*

* $p < 0.05$, two-tailed

** dichotomised 1:index>0 2:index=0

A significant positive association was found between the climate index and low back and neck-shoulder symptoms as well as sick leave due to neck-shoulder symptoms. Of the specific climatic factors (cold, draught, dampness and changes of temperature), only draught showed a significant (positive) association with neck-shoulder symptoms and sick leave due to neck-shoulder symptoms. Outdoors work was associated with fewer symptoms of the neck-shoulder region and less sick leave due to neck-shoulder symptoms. No significant interactions could be identified between climatic factors and age, gender or physical working conditions.

8.5 Discussion

8.5.1 Literature

The size of the list of references of this paper is rather misleading: none of the studies listed specifically addresses the subject. Precisely this was the reason to reframe from a more systematic review. It was expected on forehand that none of the studies would pass minimal methodological criteria, which made a simple narrative review inevitable. Thus, the conclusions of this review have to be based on rather a specific findings, which demand great care in interpretation: there is a risk of not finding relations because these relations were not studied specifically enough with a resulting lack of power or finding relations which are not controlled well enough for confounding factors. This is the more important, since climatic factors are not likely to be really major etiological factors. Furthermore, there is a lack of proper definitions and quantifications (Latman 1987) and objectively assessed climatic variables. One has also to be aware of several kinds of bias. For example, people with symptoms which are worsened by cold or draughts, will be more aware of exposures to these factors than other people and thus report those exposures more easily, which would result in an artificial (causal) correlation (Kellgren et al. 1953). Furthermore, the working conditions might be an important confounder, in particular with respect to comparisons between indoor and outdoor work (physical activity, clothing, outdoor workers may be the more healthy workers) and seasons (winter outdoors will be cold, but indoors not). However, working conditions are often hardly described in the literature studied, which makes it difficult to assess their potential impact.

A major limitation is the uncertainty about the underlying pathophysiological mechanisms for correlations found. Is there any influence of climatic factors on the disease process itself (tissue damage) or is there rather a secondary effect: activation of an already existing disease or a lowering of the pain threshold? Most authors who address this issue, assume a secondary process. Studies of Lawrence (1955 1961, 1966) and Kellgren (1952, 1953) in several working populations illustrate that: they also assessed, apart from symptoms and sick leave, more 'objective' radiological signs of disease. Climatic factors (cold and damp) did influence symptom rates and sick leave, but had no clear-cut correlation with the prevalence rates of radiological changes. This dissociation between radiographical changes and symptoms was attributed to a reduced pain threshold from cooling of the tissues at the sites of the pain (Lawrence 1961). In addition, it remains risky to interpret such cross-sectional findings causally. Latman (1981) found no seasonal variations in laboratory measures (erythrocyte sedimentation rate and plasma concentration of C-reactive protein) as indicators of the underlying inflammatory process in 2800 patients with rheumatoid arthritis and concluded that climatic factors may only influence the comfort of the patient. Junghanns (1982) stated that exposure to cold (e.g. in polar regions) is unfavourable for the diffusion of the intervertebral disc when combined with heavy work and/or static postures. In addition, cold leads to an elevated muscular tone. These processes, combined with already existing pathology, could result in symptoms becoming manifest. The favourable action of warmth could be based on a reduction of muscular spasm, resulting in reduction of pain, greater elasticity of connective tissue,

greater mobility, reduction of stiffness and a psychological relaxation (Latman 1981). Johansson & Sullivan (1975) stated that weather sensitivity of patients with rheumatoid arthritis has presumably a physical basis, but that psychological factors play a reinforcing part.
Several tentative explanations are thus suggested in the epidemiological literature studied. Influence on the physiological (hormonal and/or vascular) regulation mechanism, which could activate an already existing disease process, seems plausible. Psychological factors may contribute to this. Many questions still remain to be answered.

8.5.2 Empirical data

In agreement with literature, our empirical data show that workers do associate their symptoms with poor climatic working conditions, but the seasonal variation reported seems to be marginal. The relationship perceived by the workers is partly reproduced in the multivariate analysis: in particular draughts and wind are associated with more symptoms and sick leave due to symptoms. The strength of the association is similar for symptoms and sick leave due to symptoms, which indicates that draughts and wind are not associated particularly to more severe disorders with elevated risks of sick leave.
Surprisingly, climatic factors (and in particular draughts and wind) are more closely associated with neck-shoulder symptoms than with low back symptoms, possibly due to more unfavourable (and often artificial) climatic conditions indoors.
Low back symptoms or sick leave due to low back symptoms are not associated with outdoor work. The traditional portrait of the construction worker being at great risk of musculoskeletal disorders due to working outdoors without proper clothing, is thus not confirmed by our (cross-sectional) data. However, indoor work appears to be associated with neck-shoulder symptoms, which might be the result of repetitive movements or static work postures encountered more often indoors (office-work, VDU-work).
Of course, the cross-sectional nature of our study does not permit any firm conclusions to be drawn on the influence of climatic factors on musculoskeletal troubles. In addition, the workers themselves report all information on exposure to climatic factors and other working conditions. This may result in some inherent associations between the variables involved: workers who perceive a particular climatic factor as troublesome, might report exposure to that factor rather sooner, which could result in an overestimation of the exposure by these workers. Besides these drawbacks, a major advantage of our analysis was the possibility to control for the influence of working conditions. However, our results do not indicate any interaction between working conditions and climatic factors.

8.6 Conclusions

In conclusion, many workers attributed their musculoskeletal symptoms partly to climatic factors as a causal or aggravating factor. In addition, poor climatic working conditions, in particular draught and wind) appeared to be associated with symptoms of both back and neck-shoulder and sick leave due to neck-shoulder symptoms. Neck-shoulder symptoms were negatively related to frequent outdoor work. No interaction with physical working conditions was found. More specific epidemiological studies including precise climate measurement data, are needed to obtain a better insight.

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9. The relation between leisure time physical activity and musculoskeletal morbidity[1]

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Abstract

Objectives

To assess the association between leisure time physical activity and musculoskeletal morbidity, as well as possible interactions with physical activity at work.

Methods

A literature-search was performed to collect all studies on musculoskeletal disorders in which physical activity was involved as variable. Next, an analysis was made of questionnaire-data of a group of 2030 workers in various occupations on self-reported physical activity in leisure time and at work, musculoskeletal symptoms (low back, neck-shoulder and lower extremity) and sick leave due to these symptoms. A logistic regression analysis was carried out to estimate the association between musculoskeletal morbidity and four physical activity indices (participation in sport and sedentary activities, active life style, sedentary life style), adjusted for age, gender, education and workload. Interaction of leisure activities with age and workload was tested too.

Results

Available literature data (39 studies) showed inconsistent results. Most studies did not show any effects. Some studies indicated favourable effects of physical activity, both on low back and neck pain. Participation in some vigorous sports seemed associated with unfavourable effects.
The empirical data showed no association between participation in sport and/or other physical activities in leisure time and musculoskeletal symptoms. Sedentary activity in leisure time was associated with higher prevalence rates of low back symptoms and sick leave due to low back symptoms.

Conclusions

Stimulation of leisure time physical activity may constitute one of the means of reducing musculoskeletal morbidity in the working population, in particular in sedentary workers.

Keywords: Leisure time physical activity, physical activity, sports participation, sick leave, physical workload

9.1 Introduction

The interest in the positive effects of physical activity on health and well-being is increasing. A few years ago, the Centres for Disease Control and Prevention and the American College of Sports Medicine issued a consensus recommendation that every US adult should accumulate 30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week to prevent disease (e.g. cardiovascular disease, diabetes, osteoporosis, hypertension, depression, strokes and some cancers), to decrease all-cause mortality and to promote health (Pate et al. 1995).
Whether physical activity is also beneficial to musculoskeletal disorders of workers is less clear. Despite the risk of activity-related injuries, many experts (NIOSH 1981, Kelsey & Gordon 1988, Genaidy et al. 1992) find an association between physical activities and a lower risk of musculoskeletal disorders plausible. Stimulation of physical activities among workers - if effective - could be one of the means of preventing these disorders and of reducing the associated high costs. Randomised trials and epidemiological studies on exercises as a means of strengthening back and/or abdominal muscles and of improving fitness have produced only limited evidence of a positive effect on low back morbidity (Lahad et al. 1994, Koes et al. 1991), and empirical evidence in particular of long-term effects of exercise is still lacking (Videman et al. 1995). Alaranta et al. (1987) showed that a high preoperative level of physical activity was linked to good one-year results of surgery of lumbar intervertebral disk herniation in patients with a moderate to severe occupational handicap preoperatively, which indicates that participation in sport can also have a positive influence on the possibilities of rehabilitating workers with musculoskeletal disorders (see also Linton et al. 1989, Shephard 1991, Stewart et al. 1994). This paper presents, firstly, a review of epidemiological literature on the relation between physical activity in leisure time and musculoskeletal morbidity. Secondly, new empirical data are presented on the association between the physical activities of workers in their leisure time, and the prevalence of musculoskeletal symptoms and sick leave due to these symptoms.

9.2 Research question

The basic question addressed in the literature survey was whether physical activity in leisure time can prevent or reduce musculoskeletal symptoms, in particular low back and neck-shoulder symptoms, despite the risk of musculoskeletal injuries associated with sports participation. The data-analysis focused on aspects which have not often been addressed in literature: the distinction between (1) participation in sport and other physical activities in leisure time, (2) physical activity and physical inactivity and (3) physical activity in leisure time and physical activity at work. The following question was addressed: are the physical activities of workers in leisure time associated with symptoms of the low back, neck-shoulder and knee-ankle-foot and with sick leave due to these symptoms?
Low back and neck-shoulder were chosen since these regions constitute the major location of all musculoskeletal symptoms in the working population (Hildebrandt 1988). Symptoms of the upper back were included in the neck-shoulder symptoms, given a high correlation between these symptoms. Knee and ankle/foot ('lower extremity') were chosen since these regions form the most common sites for sports injuries (Fintelman & Hildebrandt 1993). Age and workload were involved in the analysis since some studies showed an association between age and the effect of physical

activities (Stam et al. 1996; Baun et al. 1986) and that the kind of workload to which the worker is exposed could influence the relation between leisure time physical activity and musculoskeletal symptoms too (Dul 1991).

9.3 Method and material

A literature search was carried in the Emhealth, Cisdoc and Sportsmed databases using “leisure time activity”, “physical activity”, “sports participation” and “musculoskeletal symptoms” as main keywords. Only literature in English from 1975 onwards was included. Since the number of resulting studies was small, epidemiological studies on low back and neck-shoulder symptoms that were not indexed on leisure time activity, physical activity or sports participation, were manually screened and included when physical activities outside work were addressed in the analysis. Due to the lack of specific studies, a systematic review was not relevant and a mere narrative approach was chosen.

The database used for the empirical study consisted of 2,030 workers who completed the Dutch Musculoskeletal Questionnaire (DMQ). The database represents a large variety of occupations in industry (shipyard, metal, transport), services (cleaners, child care), health care (nurses) and offices. The questionnaire measures:

- Physical activity at work: 55 questions on various kinds of workloads
- Physical activity in leisure time: the number of hours of sports participation (defined in the questionnaire as 'physically strenuous' sports) as well as the number of hours of leisure time spent on physical activities (defined in the questionnaire as gardening, shopping, housework, do-it-yourself, cycling, walking, other) and sedentary activities (defined in the questionnaire as watching TV, reading, knitting)
- Prevalence rates of musculoskeletal symptoms comparable with the 'Nordic-questionnaire on musculoskeletal disorders' (Kuorinka et al. 1987) and prevalence rates of sick leave due to these symptoms.

Using this database, we constructed the following four indices of physical activity:

- Participation in sport: (a) categorical (0 h, 1-2 h, 3 h or more per week) (b) dichotomous (yes/no)
- Active life style (dichotomous): participation in sport as well as relatively many other physical activities (12 h or more per week) in leisure time
- Sedentary activities in leisure time: (a) categorical (1-6 h, 7-11 h, 12 h or more per week) (b) dichotomous (12 h or more/less than 12 h per week corresponding to approximately the 50th percentile of the distribution)
- Inactive life style (dichotomous): relatively many sedentary activities in leisure time (12 h or more per week) as well as relatively few physical activities (less than 12 h per week) in leisure time and no sports participation.

We categorised workload (e.g. physical activity at work) in two ways: firstly, by computing an index 'physical heavy work', from 55 questions on physical (locomotor) workload (Cronbach's alpha=0.93) and dividing workers into a group with relatively high scores on this index (≥ 50th percentile) and a group with relatively low scores on this index (< 50th percentile); secondly by separating workers into a group which reported often sitting at work and a group which reported not often sitting at work. Twelve-month prevalence rates of symptoms and of sick leave due to these symptoms were taken as measures of effect and sick leave lasting for more than seven weeks was considered as a measure of the chronicity of the symptoms (Quebec Task Force On Spinal Disorders 1987). The following analyses were carried out:

- Computation of bivariate associations between musculoskeletal symptoms and the number of hours of participation in sport, other leisure time physical activities and leisure time sedentary activities (significance tested with a chi-square test).
- Logistic regression analysis to estimate the association between musculoskeletal symptoms or sick leave due to these symptoms and the four physical activity indices defined above, adjusted for age, gender, education and type of workload.
- Testing of interaction between leisure activities and age as well as work activities, by examining significant differences between models with or without interaction. Stratum-specific odds ratios were computed when interaction was present.

A p-value of 0.05 was taken as an acceptable level of significance (two-sided).

9.4 Results

9.4.1 Literature review

Thirty-nine studies were found which addressed the relation between physical leisure time activity and musculoskeletal morbidity. Only a few addressed the subject specifically. Furthermore, some general methodological weaknesses have to be mentioned:

- Physical activity was measured quite differently, mostly with questionnaires or interviews; the validity of these methods may be questioned (Terwee & Hildebrandt 1995)
- Few studies involved physical activity at work as such in the analysis, although the kind of workload to which the worker is exposed may be an important variable (Dul 1991).
- Intensity, duration, frequency and kind of loads were not well differentiated
- It was often unclear whether the measurement of physical activity represented historical or actual exposure
- No distinction was made between sports-related acute injuries and risk of chronic disorders
- Other physical activities in leisure time apart from sport were often neglected
- Physical inactivity as a possible risk factor was not addressed

In all, five prospective studies were found (Table 1). Three of them show some effects of physical activity on musculoskeletal morbidity. No effect of physical activities during leisure time on the incidence or recurrence of low back pain was found in the general Danish population (Biering-Sørensen & Thomsen 1986). In a group of female's employees in the electronics industry during a two-year follow-up, physical activities in leisure time and not sedentary hobbies were a predictor of improvement of cervicobrachial disorders, but not of remaining healthy (Jonsson et al. 1988).

In a 5-year follow-up of metal workers, Leino (1993) found a lower incidence of symptoms of the low back in male blue and white-collar workers who participated in sport. In a 3-year follow-up study of machine operators, carpenters and office workers (Pietri-Taleb et al. 1994, Riihimäki et al. 1994, Viikari-Juntura 1994) a significant increase in the incidence of sciatic pain was found due to physical activity in leisure time, in the blue-collar workers. In the white-collar workers, physical activity lowered the incidence of persistent severe neck symptoms and the incidence of severe neck trouble. Venning et al. (1987) studied personal and job-related determinants of back injuries among nurses; physical activity was not associated with the report of low back pain.

Table 1. Longitudinal studies on the relation between physical activities in leisure time and musculoskeletal disorders.

Reference	study population	n	follow-up period (years)	outcomes (musculoskeletal disorders)	results
Biering-Sørensen & Thomsen 1986	general Danish population	920	1	one year incidence and recurrence-rate (self-reported)	no effect on incidence or recurrence of low back pain
Jonsson et al., 1988	female workers in the electronics industry	69	2	improvement of cervicobrachial disorders	positive effect on improvement of cervicobrachial disorders
Leino, 1993	Finnish metal workers, blue and white collar, male and female	607	5	low back symptoms during past year and clinical findings	low exercise activity score predicts low back symptoms in males (both in blue and white collar workers)
Pietri-Taleb et al. 1994, Riihimäki et al. 1994, Viikari-Juntura et al. 1994	male machine operators, carpenters, office workers, 25-49 years	1015	3	severe neck trouble, persistent neck trouble, sciatic pain (self-reported)	physical exercise more than once a week OR 0.62 (0.39-0.99) for severe neck trouble, OR 0.5 (0.2-.09) for persistent neck trouble and OR 1.26 (1.00-1.60) for sciatic pain
Venning et al. 1987	nurses	5649	1	annual (self-reported) back injury rate	no association

Table 2. Cross-sectional, retrospective or case-control studies with reference to leisure time physical activities as risk factor for musculoskeletal disorders

Reference	study population	n (cases)	operationalization of physical activity	outcomes (musculoskeletal disorders)	multivar. analyses	results	summary *
Alaranta et al. 1987	patients operated for lumbar disc herniation	212	leisure time activity	lumbar disc herniation	no	no association	0
Balagué et al. 1988	schoolchildren	1752	self-reported (specific) participation in sport	self-reported low back pain	no	competitive sports are associated with more low back pain	-
Burton et al. 1989	English industrial and professional workers	545	self-reported regular participation in sport	self-reported history of low back pain	yes	adult sports participation increases risk of low back pain	-
Croft et al. 1993	adult aged 18-75 registered in two general practices	4504	self-reported leisure time activities (lifting, gardening, sport)	self-reported low back pain	yes	no associations with specific activities	0
Dehlin et al. 1981	female nursing aides	15	physical training (aerobic capacity, muscle endurance)	self-reported low back symptoms (3 month follow-up)	no	no influence on low back symptoms improvement of psychological perception of work	0
Derriennic et al. 1994	French workers born in 1938,1943,1948 and 1953	21.378	self-reported leisure activities (such as sports, gardening, handicrafts)	low back pain reported during an annual job-related medical examination	yes	OR 0.8 (0.7-0.9)	+
Ekberg et al. 1992	Swedish rural workers	637	self-reported exercise	self-reported symptoms and diagnosed disease of the neck and shoulders	yes	frequent exercise increases risk of disease of neck and shoulders, not of symptoms	-
Fairbank et al. 1984	pupils aged 13-17 years	446	'sports enjoyment'	self-reported low back pain	no	back pain more common in those who avoided sports	+
Frymoyer et al. 1983	primary care patients	1221	self-reported recreational activities	self-reported low back pain	yes	jogging and cross-country skiing is associated with moderate low back pain, other sports are not related	-

Table 2 *continued*.

Reference	study population	n (cases)	operationalization of physical activity	outcomes (musculoskeletal disorders)	multivar. analyses	results summary	*
Gratton & Tice 1989	English households	> 20.000	self-reported participation in sport	self-reported chronic arthritis	stratified by income, age	sport participants are less likely to suffer from arthritis	+
Heliövaara et al. 1987	Finnish general population	1537	self-reported physical activities during leisure time	hospitalisation due to herniated lumbar disc or sciatica		no effect on herniated lumbar disc or sciatica leading to hospitalisation	0
Holmström et al. 1992a,b	construction workers	1773	self-reported activities during leisure time	self-reported (severity of) low back pain and neck-shoulder pain	no	not significant with low back pain, significant with neck-shoulder pain (less active)	0/ +
Houtman et al. 1994	Dutch working population	5865	self-reported participation in sport	self-reported back, muscle or joint problems and chronic back problems	yes	no associations	0
Karvonen et al. 1980	Finnish conscripts	183	self-reported leisure time physical activities	self-reported back and leg complaints	no	less back and leg pain	+
Kelsey 1975	patients with acute herniated lumbar discs	223	self-reported specified physical activities and participation in sport	acute herniated lumbar discs	stratified by gender	no significant difference in participation in specific sports or physical activities in general	0
Kelsey et al. 1984a	patients with acute prolapsed lumbar discs	325	self-reported frequency of specified participation in sport	acute prolapsed lumbar discs	yes	no associations with diving, golfing, swimming, bowling, baseball, softball, tennis, jogging, cycling	0
Kelsey et al. 1984b	patients with acute prolapsed cervical discs	88	self-reported frequency of specified participation in sport	acute prolapsed cervical discs	yes,	diving from a board: increased risk of prolapsed cervical disc; golfing non-significant increase, other sports (swimming, bowling, baseball, softball, tennis, jogging, bicycling) no increase	0/-
Linton 1990	Swedish workers	22180	self-reported regular exercise	self-reported low back and neck pain	stratified by age	no association	0

Table 2 *continued*.

Reference	study population	n (cases)	operationalization of physical activity	outcomes (musculoskeletal disorders)	multivar. analyses	results summary	*
Mandel & Lohman 1987	nurses	428	self-reported participation in sport and exercise	self-reported low back pain lasting 48 hours	yes	participation in sport and jogging: no association; aerobic dance exercise >2 hours per week: OR 1.45 (1.10-1.92)	0/-
Mundt et al. 1993	patients with herniated lumbar discs	287	self-reported participation in sport	herniated lumbar discs	yes	no effect on the risk of a hernia caused by non-occupational lifting	0
Olsen et al. 1994	recipients of a hip prothesis	239	self-reported cumulative hours of sport activities (telephone interview)	first time hip prothesis due to idiopathic coxarthrosis	yes	RR low exposure 1, medium 2.6 high 4.5, etiologic fraction 0.56; most hazardous: track and field sports, racket sports and soccer	-
Riihimäki et al. 1989	machine operators, carpenters, office workers	852 696 674	self-reported leisure time physical activity	self-reported low back pain	yes	no association	0
Ryden et al. 1989	hospital employees	84	self-reported regular exercise	low back pain reported to the health services	yes	no association: OR 1.33 (0.44-2.84)	0
Salminen (1984)	adolescents	370	self-reported participation in organized or regular physical activities	self-reported neck and back pain	yes	no association with neck or back symptoms	0
Salminen et al. (1993)	15-year-old pupils	76	self-reported leisure time physical activity	MRI of lumbar spine	no	physically inactive subjects: more spinal muscular atrophy	+
Saraste & Hultman 1987	Swedish population 30-59 years	2872	self-reported exercise during leisure time	self-reported low back pain, hip pain or sciatica	stratified by age and gender	no association	0
Svensson et al. 1983	random sample of Swedish men 40-47 years	940	self-reported physical activity in leisure time (by interview)	self-reported low back pain	yes	no association	0

Table 2 *continued*.

Reference	study population	n (cases)	operationalization of physical activity	outcomes (musculoskeletal disorders)	multivar. analyses	results summary	*
Tollqvist 1993	construction, foremen and white collars	961	self-reported exercise habits	self-reported musculoskeletal symptoms	?	exercising regularly: fewer symptoms	+
Törner et al. 1990	Swedish fishermen	120	self-reported leisure activities (sports)	self-reported musculoskeletal symptoms	corrected for age	no association	0
Troussier et al. 1994	school children	1178	self-reported (specific) participation in sport (frequency, intensity)	self-reported low back pain	yes	Of all competitive sports, only volleyball was associated with more low back pain: RR 3.21	-
Videman et al. 1984	nurses and nursing aides	562 resp. 318	self-reported exercise in leisure time	self-reported low back pain and sciatica	no	regular exercise is not associated with low back pain, but those who took exercise 2-3 times weekly showed more sciatic pain	-
Videman et al. 1995	former elite athletes	937	self-reported lifetime sport activities, physical activity in leisure time	spinal pathology (MRI), back-related symptoms and sciatica, hospitalisation, disability	yes	MRI: maximal weight lifting and soccer associated with greater lumbar degeneration, no accelerated disc degeneration in runners and shooters. Risk of back pain: OR 0.62 for endurance sports OR 0.60 for games OR 0.67 for contact sports OR 0.7 for frequent exercise.	-/+
Vingard et al. 1993	recipients of a prosthesis due to hip arthrosis (< 50 years)	233	self-reported sports participation	incidence of osteoarthrosis	yes	RR high exposure to sports 4.5; RR high exposure to sports + high physical workloads 8.5	-
Wigaeus-Hjelm et al. 1994	nurses	197	self-reported regular physical activity/training	work related over-exertion back injuries	no	RR no regular physical activity and/or training 1.1 (0.8-1.6)	0

0: no association +: favourable effect of physical activity -: unfavourable effect of physical activity

Thirty-four cross-sectional or retrospective studies were found (table 2). Seven studies indicated favourable effects of physical activities. In sixteen studies no associations were reported. Ten studies indicated unfavourable effects, six of them being effects associated with specific vigorous sports: board diving (elevated risk of cervical disc prolaps, Kelsey et al. 1984a), cross-country skiing and jogging (elevated risk of back symptoms, Frymoyer et al. 1983), aerobic dance exercise performed more than 2 h per week (elevated risk of back symptoms, Mandel & Lohman 1987), bowling, gymnastics, American football playing, discus-throwing, rowing and mountain sports (elevated risk of spondylolisthesis, Wiltse 1975). Videman et al. (1995) obtained magnetic resonance images of selected subgroups of former elite athletes with contrasting physical loading patterns. They found associations between maximal weight lifting and enhanced degeneration of the entire lumbar spine, and between soccer and degeneration of the lower lumbar region, but found no association between competitive runners and increased disc degeneration. In contrast, prevalence rates of low back pain were found to be lower among the athletes than the control subjects. Salminen et al. (1993) found more spinal muscular atrophy on Magnetic Resonance Imaging (MRI) of the lumbar spine in physically inactive subjects.

Vingard et al. (1993) performed a case-control study on sports activities of 233 male recipients of a prosthesis due to severe hip osteoarthrosis and 302 men randomly selected from the general population. Men with high exposure to sports (in particular track and field and racket sports) had a Relative Risk (RR) of 4.5 compared to those with low exposure. Men exposed to high loads both from work and sports had a RR of 8.5 compared with those with low physical load in both activities.

In conclusion, we found that available data were far from ideal. Both prospective and retrospective studies showed inconsistent results. Most studies did not show any effects. Some studies did indicate favourable effects of physical activity, both on low back and neck pain. Participation in some vigorous sports seemed associated with unfavourable effects.

9.4.2 Empirical study

Description of the physical activity of the workers and the correlation between the variables of physical activity.

Table 3 shows that half of the workers (51%) reported no participation in sport. Other physical activities in leisure time were common, such as are sedentary activities. Only 13% of the workers could be considered truly 'inactive' in leisure, spending relatively much time in sedentary activities, doing relatively few other physical activities and no sport. An equal number of workers (27%) had rather sedentary work or physically strenuous work. Fourteen per cent of the workers spent relatively much time in sedentary activities and had a relatively sedentary occupation. Three per cent of the workers spent relatively much time in sedentary activities, had a relatively sedentary occupation and did not participate in sport.

Table 3. Distribution of all variables involved in the analysis among the 2,030 workers.

	%	mean (standard deviation)	
mean age		33.7	(9.6)
mean educational level (1= only primary school, 5=academic degree)		3.4	(1.7)
% females	51		
% workers performing 'physically strenuous' sports	49		
% workers performing 'physically strenuous' sports - three or more hours a week	28		
% of workers performing other physical activities in leisure time ≥12 h per week	49		
% of workers performing sports and ≥12 h of other physical activities in leisure time (active lifestyle)	15		
% of workers doing sedentary activities in leisure time ≥12 h per week	54		
% of workers doing sedentary activities ≥12 h per week as well as < 12 hs of other physical activities and no sport (inactive lifestyle)	13		
% of workers often doing sedentary activities at work	27		
% of workers relatively often doing physical strenuous activities at work	27		
% of workers often sitting both at work and in leisure time	14		
% of workers often sitting at work, having a inactive life style (much sitting, few activities, no sport)	3		
mean of physical fitness (1=good, 4=poor)		1.70	(.7)
mean of an index of stress symptoms (max.=6)		1.29	(1.6)
mean of an index of general illness behaviour (max.=5)		1.71	(1.5)
% of workers reporting symptoms during the past 12 months of the:			
- low back	60		
- neck-shoulder	44		
- lower extremity	31		
% workers reporting sick leave/long-term sick leave during the past 12 months due to symptoms of the:			
- low back	48/17		
- neck-shoulder	34/13		
- lower extremity	25/12		

Correlations between most physical activity variables as well as between physical activities in leisure time and at work were low (Table 4). Women appeared to report more physical activities in leisure time than men, but less physically heavy work.

Table 4. Correlation matrix of 10 variables of physical activity at work and in leisure time and age, gender, education (n=2030). ns= not significant p > .05)

		1	2	3	4	5	6	7	8	9	10
1	participation in sport >3 h	-									
2	other leisure activity (< 11h/> 11h)	ns	-								
3	active lifestyle	.58	.43	-							
4	leisure sedentary activity (< 11h/> 11h)	-.07	.08	ns	-						
5	inactive during leisure	-.26	-.39	-.17	.36	-					
6	sedentary work	.09	ns	ns	ns	ns	-				
7	heavy physical work	ns	-.08	ns	ns	.08	.06	-			
8	age	-.15	.10	-.07	ns	ns	.13	.10	-		
9	gender (1=male 2=female)	-.08	.24	ns	.08	-.11	-.17	-.32	-.26	-	
10	education (1=low 5=high)	.08	ns	ns	.06	-.07	ns	-.19	-.25	.28	-

Relation between physical activity and self-reported musculoskeletal symptoms and sick leave due to these symptoms

No relation was found between the number of hours of participation in sport or in other physical activities and symptoms and sick leave due to symptoms of the low back, neck-shoulder and lower extremities. Only workers who spent relatively much time in sedentary activities in leisure time showed significantly higher prevalence rates of low back symptoms and sick leave due to low back symptoms than workers who spent relatively less time in sedentary activities in leisure time.

Table 5. Estimated odds ratios (OR) and 95% confidence intervals (CI) by multiple logistic regression analysis of four indices of physical leisure activities on symptoms of low back, neck-shoulder and lower extremity (n=2030). Included in the model: age, gender, education and type of workload (sedentary or physically heavy work).

	no sport activities	active life-style	sedentary leisure activities	inactive life-style
low back				
symptoms	1.04 (0.84-1.29)	0.99 (0.72-1.35)	1.46* (1.18-1.29)	1.54* (1.06-2.23)
sick leave	0.94 (0.74-1.16)	1.10 (0.80-1.50)	1.60* (1.29-1.98)	1.28 (0.90-1.83)
only prolonged sick leave	1.29 (0.98-1.69)	0.83 (0.55-1.26)	1.51[1]*(1.15-1.98)	1.30 (0.86-1.96)
neck-shoulder				
symptoms	0.95 (0.77-1.18)	0.83 (0.60-1.13)	1.02 (0.82-1.27)	0.90 (0.63-1.27)
sick leave	0.99 (0.80-1.23)	1.23 (0.90-1.69)	1.07 (0.86-1.33)	1.01 (0.71-1.44)
only prolonged sick leave	1.16 (0.85-1.59)	1.09 (0.69-1.70)	1.29[1](0.95-1.77)	1.14 (0.70-1.86)
lower extremity				
symptoms	1.00[2] (0.79-1.27)	1.06 (0.76-1.48)	1.07[1](0.85-1.36)	0.86 (0.59-1.25)
sick leave	0.98[2] (0.77-1.23)	1.14 (0.82-1.59)	1.14[1](0.88-1.47)	0.92 (0.62-1.37)
only prolonged sick leave	1.37* (1.00-1.87)	1.03 (0.66-1.62)	1.25 (0.89-1.74)	0.98 (0.66-1.62)

* $p < 0.05$.

[1] significant interaction with sedentary work

[2] significant interactions with physically strenuous work

The multivariate analysis (table 5) showed no difference between workers participating and workers not participating in sport, nor between workers with or without an active lifestyle. However, (relatively many) sedentary activities did show odds ratios for low back symptoms and sick leave due to low back symptoms that differed significantly from one. In addition, non-participation in sport was associated with prolonged sick leave due to symptoms of the lower extremity.

A few significant interactions were seen, although the odds ratios per stratum often showed confidence intervals crossing 1. Workers with sedentary work tended to have (in comparison to non-sedentary workers):

- More low back symptoms if they did not participate in sport (OR 1.31)
- Fewer symptoms and less sick leave for the lower extremities, if they reported many sedentary leisure time activities (OR 0.70 and. 0.76 respectively)
- more prolonged sick leave due to low back symptoms as well as neck-shoulder symptoms, if they reported many sedentary leisure time activities (OR 2.71 and 2.12 respectively).

Workers with physically strenuous work tended to have more lower extremity symptoms and associated sick leave if they did not participate in sport (OR 1.40 and 1.38 respectively) compared with workers without physically strenuous work.

9.5 Discussion

The proportion of workers participating in sport (50%) in our database is lower than reported by Backx et al. (1994) for the general Dutch population (66%), but that percentage included other activities in leisure time than sports. The mean number of hours of participation in sport per week (4.1 h), reported by the workers participating in sport in this study is only slightly lower than the self-reported 4.5 h found in a study on 4,000 Dutch wage-earners (Bloemhoff & Schmikli 1996).
In agreement with most literature, we found rather weak or absent associations between physical (in)activity, participation in sport and musculoskeletal symptoms.
This was in contrast with our findings in the same worker population (Hildebrandt et al. 1996) that (1) physical activities in leisure time were related to a higher self-reported physical fitness, fewer stress symptoms (only in the younger age groups) and less general illness behaviour and (2) that sedentary leisure activities were related to a poorer self-reported physical fitness and general illness behaviour, but not to more stress symptoms. Nevertheless, we found some indications that workers not participating in sport show an increased prolonged sick leave due to symptoms of the low back and lower extremities and that workers with many sedentary activities in leisure time show an increased symptom rate and associated prolonged sick leave rate for low back and neck-shoulder symptoms. However, one has to be cautious in interpreting this kind of associations causally: workers with chronic symptoms may stop their participation in sport temporarily and subsequently do more sedentary activities, which means that their non-participation is the result of their symptoms and not the cause. In general, it is important to realise that our cross-sectional data do not allow for a distinction between cause and effect: participation in sport can influence health (positively or negatively), but health complaints - and certainly severe complaints - can also limit physical activities. In addition, it is possible that physically active workers are healthier not because of their participation in sport, but because of other characteristics which were not measured (Keeler et al. 1989) or - the reverse - are active because of a better health or physical fitness.
Another mechanism could be involved too. Many positive effects of strenuous physical activities (e.g. reduction of the risk of cardiovascular disease) are associated primarily with the energetic load, whereas the negative results are related primarily to the (bio)mechanical loads during these activities. For symptoms of the musculoskeletal system, a focus on energy consumption and physical exertion seems to be inadequate (Riihimäki et al. 1989) and biomechanical factors, such as twisting, bending and sudden peak loads (e.g. accidents and injuries), should also be considered, both in work and in leisure. From this point of view, it seems logical that participation in sport with a high energetic compound has a positive effect on the cardiovascular system (as is shown in many studies), but the effect on the musculoskeletal system will also be dependent on the nature, location and size of the biomechanical loads during sports and work: the loads on the elbow, experienced playing tennis may add to the loads on the elbow during work as a plasterer and thus to the risk of health damage. Similarly, heavy loading of the elbow during work may increase the risk of an injury during tennis (Dul 1991). But physical activities or sports can also lead to specific training effects which can enlarge the worker's capabilities and reduce the risk of injury: Dimberg et al. (1989) suggested a positive effect of training as a possible explanation for the fact that industrial workers who played racket sports reported less symptoms of the neck and hands.
Surprisingly, whereas non-participation in sport did not result in increased ORs, sedentary activities do, at least for low back symptoms and associated sick leave. This indicates that these variables measure different things, as is also shown by the absence of any correlation between participation in sport and sedentary leisure activities. Chasan-Taber et al. (1996) reported differences in associations between fitness and the spectrum of activity, implying that inactivity, moderate

activity and vigorous activity should be considered independently in epidemiological analyses. Our findings thus underline the importance of physical inactivity as a risk factor for musculoskeletal morbidity. Physical inactivity may be also an important prognostic factor for chronicity of symptoms; interventions focusing on prevention or decreasing physical inactivity are reported to be successful, although the long-terms effects are still unknown (Linton et al. 1989, Lahad et al. 1994). It seems, therefore, desirable to add a specific measurement of physical inactivity to the measurement of physical activities in future studies.

Our findings show a few interactions between physical activities in work and in leisure time. These indicate that physical inactivity in leisure time (non-participation in sport or many sedentary leisure activities) is associated with higher prevalence rates of symptoms in particular workers with sedentary tasks. Therefore, stimulating participation in sport and other leisure activities may have greatest effects in a group of workers with sedentary tasks. Participation in sport - or physical activities in leisure time in general - may compensate for a relatively inactive work situation. In this respect, it seems surprising that the recent discussions on the health risks of an inactive lifestyle focuses entirely on leisure time activities, whereas a growing number of workers are 'exposed' to relatively physically inactive working situations for eight hours per day (e.g. office and VDU work). Prevention of physical inactivity should therefore be directed not only towards leisure time activities, but also towards work tasks.

In contrast, our findings also indicate that participation in sport by non-sedentary workers may have unfavourable effects. A tentative explanation could be that the consequences of sport injuries may be more disabling in non-sedentary work situations. Furthermore, the added value of sports could be less substantial due to a more active work style in these groups, although it seems that a physically active working situation is not per se related to the physical fitness of the workers involved (Ilmarinen et al. 1991; Nygard et al. 1991; Nygard et al. 1993). In addition, Nygard et al. (1993) found a negative relation between heavy physical work and maximal oxygen uptake: intensity, duration and frequency of these work activities may not be enough to obtain training effects and activities involve often only particular body segments with static components, e.g. workload of a primarily biomechanical nature. For that very reason attention should be paid to (compensating) physical activities in these occupations too.

9.6 Conclusions

Physical activities in leisure time (participation in sport and/or other physical activities) are not associated with prevalence rates of low back and neck-shoulder morbidity. However, workers with relatively many sedentary activities in leisure time do show higher prevalence rates of low back symptoms and sick leave due to low back symptoms. In particular, in workers with sedentary tasks, non-participation in sport or having many sedentary leisure activities seem to be associated with higher prevalence rates of symptoms.

It is concluded that stimulation of participation in sport and other leisure activities in order to avoid physical inactivity could be one of the means to reduce musculoskeletal morbidity in the working population, particularly in sedentary workers.

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10. General discussion and conclusions

10.1 Introduction

This general discussion will address the possibilities and limitations of the DMQ in occupational health care. First, the identification of high-risk groups and risk factors will be discussed. Subsequently, the use and feasibility of the instrument itself is addressed. Position statements, which summarize the main conclusions, precede each paragraph. Finally, to enable final conclusions the findings presented in this thesis will be reviewed against the criteria for quality assessment of occupational health services instruments as referenced in chapter 1.

10.2 Identification of risk groups

'The questionnaire differentiates worker groups on different levels'

Both the field and validity studies indicate that it is possible to identify high-risk groups at a national level (Chapter 7), at branch level (Chapter 5) and at company level, including task groups within departments of a specific company (Chapter 6).
The studies reported in chapters 3 and 6 indicate that differentiation of worker groups is best at the level of tasks groups: at this level, workload is relatively homogeneous and associated risks and symptom rates are most pronounced. The last mentioned studies indicate that differences between subgroups can become diluted on a more aggregated level. This implies that branches as a whole may show low risks, while particular jobs or tasks within these branches can in fact be hazardous. This is illustrated in the steel industry study, where high-risk task groups were identified within departments, which were not identified as high risk.

'The questionnaire differentiates worker groups according to their physical workload and prevalence rates of musculoskeletal symptoms'

The field studies indicate that the questionnaire differentiates between worker groups with different physical workload or musculoskeletal symptoms. Although the validity studies were insufficiently decisive to allow for final conclusions, they seem to support the conclusions of the field studies that worker groups can be differentiated according to musculoskeletal workload and symptoms. The validity studies indicate that the differentiation based on the DMQ is similar to that based on detailed measurements of workload factors and a clinical evaluation. Groups with minimal contrast. however, cannot be differentiated by the DMQ. This is in accordance with the results of the field studies discussed earlier. At a more aggregated level contrasts become blurred, probably due to heterogeneous exposures within groups, e.g. industrial branches and even departments, which often include a wide and heterogeneous range of occupations and tasks. In addition, as the survey has a cross-sectional character, a certain selection process will inevitably weaken the relation between the exposures and effects measured. These mechanisms may also explain the disagreement found in the studies in agriculture and steel industry: high risk groups with respect to workload did not correspond entirely with the high risk groups with respect to musculoskeletal symptoms. As a consequence, both exposure and effect data should be used for priority setting. In addition, an approach based solely on reduction of exposures will ignore the fact that guidelines are often based on healthy populations, and therefore may not be sufficient to protect workers with health problems or disabilities.

'The questionnaire should always be part of a broader preventive approach'

This thesis focuses on the possibilities of the DMQ rather than its limitations. However, several limitations may be mentioned:

- The study of small worker groups is impeded by its limited statistic power. This can prove to be a severe limitation when the study is performed on the meso level of task groups, because the number of workers performing the same tasks is often limited. In these cases more precise methods will be necessary or an 'expert-guess' of the occupational health professional.
- Co-operation of the workers and the management involved is crucial at all levels. Without their effort response rates will be low, questionnaires will be filled in poorly, and the necessary follow-up is likely to fail.
- A certain level of contrast between the studied groups is necessary to identify risk groups and to allow a ranking order to be determined. This thesis does not give any indication of a minimal level of contrast necessary for such a ranking.
- Without help of the Loquest-software, data entry and data analysis of questionnaires can be laborious, in particular when large worker groups are involved.
- Detailed data on exposures to postures, movements, and force exertions cannot be collected with a questionnaire. In many instances, a questionnaire survey needs to be followed by further, more detailed analyses of specific exposures.

These limitations should emphasise that the DMQ is only part of a (first) stage in a comprehensive step-by-step approach.

10.3 Identification of risk factors

As mentioned above, an additional limitation of the questionnaire surveys discussed here is their cross-sectional character. Therefore, the data collected do not allow for any firm conclusions on possible causal relationships between risk factors and musculoskeletal symptoms. In addition, possibilities to quantify risk factors in a questionnaire survey are limited, hampering the identification of dose-response relationships. However, it should be stressed that the analyses on the relationships between risk factors and effects presented in this thesis were of an exploratory nature, aiming to generate new hypotheses and not to test them. Taking these limitations into account, the analysis of such questionnaire data is still valuable.

'Low back pain is work related'

The analysis of national survey data presented in Chapter 6 shows an association between occupation and prevalence rate of low back symptoms. Prevalence rates between occupations differ by a factor two. The widest differences are found between sedentary and non-sedentary occupations. Most likely this is due to differences in physical workload, although differences in other risk factors (e.g. psychosocial factors) and general socio-economic status may also contribute. The findings of this study generally support the statement issued by the US National Research Council on work related musculoskeletal disorders: *there is a higher incidence of reported pain, injury, loss of work, and disability among individuals who are employed in occupations where there is a high level of exposure to physical loading than for those employed in occupations with lower levels of exposure* (National Research Council, 1999). Recent systematic reviews confirm the relationship between several workload factors and the occurrence of symptoms of the low back (Hoogendoorn et al. 1999), neck (Ariens et al. 1999), and shoulder (Van der Windt et al., 2000).

‘Climatic working conditions such as draught, cold, temperature fluctuations and outdoor work are associated with musculoskeletal symptoms’

It is a common observation among workers that climatic factors influence their symptoms. The analysis presented in Chapter 9 indicates that this feeling is indeed more than merely an old wives’ tale. Particularly, the positive association between outdoor work and symptoms is important, as recall bias will have no impact on this self-reported working condition. The other self-reported climatic factors may be biased by a higher awareness of climatic factors in persons with symptoms. The possibility to adjust the results for workload factors prevented a bias by a plausible association of outdoor work with high physical workload. The analysis thus supports the policy in e.g. the building and construction industry of prescribing or supplying protective clothing in winter for outdoor work.

‘A physically less active lifestyle is related with musculoskeletal symptoms, in particular in sedentary workers’

As the data analysed in Chapter 8 are cross-sectional, they do not allow final conclusions, in particular for the relationship between sports participation and musculoskeletal symptoms. It is plausible that in particular cases severe symptoms will hamper sports participation. However, the research was carried out among workers actually performing their tasks, thus excluding workers affected with severe symptoms. Also, the outcome measure (12 month prevalence of all symptoms, either mild or severe) compensates for this effect to some extent, since the majority of the ‘affected’ workers report their symptoms as ‘mild symptoms, which will presumably not hamper sports participation’. Thus, the analysis indicates that (1) a physically active lifestyle may prevent musculoskeletal symptoms to some extent despite the inherent risk of (acute) injuries, and (2) sports participation may be especially beneficial to those workers performing sedentary tasks, since sports participation can compensate the lack of exercise during working hours. Stimulating an active lifestyle may therefore be one way to control musculoskeletal morbidity and associated sick leave in companies. In future research more attention should be given to stimulation of daily activity and consequent physical fitness, and its contribution to the prevention of musculoskeletal symptoms. Intervention studies are needed to allow the formulation of threshold values for daily physical activity that will prevent symptoms.

Further research is needed to clarify the role of climatic factors in causing or aggravating musculoskeletal morbidity as well as the role of physical fitness in preventing musculoskeletal symptoms and associated sick leave. Specific exposure and outcome variables and intervening variables addressing these issues should be incorporated in forthcoming studies, and specific intervention studies should be performed.

10.4 Use and feasibility of the instrument itself

‘The questionnaire constitutes the start of successful prevention’

In many instances the DMQ has shown to be a successful start of a more extensive prevention approach.

The results of the survey in the steel industry were used – in combination with existing ergonomic data – to identify three high-risk working tasks. For these tasks, ergonomic guidelines and improvements were developed and implemented (Dul et al. 1991). The approach chosen for the agricultural branch illustrates the passage through every stage of prevention. The results of the initial survey reported in Chapter 5 – again, taken along with an analysis of existing ergonomical data – contributes to the process to prioritise the protective vegetable growing branch for further action. In this branch, a more detailed analysis of symptoms and workload was carried out, and possible solutions were gathered (Van Dieën 1989b, Van der Schilden 1989, Berndsen et al. 1991). Also, a pilot study was carried out on how to implement these solutions optimally (Wortel et al. 1993, Wortel et al. 1994). Afterwards, the agricultural occupational health service adopted this approach. These studies emphasize the significance of the DMQ in the initial problem analysis, preceding further steps in the preventive approach.

'Establishing a database with data from several surveys renders added value'

Aggregating data from several surveys into one database enables the researcher to interpret findings of a particular survey, and to explore more general questions that are short of scientific data. An aggregated database offers attractive possibilities to generate hypotheses from these questions with relative ease and at low cost . However, two limitations have to be mentioned. First, the database thus achieved does not contain a representative sample of the worker population, but a selection of (more or less high risk) groups. After all, the surveys were carried out due to a 'suspicion' or perception of possible high risks. Using the database as a reference group should be done with care, since the exposures in the groups involved will certainly be higher than average. On the other hand, prevalence rates of risk factors will be relatively high in the database, which could facilitate secondary analyses on the relation between certain risk factors and musculoskeletal symptoms. Secondly, it should be emphasized – as discussed earlier - that such a database contains cross sectional data; definitive conclusions on cause effect relationships cannot be drawn.
To interpret the results of a particular survey, the inclusion in the database of a reference group of 'optimal' exposed workers with the lowest risks of effects would be desirable, although such workers will be hard to find.

'The questionnaire has stimulated standardization of measurements'

Widespread use of this standardised questionnaire in occupational health care will facilitate the comparison of results, both at a national and an international level. At a national level, a short version of the questionnaire is part of a risk assessment and evaluation instrument widely used by occupational health services. The main symptom questions have been added to the continuous survey on health and living conditions (POLS) of the Dutch Bureau of Statistics (CBS). Parts are also used in other large national studies, such as the Dutch study on musculoskeletal disorders, absenteeism, stress and health (SMASH). At international level, the main symptom questions of the DMQ are compatible with those of the Nordic Questionnaire, which can be considered an international standard. The large amount of publications on questionnaires measuring musculoskeletal workload and associated symptoms in recent years should make it possible to design a new international standard-questionnaire. Incorporation of such an instrument on forthcoming epidemiological studies would enhance comparability of studies across study-populations and countries enormous and thus create a clear added value.

'The questionnaire is feasible for professionals in occupational health services

A software program has been developed to analyse data collected with the questionnaire as well as to generate a standard report with the main findings of the survey, including a management summary. The program is already used by Dutch occupational health services as well as by ergonomic and physical therapy practices. In practice, the software provides a major advantage, especially since it saves precious time.

10.5 Conclusions

To allow for final conclusions, the findings presented in this thesis are reviewed according to the criteria for quality assessment of occupational health services instruments as referenced in Chapter 1 (Van Dijk et al. 1993). In Table 1, the scheme as proposed by Van Dijk et al. has been applied to the DMQ as a measuring instrument for occupational health services.

Table 1. Description and quality assessment of the DMQ

OBJECT/STRATEGY	
Measurement	Self-reported workload and health of employees
Object aspects	Musculoskeletal risk factors and symptoms
Tailor-made	No, because of the need for comparability between groups on meso and macro levels
Population selection	Population at risk or sample
Situation selection	Often sampling strategy
Unique/periodical	Often unique
Aggregation level	Meso or macro level
TECHNICAL QUALITY	
Standardization	Good
Reliability	Unknown
Validity	Some aspects good, some aspects warrant further research
Precision	Presumably moderate, further research warranted
PROCESS QUALITY	
Employees	Good
Employers	Moderate to good
Occupational health services	Good, when utilizing Loquest-software
STRATEGIC QUALITY (COMPANY POLICY)	Good

Object and strategy are described in detail in Chapter 1, and examples of applications on macro and meso levels are presented in Chapters 4-5. A description of the technical quality is based on Chapters 2-4. Standardization will be good, given the availability of a manual and software for occupational health professionals working with the DMQ. Various validity aspects of the DMQ were explored in this thesis. The findings presented suggest that the DMQ can identify groups, as long as some contrast between groups is discernible. These findings are in agreement with other recent studies, which conclude that questionnaires can be used to identify risk factors at group level (Burdorf 1999, Neumann et al. 1999, Viikari-Juntura et al. 1999). Future prospective studies should clarify which combinations of risk factors predict musculoskeletal symptoms and disability best and are thus most important to involve in ergonomical or other interventions.

Since the DMQ is meant to be part of a participatory process, acceptance by employees and management will be ensured. Some potential obstacles in occupational health services – lack of time and expertise to analyse data and report results – have been tackled with specific software.

Part of this acceptance is also the willingness of employees to complete the questionnaire. Questionnaire surveys are highly dependent on the co-operation of the workers involved. In the steel industry, a group wise approach was chosen: workers were allowed to attend the classes during working hours. This resulted in a relatively high response rate. In agriculture, a postal

questionnaire had to be chosen given the high numbers of respondents needed, resulting in a much lower response rate. All in all, the acceptance by the employees appears to be satisfactory.
The strategic quality of the DMQ is enhanced by the software that comes with it; it generates an automated report with a management outline containing main results and starting points for further preventive activities.
In conclusion, the DMQ can satisfy most criteria of Table 1, thus offering an attractive application for the daily practice of occupational health care. Areas of future research should primarily concern its technical quality. The findings presented in this thesis on the technical quality of the instrument need verification, and some aspects not yet scrutinized (e.g. reliability, precision) should get attention in future studies.

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Summary

Work related musculoskeletal disorders constitute a major problem to modern society. They are a major cause of work absenteeism and disability, thus constituting one of the most expensive disease categories. There is a great need for effective ways to prevent or reduce musculoskeletal problems. Given the extent of the problem, priorities have to be set concerning the workplaces that need interventions most. Quantitative data on actual risks and morbidity are needed to take well-considered decisions. Occupational health services are often requested to supply these data; to obtain valid data from daily practice they need standardized and feasible collecting methods.
This thesis describes the characteristics and use of such a method, the ‘Dutch Musculoskeletal Questionnaire’, DMQ. The aim of the DMQ is to measure both work related musculoskeletal risk factors and symptoms in worker populations in such a standardized way that it is feasible in daily practice of occupational health services and ergonomical counselling.

The first part of this thesis (Chapters 2-4) explores the basic qualities of the questionnaire.
Several validity aspects were addressed by analyses on a database containing the data of 1,575 workers in various occupations who completed the questionnaire (Chapter 2). By means of a factor analysis the questions on musculoskeletal workload and associated potentially hazardous working conditions were grouped into seven indices: force, dynamic and static load, repetitive load, climatic factors, vibration, and ergonomic environmental factors. Together with four separate questions on standing, sitting, walking, and uncomfortable postures, the indices constitute a brief overview of the main findings on musculoskeletal workload and associated potentially hazardous working conditions. Homogeneity of the indices, assessed by computing Cronbach's alphas, was found to be satisfactory, as was the divergent validity of the indices assessed by computing intercorrelations with an index of psychosocial working conditions. Discriminative power was good: worker groups with contrasting musculoskeletal loads could be differentiated on the basis of the indices. Significant associations of most indices with musculoskeletal symptoms demonstrated concurrent validity.
In addition, the possibility was explored to obtain from the DMQ a valid ranking of worker groups with respect to workload exposure (Chapter 3) and musculoskeletal symptoms (Chapter 4). Four homogeneous worker groups (VDU workers, office workers, dispatch workers, and assembly workers) completed the questionnaire and were observed through video performing their main tasks. Self-reported exposure to postures was computed for each group, as well as the mean frequency and duration of postures in different trunk flexion and rotation angle-categories. Both methods identified the same groups with the highest exposures to unfavourable postures. Simple qualitative questions seemed adequate. In Chapter 4, four other homogeneous worker groups (VDU workers, office workers, vehicle drivers and printers) were scrutinized; they completed the questionnaire as well as a standardized physical examination. The questionnaire appeared to identify the same worker groups with high prevalence rates of low back pain as the physical examination. Seven-day prevalence rates resulted in the highest specificity, while lifetime prevalence rates resulted in the best sensitivity. Overall, the one-year prevalence rates turned out to be a reasonable intermediate choice.

In the second part of this thesis, two studies are reported in which the DMQ was applied to identify problems at macro and meso levels. The former study describes a survey in agriculture at and within branch level (Chapter 5). The latter describes a survey in the steel industry at and within company level (Chapter 6).

In Dutch agriculture a postal survey was carried out to identify branches that needed priority in agricultural occupational health care. 2,580 male employees and employers from twelve different branches completed the DMQ. Marked differences were found in size and nature of self-reported musculoskeletal workload and musculoskeletal morbidity. Particularly, in farming of protective vegetables and in arboriculture relatively high exposure levels and high symptom rates were shown.
A second survey was carried out in a large steel company to determine priorities for ergonomic improvements in five maintenance departments. 436 workers completed the DMQ during work hours. Significant differences were shown between the five departments as well as between task groups within the departments. Several task groups with relatively high exposure levels and high symptom rates could be identified.

The third part of this thesis presents three studies in which questionnaire data were used to explore relationships between possible risk factors and musculoskeletal symptoms.
In Chapter 7 a secondary analysis of national survey data is described to explore the relation between work, operationalized as occupation or trade, and low back symptoms. Although this study was not carried out with the DMQ, it involved self-reported data on back symptoms, comparable to the DMQ. The sample used was representative for the working population in the Netherlands and consisted of 5,840 men and 2,908 women. 33 trades and 34 professions with at least 50 respondents were included in the analysis. A substantial variation in prevalence rates of low back pain was found between trades and professions, ranging from 12 to 41%. High prevalence rates of back pain were found in particular in non-sedentary professions, which suggests that physically heavier work is indeed a risk factor for these symptoms.
In Chapters 8 and 9, two secondary analyses are reported of the DMQ database, containing data from 2,030 workers in 24 different occupations. The analyses aimed to explore the relation between musculoskeletal symptoms and, on the one hand, adverse climatic working conditions and, on the other hand, physical (in)activity. These two factors are often associated with musculoskeletal symptoms, but as of yet little scientific evidence has been available.
About a quarter of the workers associated symptoms of the low back and neck-shoulders with unfavourable climatic factors, in most cases as aggravating agents (Chapter 8). Self-reported prevalence rates of low back and neck-shoulder symptoms were slightly lower in summer. The statistical analysis showed that the occurrence of unfavourable climatic factors was related to both low back and neck-shoulder symptoms. In addition, frequent outdoor work was related to higher prevalence rates of neck-shoulder symptoms. These findings suggest a relationship between unfavourable climatic working conditions and musculoskeletal symptoms. More specific epidemiological studies are called for.
With respect to physical (in)activity (Chapter 9), a logistic regression analysis was carried out to study the association between four physical activity indices (participation in sport, sedentary activities, active life style, sedentary life style) and musculoskeletal morbidity, adjusted for age, gender, education, and workload. No association was found between participation in sport and/or other physical activities in leisure time and musculoskeletal symptoms, but sedentary activity in leisure time was associated with higher prevalence rates of low back symptoms and sick leave due to low back symptoms.

The results of the studies reported in the first part of this thesis suggest that the DMQ can be used to identify high-risk groups with respect to workload as well as worker groups with high prevalence rates of musculoskeletal symptoms. The surveys reported in the second part of this thesis show that the DMQ can constitute a simple and quick inventory for occupational health services to provide data necessary to prioritise workload factors and worker groups with regard to ergonomic interventions. The analyses reported in the third part of this thesis show that - despite the limitations due to it's cross sectional character – the DMQ database may be used to explore relevant scientific hypotheses.

Samenvatting

Werkgerelateerde aandoeningen van het bewegingsapparaat vormen een belangrijk probleem in onze maatschappij. Zij behoren tot de belangrijkste oorzaken van het ziekteverzuim en de arbeidsongeschiktheid en vormen daardoor een grote maatschappelijke kostenpost. Voor de betrokkenen vormen zij een chronisch lijden en een bedreiging voor de arbeidsparticipatie en inkomensverwerving. De behoefte aan effectieve interventies om deze aandoeningen te voorkomen of de gevolgen ervan te beperken is groot. Gezien de grote omvang van het probleem moeten prioriteiten worden gesteld zodat werkplekken met de hoogste risico's of de grootste gezondheidsproblemen het eerst aandacht verkrijgen. Om goed doordachte beslissingen mogelijk te maken, zijn kwantitatieve gegevens over risico's en gezondheidsproblemen gewenst. Arbodiensten worden vaak gevraagd deze aan te leveren. Zij behoeven daartoe gestandaardiseerde en praktisch toepasbare methoden om deze gegevens in de dagelijkse praktijk daadwerkelijk te verzamelen.

Dit proefschrift beschrijft de eigenschappen en praktische toepassing van zo'n methode, de Vragenlijst BewegingsApparaat (VBA, in het Engels de 'Dutch Musculoskeletal Questionnaire', DMQ). Doel van deze vragenlijst is het valide en gestandaardiseerd meten van werkgerelateerde risicofactoren voor aandoeningen van het bewegingsapparaat en klachten van het bewegingsapparaat in werknemersgroepen op een wijze die in de dagelijkse praktijk van arbodiensten en ergonomische advisering hanteerbaar is.

Het eerste deel van dit proefschrift (hoofdstukken 2-4) verkent de eigenschappen van de vragenlijst. Een aantal aspecten van validiteit komen aan de orde in een analyse van een databestand van 1575 werknemers in diverse beroepen die deelnamen aan DMQ surveys (hoofdstuk 2). De vragen over fysieke belasting en daaraan gerelateerde risicovolle werksituaties konden op basis van een factoranalyse gegroepeerd worden in zeven indices: krachtuitoefening, dynamische en statische belasting, repeterende belasting, klimaat, trillingen en ergonomische omgevingsfactoren. Tezamen met vier separate vragen over staan, zitten, lopen en ongemakkelijke houdingen verschaffen deze indices een bondig overzicht van de belangrijkste uitkomsten van het onderzoek met de DMQ met betrekking tot de belasting van het bewegingsapparaat in het werk. De homogeniteit van de indices, afgemeten aan de Cronbach's alpha, bleek bevredigend. Hetzelfde gold voor de divergente validiteit afgemeten aan intercorrelaties met een index van psychosociale werkomstandigheden. Het discriminerend vermogen was goed: werknemersgroepen met contrasterende werkbelasting konden goed van elkaar worden onderscheiden. De concurrente validiteit bleek uit significante relaties tussen de meeste indices en klachten van het bewegingsapparaat.

Daarnaast is verkend of met de vragenlijst een valide rangordening was aan te brengen tussen groepen werknemers ten aanzien van hoogte van de werkbelasting en klachten van het bewegingsapparaat. In hoofdstuk drie wordt een onderzoek gerapporteerd waarin vier qua werkbelasting homogene groepen (beeldschermmedewerkers, kantoormedewerkers, expeditiemedewerkers en magazijnmedewerkers) vragen over hun houding invulden en daarnaast via video-opnamen werden geobserveerd om frequentie en duur van hun romphouding (flexie en rotatie) tijdens de belangrijkste werkzaamheden objectief vast te leggen. Beide methoden identificeerden dezelfde groep met de hoogste expositie aan ongunstige houdingen. Simpele kwalitatieve vragen bleken hiervoor voldoende. In hoofdstuk vier wordt een onderzoek beschreven onder vier andere homogene werknemersgroepen (beeldschermwerkers, kantoormedewerkers, chauffeurs en drukkers) die naast vragen over hun rugklachten ook een uitgebreid

gestandaardiseerd lichamelijk rugonderzoek ondergingen. Ook nu identificeerden beide methoden dezelfde groep als de groep met de hoogste klachtenniveaus. De zeven-dagen-prevalentie resulteerde in de hoogste specificiteit, de 'life time'-prevalentie in de hoogste sensitiviteit. De één-jaars-prevalentie vormde een redelijk compromis.

In het tweede deel van dit proefschrift worden twee studies gerapporteerd waarin de DMQ is toegepast om probleemgroepen te identificeren op zowel het macro- als het mesoniveau: een survey in de land- en tuinbouw op en binnen brancheniveau (hoofdstuk 5) en een survey in de staalindustrie op en binnen bedrijfsniveau (hoofdstuk 6).
In de land- en tuinbouw werd een postenquête uitgevoerd om branches te identificeren die prioriteit binnen de arbozorg zouden moeten krijgen. 2580 mannelijke werknemers en ondernemers uit twaalf branches vulden de vragenlijst in. Tussen de branches werden duidelijke verschillen gevonden in prevalentie van risicofactoren en klachten. Met name de glasgroente- en boomteelt hadden zowel hoge blootstellingniveaus als hoge klachtenprevalenties.
Een tweede survey werd uitgevoerd in een groot staalbedrijf om prioriteiten te stellen voor een ergonomisch verbeteringstraject binnen vijf onderhoudsafdelingen. 436 werknemers vulden de vragenlijst op het werk in. Tussen de afdelingen zowel als tussen taakgroepen binnen deze afdelingen werden duidelijke verschillen waargenomen en diverse taakgroepen met zowel hoge blootstellingniveaus als hoge klachtenprevalenties konden geïdentificeerd worden.

In het derde deel van dit proefschrift worden drie onderzoeken gepresenteerd, waarin vragenlijstgegevens gebruikt zijn om relaties tussen mogelijke risicofactoren en klachten van het bewegingsapparaat te verkennen.
In hoofdstuk zeven wordt een secundaire analyse beschreven van data van een nationale gezondheidsenquête om de relatie tussen werk - geoperationaliseerd in beroep en bedrijf - en rugklachten in kaart te brengen. Hoewel dit onderzoek niet met de DMQ is uitgevoerd, betrof het wel een zelfde type data, namelijk zelf-gerapporteerde klachten. De betrokken steekproef was representatief voor de Nederlandse werkende bevolking en bestond uit 5840 mannen en 2908 vrouwen. In totaal konden 33 bedrijfsklassen en 34 beroepsklassen met tenminste 50 respondenten onderscheiden worden. Er bleek een aanzienlijke variatie in prevalentie van rugklachten tussen bedrijven en beroepen, variërend tussen 12 en 41%. Er werd geconstateerd dat hoge prevalenties van rugklachten vooral voorkwamen in niet-zittende beroepen, hetgeen suggereert dat lichamelijk zwaarder werk inderdaad een risicofactor voor deze klachten is.
Vervolgens komen twee secundaire analyses aan de orde van het DMQ-databestand, dat 2030 werknemers in 24 verschillende beroepen bevatte. De analyses betroffen de relatie tussen klachten van het bewegingsapparaat en twee factoren die weliswaar vaak met deze klachten worden geassocieerd, maar waarvoor nog weinig wetenschappelijke onderbouwing bestond: ongunstige klimatologische werkomstandigheden en lichamelijke inactiviteit.
Ongunstige klimatologische werkomstandigheden (hoofdstuk 8) werden door ongeveer een kwart van de werknemers geassocieerd met rug- en nek-schouderklachten, meestal in ongunstige zin. De zelf-gerapporteerde prevalentie van lage rug- en nek-schouder klachten bleek in de zomer wat lager. Statistisch bleken ongunstige klimaatfactoren niet alleen gerelateerd aan rug- en nek-schouderklachten, maar ook aan verzuim ten gevolge van deze klachten; dit gold met name voor tocht in relatie tot nek-schouderklachten. Daarnaast bleek frequent werken in de buitenlucht samen te gaan met meer nek-schouderklachten. Deze bevindingen suggereren een relatie tussen ongunstige klimatologische werkomstandigheden en klachten van het bewegingsapparaat, die nader specifiek onderzoek rechtvaardigt.

Ten aanzien van lichamelijke (in)activiteit (hoofdstuk 9) werd een logistische regressieanalyse uitgevoerd om de relatie met klachten aan het bewegingsapparaat te verkennen in samenhang met leeftijd, geslacht, opleiding en werkbelasting. In deze analyse werden vier indices voor lichamelijke (in)activiteit gehanteerd: sportparticipatie, zittende activiteiten, actieve leefstijl en sedentaire leefstijl. Er werd geen relatie gevonden tussen sportparticipatie en/of andere lichamelijke activiteiten in de vrije tijd en bewegingsapparaatklachten, maar zittende activiteiten in de vrije tijd waren wel gerelateerd aan een hogere prevalentie van rugklachten en ziekteverzuim ten gevolge van rugklachten.

De resultaten van het onderzoek zoals gerapporteerd in het eerste deel van dit proefschrift duiden erop dat de DMQ gebruikt kan worden om hoge risico groepen en groepen met hoge klachtenpercentages te identificeren. De beschreven surveys in het tweede deel van dit proefschrift laten zien dat de DMQ een eenvoudige en snelle onderzoeksmethode kan zijn voor deskundigen in de praktijk om prioriteiten te stellen met betrekking tot groepen die ergonomische interventie behoeven. De analyses zoals beschreven in het derde deel van dit proefschrift geven aan dat het met het DMQ opgebouwde verzamelbestand – ondanks de nadelen die verbonden zijn aan het transversale karakter van dit bestand – ook bruikbaar is om meer wetenschappelijke vraagstellingen te exploreren.

Dankwoord

Het doet mij genoegen dit dankwoord te schrijven, want het betekent dat ik de laatste stap ga zetten in het meerjaren traject dat uiteindelijk dit 'boekje' heeft opgeleverd. Het geeft mij tevens de gelegenheid de vele personen en instanties te bedanken die het onderzoek dat aan dit proefschrift ten grondslag ligt mogelijk hebben gemaakt, dat mede uitgevoerd hebben of mij terzijde hebben gestaan bij de schriftelijke verslaglegging daarvan.
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Het is uiteraard onmogelijk iedereen bij name te bedanken, maar een aantal personen wil ik toch graag apart noemen. Allereerst een woord van dank aan mijn beide promotoren, voor hun begeleiding, opbouwende kritische opmerkingen en hun eindeloos geduld. Han, je was altijd attent en motiverend tijdens ons overleg en hebt me nooit onder druk gezet als het weer eens lang duurde voordat je wat hoorde, je had blijkbaar een groot vertrouwen in een goede afloop en ik ben blij je niet teleurgesteld te hebben. Frank, je betrokkenheid bij het onderwerp was groot en je verraste altijd weer door een dwarsverband met andere onderwerpen of invalshoeken te leggen ('je moet dat artikel eens lezen…'), hetgeen zeer stimulerend werkte.
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De directie en sectorcoördinatoren, divisiehoofden, sectorhoofden, teamleiders van NIPG-TNO, TNO PG, NIA TNO en TNO Arbeid (ja, dit proefschrift heeft vele reorganisaties overleefd) wil ik ook bedanken voor hun ondersteuning, die de totstandkoming van dit proefschrift mogelijk heeft gemaakt.
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About the author

Vincent Hubertus Hildebrandt was born in The Hague in 1954. He graduated from secondary school in 1972 and studied at the Faculty of Medicine of the Erasmus University Rotterdam, receiving his certificate as general physician in 1980. In 1984 he followed the courses 'Quantitative methods in Epidemiology' (Kleinbaum & Greenberg) and 'Environmental and Occupational Epidemiology' (Shy & Bertazzi). From 1985-1988 he studied Occupational Medicine at NIPG-TNO in Leiden, which resulted in a registration as occupational health physician in 1988.
He started his professional career at NIPG-TNO in Leiden in 1982 and is now senior-researcher at TNO Work and Employment in Hoofddorp. His current area of research is physical (in)activity in the working population and he has been coordinating a research program on this subject since 1997.

Appendix 1
Dutch (final) version of the DMQ

The bèta-release of Loquest (Dutch-version), a software program for data-entry and data-analysis of the DMQ, including an autoreport and a comprehensive manual for occupational health professionals (in Dutch) is downloadable from the website of TNO Work and Employment (www.arbeid.tno.nl, search for LOQUEST). A provisional English translation of the DMQ to download can also be obtained from that page.

Vragenlijst BewegingsApparaat (VBA)

Nota bene:

De korte versie van de VBA bevat de volgende pagina's:
- *Algemeen (pagina 1)*
- *Gezondheid 2 (pagina 3)*
- *Werk 1 (pagina 4); op deze pagina moet u zelf nog de taken invullen die in uw onderzoekspopulatie voorkomen.*
- *Werk 1a (dit is een aparte pagina voor alleen de verkorte versie, die als laatste pagina is bijgevoegd)*

De standaardversie van de VBA bevat de pagina's 1 t/m 9.
De uitgebreide versie van de VBA bevat de pagina's 1 t/m 14.
Voor alle versies zijn de pagina's 15-16 facultatief.
Met het programma Loquest kunnen de pagina's 1-14 worden ingevoerd.

TNO Arbeid
Hoofddorp 2001

Lees dit eerst

Deze vragenlijst gaat over uw werk en uw gezondheid.
De meeste vragen kunt u eenvoudig met 'ja' of 'nee' beantwoorden. Het is de bedoeling dat u de vragen zonder lang nadenken beantwoordt, want uw eerste ingeving is vaak het beste antwoord. We verzoeken u de vragen zelf te beantwoorden, dus zonder overleg met anderen.

Kruis altijd slechts één antwoord aan, ook al vindt u de keuze tussen antwoordmogelijkheden misschien moeilijk. Kies het antwoord dat naar uw mening het beste bij uw situatie past.

Het kan voorkomen dat bepaalde vragen veel op elkaar lijken. Toch is het belangrijk dat u alle vragen invult.

Voorbeeld hoe in te vullen:

Zet een kruisje in het hokje achter de vraag, bijvoorbeeld:

Heeft u regelmatig hoofdpijn? **ja ☒ nee ❑**

Wanneer u zich echter vergist heeft zet dan weer een kruisje, maar dan in het juiste hokje en zet daar vervolgens ook een cirkel omheen. Bijvoorbeeld:

Heeft u regelmatig hoofdpijn? **ja ☒ nee ☒**

Uw antwoorden worden strikt vertrouwelijk behandeld. Dat betekent dat niemand van uw organisatie inzage krijgt in uw persoonlijke gegevens en antwoorden. Alleen de onderzoekers krijgen toegang tot deze gegevens. Bij de presentatie van de resultaten worden alleen groepsresultaten gegeven en zijn uw persoonlijke gegevens dus niet meer herkenbaar!

Alvast hartelijk dank voor uw medewerking!

Algemeen

Lees eerst de toelichting op de vorige pagina voor u gaat invullen!

1. Wat is uw leeftijd? — — jaar

2. Bent u man of vrouw? man ☐$_1$ vrouw☐$_2$

3. – Heeft U de Nederlandse nationaliteit? ja ☐$_1$ nee☐$_2$
   – Spreekt en/of leest u gemakkelijk Nederlands? ja ☐$_1$ nee☐$_2$

4. Wat is de <u>hoogste</u> opleiding die u heeft <u>afgemaakt</u>?
   - geen opleiding afgemaakt of lagere school ☐$_1$
   - lager beroepsonderwijs (bijv. LEAO, LTS), leerlingenstelsel, kort-MBO ☐$_2$
   - middelbaar algemeen- of beroepsonderwijs (bijv. MAVO, MEAO, MTS) ☐$_3$
   - voortgezet algemeen onderwijs (bijv. HAVO, HBS, Atheneum, Gymnasium) ☐$_4$
   - hoger beroeps- en universitair onderwijs (bijv. HEAO, HTS, SA, PA, MO-A, MO-B) ☐$_5$

5. – Wat is uw lichaamslengte? ongeveer — — — cm
   – Wat is uw lichaamsgewicht? ongeveer — — — kg

6. – Hoeveel jaar doet u uw huidige werk al bij deze werkgever? — — — jaar
   – Hoeveel uur per week doet u dit werk gewoonlijk *(inclusief eventueel overwerk!)*? — — uur per week
   – Hoeveel dagen per week doet u dit werk gewoonlijk? — dagen per week

7. – Hebt u een tijdelijke aanstelling (korter dan een jaar) of bent u uitzendkracht? ja ☐$_1$ nee☐$_2$
   – Krijgt u op dit moment een uitkering wegens ziekte of arbeidsongeschiktheid? ja ☐$_1$ nee☐$_2$
   – Doet u nog ander werk (betaald of onbetaald)? ja ☐$_1$ nee☐$_2$
   – Werkt u linkshandig? ja ☐$_1$ nee☐$_2$

8. Geeft u in het dagelijks werk direct leiding aan mensen?

9. Hoelang duurt gemiddeld de reis van huis naar uw werkplek (enkele reis)?

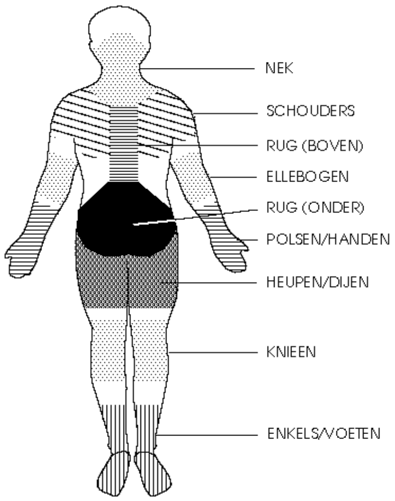
10. Hoe reist u gewoonlijk naar uw werk: *(U mag meerdere kruisjes zetten)*
    - te voet ☐$_1$
    - fiets ☐$_1$
    - brommer. motor ☐$_1$
    - auto ☐$_1$
    - (bedrijfs)bus ☐$_1$
    - tram, trein ☐$_1$

11. In welk soort dienst werkt u?
    - dagdienst ☐$_1$
    - onregelmatig diensten ☐$_2$
    - 2-ploegendienst ☐$_3$
    - 3-ploegendienst ☐$_4$
    - 4- of 5-ploegendienst ☐$_5$

Gezondheid (1)

1.	Hoe is het in het algemeen met uw gezondheid gesteld?	goed ☐$_1$
		redelijk ☐$_2$
		matig ☐$_3$
		slecht ☐$_4$
2.	Hoe is de laatste tijd naar uw mening uw lichamelijke conditie?	goed ☐$_1$
		redelijk ☐$_2$
		matig ☐$_3$
		slecht ☐$_4$
3.	– Vereist uw werk veel kracht?	ja ☐$_1$ nee ☐$_2$
	– Vereist uw werk veel uithoudingsvermogen?	ja ☐$_1$ nee ☐$_2$
4.	Hoe lichamelijk vermoeid bent u gewoonlijk aan het eind van een normale werkdag?	niet vermoeid ☐$_1$
		enigszins vermoeid ☐$_2$
		tamelijk vermoeid ☐$_3$
		erg vermoeid ☐$_4$
5.	Hoe geestelijk vermoeid bent u gewoonlijk aan het eind van een normale werkdag?	niet vermoeid ☐$_1$
		enigszins vermoeid ☐$_2$
		tamelijk vermoeid ☐$_3$
		erg vermoeid ☐$_4$
6.	– Hebt u de laatste tijd gezondheidsklachten?	ja ☐$_1$ nee ☐$_2$
	– Bent u de afgelopen zes maanden naar de dokter geweest? *(geen sport- of pilcontrole)*	ja ☐$_1$ nee ☐$_2$
	– Bent u nu onder behandeling van een arts?	ja ☐$_1$ nee ☐$_2$
	– Bent u de afgelopen zes maanden wel eens van uw werk thuis gebleven wegens ziekte of ongeval?	ja ☐$_1$ nee ☐$_2$
	– Gebruikt u geregeld medicijnen *(behalve eventueel de pil)*?	ja ☐$_1$ nee ☐$_2$
7.	Rookt u of heeft u gerookt? ?	ja, ik rook nu ☐1
		ja, ik heb vroeger gerookt ☐$_2$
		nee, ik heb nooit gerookt ☐$_3$
8.	– Voelt u zich vaak gespannen?	ja ☐$_1$ nee ☐$_2$
	– Bent u vaak nerveus?	ja ☐$_1$ nee ☐$_2$
	– Voelt u zich vaak gejaagd?	ja ☐$_1$ nee ☐$_2$
	– Bent u vaak moedeloos?	ja ☐$_1$ nee ☐$_2$
	– Staat u geregeld moe op?	ja ☐$_1$ nee ☐$_2$

Gezondheid (2)



1. Heeft u <u>ooit</u> last (pijn, ongemak) gehad:
   - van uw nek — ja ☐$_1$ nee☐$_2$
   - boven in de rug — ja ☐$_1$ nee☐$_2$
   - onder in de rug — ja ☐$_1$ nee☐$_2$
   - van uw schouders — ja ☐$_1$ nee☐$_2$
   - van uw ellebogen — ja ☐$_1$ nee☐$_2$
   - van uw polsen/handen — ja ☐$_1$ nee☐$_2$
   - van uw heupen/dijen — ja ☐$_1$ nee☐$_2$
   - van uw knieën — ja ☐$_1$ nee☐$_2$
   - van uw enkels/voeten — ja ☐$_1$ nee☐$_2$

2. Heeft u <u>de afgelopen 12 maanden</u> last (pijn, ongemak) gehad van uw:

	JA, een enkele keer	**JA, regelmatig**	**JA, langdurig**	**NEE, nooit**
▪ nek	☐$_1$	☐$_2$	☐$_3$	☐$_4$
▪ boven in de rug	☐$_1$	☐$_2$	☐$_3$	☐$_4$
▪ onder in de rug	☐$_1$	☐$_2$	☐$_3$	☐$_4$
▪ linker schouder	☐$_1$	☐$_2$	☐$_3$	☐$_4$
▪ rechter schouder	☐$_1$	☐$_2$	☐$_3$	☐$_4$
▪ linker elleboog	☐$_1$	☐$_2$	☐$_3$	☐$_4$
▪ rechter elleboog	☐$_1$	☐$_2$	☐$_3$	☐$_4$
▪ linker pols/hand	☐$_1$	☐$_2$	☐$_3$	☐$_4$
▪ rechter pols/hand	☐$_1$	☐$_2$	☐$_3$	☐$_4$
▪ linker heup/dij	☐$_1$	☐$_2$	☐$_3$	☐$_4$
▪ rechter heup/dij	☐$_1$	☐$_2$	☐$_3$	☐$_4$
▪ linker knie	☐$_1$	☐$_2$	☐$_3$	☐$_4$
▪ rechter knie	☐$_1$	☐$_2$	☐$_3$	☐$_4$
▪ linker enkel/voet	☐$_1$	☐$_2$	☐$_3$	☐$_4$
▪ rechter enkel/voet	☐$_1$	☐$_2$	☐$_3$	☐$_4$

3. Heeft u <u>de afgelopen 7 dagen</u> last (pijn, ongemak) gehad:
   - van uw nek — ja ☐$_1$ nee☐$_2$
   - boven in de rug — ja ☐$_1$ nee☐$_2$
   - onder in de rug — ja ☐$_1$ nee☐$_2$
   - van uw schouders — ja ☐$_1$ nee☐$_2$
   - van uw ellebogen — ja ☐$_1$ nee☐$_2$
   - van uw polsen/handen — ja ☐$_1$ nee☐$_2$
   - van uw heupen/dijen — ja ☐$_1$ nee☐$_2$
   - van uw knieën — ja ☐$_1$ nee☐$_2$
   - van uw enkels/voeten — ja ☐$_1$ nee☐$_2$

Werk (1)

1. Wilt u hieronder aankruisen met welke taken u nooit of zelden, af en toe, vrij veel of (bijna) altijd bezig bent?

	zelden of nooit	af en toe	vrij veel	(bijna) altijd
1.	☐1	☐2	☐3	☐4
2.	☐1	☐2	☐3	☐4
3.	☐1	☐2	☐3	☐4
4.	☐1	☐2	☐3	☐4
5.	☐1	☐2	☐3	☐4
6.	☐1	☐2	☐3	☐4
7.	☐1	☐2	☐3	☐4
8.	☐1	☐2	☐3	☐4
9.	☐1	☐2	☐3	☐4

2. Wilt u nu bij iedere taak die u wel eens doet het getal in de rij omcirkelen dat het beste weergeeft hoe lichamelijk inspannend u die taak voor uzelf vindt (licht, normaal, zwaar of erg zwaar) en onderaan aankruisen hoe zwaar u het totaal van al uw taken vindt?

	licht	.	normaal	.	zwaar	.	erg zwaar
	1	2	3	4	5	6	7
1.	1	2	3	4	5	6	7
2.	1	2	3	4	5	6	7
3.	1	2	3	4	5	6	7
4.	1	2	3	4	5	6	7
5.	1	2	3	4	5	6	7
6.	1	2	3	4	5	6	7
7.	1	2	3	4	5	6	7
8.	1	2	3	4	5	6	7
9.	1	2	3	4	5	6	7
alle taken tezamen	1	2	3	4	5	6	7

Werk (2)

1. – Doet u de gehele werkdag min of meer hetzelfde werk? ja ☐1 nee☐2
– Verschilt uw werk van dag tot dag? ja ☐1 nee☐2
– Rouleren de werkzaamheden steeds tussen u en uw collega's? ja ☐1 nee☐2
– Is de aard van uw werk afhankelijk van het seizoen of tijdstip in het jaar? ja ☐1 nee☐2
– Voert u uw werk meestal op dezelfde werkplek(ken) uit? ja ☐1 nee☐2
– Voert u uw werk vaak in de buitenlucht uit? ja ☐1 nee☐2
– Heeft u een overwegend 'zittende' functie? ja ☐1 nee☐2
– Bestaat uw werk vooral uit het uitvoeren van steeds dezelfde handelingen vele malen per minuut? ja ☐1 nee☐2
– Heeft u in uw werk te maken met klanten, patiënten of pupillen? ja ☐1 nee☐2
– Heeft u in uw werk te maken met kou, tocht, temperatuurwisselingen? ja ☐1 nee☐2
– Zit u in uw werk vaak in rijdende voertuigen (bijv. auto, heftruck)? ja ☐1 nee☐2

2. *Deze vraag gaat over uw rustpauzes. We bedoelen de pauzes die u ook echt neemt of kunt nemen!*
– Hoeveel rustpauzes heeft u gewoonlijk per dag? _ rustpauzes per dag
– Als u alle rustpauzes per dag optelt, hoeveel pauzetijd heeft u dan? _ _ _ minuten per dag
– Heeft u voldoende aan de normale rustpauzes? ja ☐1 nee☐2
– Gaat u na de rustpauzes weer uitgerust aan het werk? ja ☐1 nee☐2

3. – Kunt u het tijdstip waarop u begint of stopt met werken zelf kiezen? ja ☐1 nee☐2
– Kunt u zelf kiezen wanneer u pauzeert? ja ☐1 nee☐2
– Kent u uw werkrooster langer dan een maand van tevoren? ja ☐1 nee☐2
– Kunt u verlofdagen opnemen wanneer u dat zelf wilt? ja ☐1 nee☐2
– Is er op de afdeling waar u werkt sprake van een personeelstekort? ja ☐1 nee☐2
– Moet u geregeld voor collega's invallen? ja ☐1 nee☐2
– Werkt u geregeld over? ja ☐1 nee☐2

4. Heeft u <u>in het verleden</u> ander werk dan uw huidig werk gehad? ja ☐1 nee☐2
<u>Zo ja</u>: Welke werkzaamheden heeft u <u>in vorig werk</u> nooit, af en toe, vrij veel of heel veel uitgevoerd?

	zelden of nooit	**af en toe**	**vrij veel**	**heel veel**
▪ langdurig staand werken	☐1	☐2	☐3	☐4
▪ langdurig zittend werken	☐1	☐2	☐3	☐4
▪ langdurig werken achter een beeldscherm	☐1	☐2	☐3	☐4
▪ langdurig geknield of gehurkt werken	☐1	☐2	☐3	☐4
▪ lasten (meer dan 5 kg) verplaatsen	☐1	☐2	☐3	☐4
▪ zware lasten (meer dan 20 kg) verplaatsen	☐1	☐2	☐3	☐4
▪ kracht zetten met de armen of handen	☐1	☐2	☐3	☐4
▪ met trillend of stotend gereedschap werken	☐1	☐2	☐3	☐4
▪ in voertuigen rijden	☐1	☐2	☐3	☐4
▪ in ongemakkelijke houdingen werken	☐1	☐2	☐3	☐4
▪ langdurig in dezelfde houding werken	☐1	☐2	☐3	☐4
▪ vele malen per minuut dezelfde bewegingen maken met de armen en/of handen	☐1	☐2	☐3	☐4

Werk (3)

1. Moet u in uw werk vaak zware lasten (meer dan 5 kg):
   – tillen? ja ☐1 nee☐2
   – duwen of trekken? ja ☐1 nee☐2
   – dragen? ja ☐1 nee☐2

2. Moet u in uw werk vaak tillen:
   – in een ongemakkelijke houding? ja ☐1 nee☐2
   – met de last ver van het lichaam? ja ☐1 nee☐2
   – met gedraaid bovenlichaam? ja ☐1 nee☐2
   – met de last boven borsthoogte? ja ☐1 nee☐2
   – met één hand? ja ☐1 nee☐2
   – met een last die slecht is vast te pakken of vast te houden? ja ☐1 nee☐2

3. Moet u in uw werk vaak zeer zware lasten van meer dan 20 kg:
   – tillen? ja ☐1 nee☐2
   – duwen of trekken? ja ☐1 nee☐2
   – dragen? ja ☐1 nee☐2

4. Moet u in uw werk vaak:
   – licht buigen met het bovenlichaam en weer terug? ja ☐1 nee☐2
   – flink bukken met het bovenlichaam en weer terug? ja ☐1 nee☐2
   – licht draaien met het bovenlichaam en weer terug? ja ☐1 nee☐2
   – flink draaien met het bovenlichaam en weer terug? ja ☐1 nee☐2
   – tegelijk buigen en draaien met het bovenlichaam en weer terug? ja ☐1 nee☐2

5. Moet u in uw werk vaak lang achtereen:
   – in licht voorovergebogen houding werken? ja ☐1 nee☐2
   – in sterk voorovergebogen houding werken? ja ☐1 nee☐2
   – in licht gedraaide houding werken? ja ☐1 nee☐2
   – in sterk gedraaide houding werken? ja ☐1 nee☐2
   – in voorovergebogen èn gedraaide houding werken? ja ☐1 nee☐2

6. Moet u in uw werk vaak de nek:
   – vooroverbuigen of voorovergebogen houden? ja ☐1 nee☐2
   – achteroverbuigen of achterovergebogen houden? ja ☐1 nee☐2
   – draaien of gedraaid houden? ja ☐1 nee☐2

7. Moet u in uw werk vaak de pols:
   – buigen of lang achtereen gebogen houden? ja ☐1 nee☐2
   – draaien of lang achtereen gedraaid houden? ja ☐1 nee☐2

8. Maakt u in uw werk vaak vele malen per minuut:
   – dezelfde bewegingen met uw arm, hand of vingers? ja ☐1 nee☐2
   – dezelfde buig- of draaibewegingen met het bovenlichaam? ja ☐1 nee☐2
   – dezelfde buig- of draaibewegingen met het hoofd? ja ☐1 nee☐2

Werk (4)

1. Hoeveel minuten per dag werkt u doorgaans met uw handen:
   – boven schouderhoogte? ongeveer _ _ _ minuten per dag
   – onder kniehoogte? ongeveer _ _ _ minuten per dag
   (indien niet van toepassing, vul dan '0' in)

2. Moet u in uw werk <u>vaak</u>:
   – ver reiken met uw handen of armen? ja ☐1 nee☐2
   – uw handen tot <u>onder</u> de schouders geheven houden? ja ☐1 nee☐2
   – uw handen tot <u>boven</u> de schouders geheven houden? ja ☐1 nee☐2
   – in ongemakkelijke houdingen werken? ja ☐1 nee☐2

3. Moet u in uw werk <u>vaak</u> <u>lang achtereen</u>:
   – staan? ja ☐1 nee☐2
   – zitten? ja ☐1 nee☐2
   – lopen? ja ☐1 nee☐2
   – geknield of gehurkt werken? ja ☐1 nee☐2
   – in dezelfde houding werken? ja ☐1 nee☐2

4. Moet u in uw werk <u>vaak</u>:
   – op de knieën zitten of zich op de knieën voortbewegen? ja ☐1 nee☐2
   – pedalen bedienen met uw voeten? ja ☐1 nee☐2
   – trappen lopen? ja ☐1 nee☐2
   – op ongelijke ondergrond lopen? ja ☐1 nee☐2
   – op uw rug liggen? ja ☐1 nee☐2

5. Heeft u in uw werk vaak trillend(e) gereedschap of apparaten in uw handen? ja ☐1 nee☐2

6. Heeft u in uw werk <u>vaak</u> gebrek aan:
   – ruimte om uw werk goed te kunnen doen? ja ☐1 nee☐2
   – ruimte boven u zodat u voorovergebogen moet staan? ja ☐1 nee☐2
   – ruimte om overal goed bij te kunnen komen met uw gereedschap? ja ☐1 nee☐2

7. Kunt u in uw werk <u>vaak</u> niet goed kracht zetten omdat u:
   – in een ongunstige houding moet werken? ja ☐1 nee☐2
   – te weinig steun kunt vinden? ja ☐1 nee☐2

8. Moet u in uw werk <u>vaak</u>:
   – plotselinge, onverwachte bewegingen maken? ja ☐1 nee☐2
   – korte, maximale krachtinspanningen leveren? ja ☐1 nee☐2
   – kracht zetten met uw armen of handen? ja ☐1 nee☐2
   – stevig knijpen met de handen? ja ☐1 nee☐2
   – grote kracht uitoefenen op gereedschappen of apparaten? ja ☐1 nee☐2

9. Komt het voor dat u tijdens uw werk (bijna) uitglijdt of valt? ja ☐1 nee☐2

Werk (5)

1. – Is uw werk lichamelijk erg inspannend? ja ☐1 nee☐2
– Is uw werk geestelijk erg inspannend? ja ☐1 nee☐2

2. Is uw werk zo lichamelijk inspannend dat u vaak moet transpireren tijdens het werk of 'buiten adem' bent? ja ☐1 nee☐2

3. – Ligt het tempo of de drukte van het werk geregeld behoorlijk hoog? ja ☐1 nee☐2
– Werkt u geregeld onder tijdsdruk? ja ☐1 nee☐2
– Moet u geregeld jagen om op tijd klaar te zijn? ja ☐1 nee☐2
– Heeft u geregeld problemen met het tempo of de drukte van het werk? ja ☐1 nee☐2
– Zou u het in het werk eigenlijk kalmer aan moeten doen? ja ☐1 nee☐2
– Is het werk voor u vaak te vermoeiend? ja ☐1 nee☐2

4. – Moet u erg snel werken? ja ☐1 nee☐2
– Moet u heel veel werk doen? ja ☐1 nee☐2
– Moet u extra hard werken? ja ☐1 nee☐2
– Heeft u over het algemeen genoeg tijd om al uw werk af te krijgen? ja ☐1 nee☐2
– Is het op uw werk hectisch of is het op uw werk een gekkenhuis? ja ☐1 nee☐2

5. – Kunt u zelf bepalen hoe u het werk uitvoert/doet? ja ☐1 nee☐2
– Kunt u in het werk meestal beschikken over voldoende hulpmiddelen *(denk aan apparatuur, gereedschap, informatie, communicatie- en transportmiddelen)*? ja ☐1 nee☐2
– Bepaalt u zelf de volgorde van uw werkzaamheden? ja ☐1 nee☐2
– Kunt u de instelling van uw werkplek zelf regelen *(denk aan de hoogte van uw tafel, stoel)*? ja ☐1 nee☐2
– Beslist u zelf wanneer u een taak uitvoert? ja ☐1 nee☐2
– Kunt u gemakkelijk even weg van de plaats waar u werkt? ja ☐1 nee☐2
– Kunt u uw werk, als u dat nodig vindt, zelf onderbreken? ja ☐1 nee☐2
– Kunt u zelf uw werktempo regelen? ja ☐1 nee☐2

6. – Voelt u zich mentaal uitgeput door uw werk? ja ☐1 nee☐2
– Voelt u zich aan het einde van een werkdag leeg? ja ☐1 nee☐2
– Voelt u zich 's morgens bij het opstaan, als er weer een werkdag voor u ligt, vermoeid? ja ☐1 nee☐2
– Voelt u zich 'opgebrand' door uw werk? ja ☐1 nee☐2
– Voelt u zich gefrustreerd door uw baan? ja ☐1 nee☐2
– Denkt u dat u zich teveel inzet voor uw werk? ja ☐1 nee☐2
– Voelt u zich aan het eind van uw latijn? ja ☐1 nee☐2

7. – Is uw werk meestal boeiend? ja ☐1 nee☐2
– Heeft u in uw werk voldoende afwisseling? ja ☐1 nee☐2
– Vindt u het werk te eenvoudig? ja ☐1 nee☐2
– Heeft u voor dit werk genoeg scholing? ja ☐1 nee☐2
– Heeft u meestal plezier in uw werk? ja ☐1 nee☐2

Werk (6)

1. Heeft u in het werk veel hinder van:
   - lawaai? ja ☐1 nee☐2
   - gebrek aan frisse lucht? ja ☐1 nee☐2
   - droge lucht? ja ☐1 nee☐2
   - wisseling van temperatuur? ja ☐1 nee☐2
   - stank? ja ☐1 nee☐2

2. – Wordt uw werk vaak belemmerd door onverwachte situaties? ja ☐1 nee☐2
   - Is uw werk doorgaans goed georganiseerd? ja ☐1 nee☐2
   - Kunt u voldoende overleggen over uw werk? ja ☐1 nee☐2
   - Wordt uw werk vaak bemoeilijkt door afwezigheid van anderen? ja ☐1 nee☐2
   - Wordt u in het werk geregeld gehinderd door gebreken in het werk van anderen? ja ☐1 nee☐2

3. – Werkt u onder goede dagelijkse leiding? ja ☐1 nee☐2
   - Ergert u zich vaak aan anderen op het werk? ja ☐1 nee☐2
   - Houdt de dagelijkse leiding voldoende rekening met wat u zegt? ja ☐1 nee☐2
   - Vindt u de onderlinge sfeer op het werk goed? ja ☐1 nee☐2
   - Heeft de dagelijkse leiding een juist beeld van u in uw werk? ja ☐1 nee☐2
   - Wordt u door de directe leiding voldoende ondersteund in uw werk? ja ☐1 nee☐2
   - Kunt u als dat nodig is in uw werk, een beroep doen op één of meerdere collega's? ja ☐1 nee☐2
   - Wordt u voldoende op de hoogte gehouden van wat er zich binnen het bedrijf waar u werkt afspeelt? ja ☐1 nee☐2

4. – Zijn er omstandigheden in het werk die een ongunstige invloed hebben op uw privé-leven? ja ☐1 nee☐2
   - Zijn er privé-omstandigheden die een ongunstige invloed hebben op uw werk? ja ☐1 nee☐2
   - Neemt u de problemen van werk 'mee naar huis'? ja ☐1 nee☐2
   - Neemt u de problemen van thuis 'mee naar uw werk'? ja ☐1 nee☐2
   - Vindt u dat het in orde is met de veiligheid in uw werk? ja ☐1 nee☐2
   - Zijn uw vooruitzichten bij deze werkgever goed? ja ☐1 nee☐2
   - Zijn uw loopbaanmogelijkheden voldoende? ja ☐1 nee☐2
   - Voelt u zich in dit bedrijf voldoende gewaardeerd? ja ☐1 nee☐2
   - Vindt u uw beloning in overeenstemming met het werk dat u doet? ja ☐1 nee☐2

5. – Is voor de uitvoering van uw werk vakbekwaamheid/vakmanschap vereist? ja ☐1 nee☐2
   - Is uw werk gevarieerd? ja ☐1 nee☐2
   - Vereist uw baan dat u nieuwe dingen leert? ja ☐1 nee☐2
   - Vereist uw baan creativiteit? ja ☐1 nee☐2
   - Heeft u de gelegenheid om uw vakbekwaamheid/vakmanschap te ontwikkelen? ja ☐1 nee☐2
   - Moet u in korte tijd steeds weer dezelfde handelingen verrichten? ja ☐1 nee☐2

6. Al met al, vindt u nu zelf dat u goed, redelijk, matig of niet goed zit met uw werk?
   goed ☐1
   redelijk ☐2
   matig ☐3
   niet goed ☐4

Vrije tijd

1. Hoeveel uur zit u gemiddeld per week in een rijdend voertuig *(bijv auto, bus, heftruck, maar geen trein)*:
   – tijdens uw werk? ongeveer — — uur per week
   – tijdens de reis van woning naar werk? ongeveer — — uur per week
   – in uw vrije tijd? ongeveer — — uur per week
   (indien niet van toepassing, vul dan '0' in)

2. Hoe vaak heeft u in uw vrije tijd in de afgelopen 4 maanden inspannende sporten of zware lichamelijke activiteiten gedaan die lang genoeg duurden om bezweet te raken?
   niet ☐$_1$
   minder dan 1 keer per maand ☐$_2$
   ongeveer 1 keer per maand ☐$_3$
   ongeveer 2 à 3 keer per maand ☐$_4$
   ongeveer 1 à 2 keer per week ☐$_5$
   3 of meer keer per week ☐$_6$

3. Heeft u de afgelopen 12 maanden lichamelijk inspannende sport(en) beoefend? ja ☐$_1$ nee ☐$_2$
   Zo ja:
   – beoefent u (één of meerdere van) deze sport(en) in wedstrijdverband? ja ☐$_1$ nee ☐$_2$
   – hoeveel uur sport u gemiddeld per week? — — uur per week
   – hoeveel maanden per jaar? — — maanden per jaar
   – hoeveel jaren beoefent u die sport(en) al? — — jaren
   – welke sport(en)?
   (als u meer sporten beoefent, kruis dan de sport aan die u het meest intensief beoefent)

☐$_1$ atletiek	☐$_8$ fitness/aerobics	☐$_{15}$ motorsporten	☐$_{22}$ surfen	☐$_{29}$ wandelen
☐$_2$ badminton	☐$_9$ golf	☐$_{16}$ paardensport	☐$_{23}$ tafeltennis	☐$_{30}$ watersporten
☐$_3$ basketball	☐$_{10}$ handbal	☐$_{17}$ roeien	☐$_{24}$ tennis	☐$_{31}$ wielrennen
☐$_4$ bergsporten	☐$_{11}$ hockey	☐$_{18}$ schaatsen	☐$_{25}$ turnen/gymnastiek	☐$_{32}$ zeilen
☐$_5$ bowling	☐$_{12}$ honkbal/softbal	☐$_{19}$ schietsporten	☐$_{26}$ vechtsporten	☐$_{33}$ zwemmen
☐$_6$ dansen/ballet	☐$_{13}$ krachtsporten	☐$_{20}$ skiën	☐$_{27}$ volleybal	☐$_{34}$ anders, nl.
☐$_7$ fietsen	☐$_{14}$ luchtsporten	☐2 squashen	☐$_{28}$ (zaal)voetbal	……………………..

4. Bent u in de afgelopen 12 maanden tijdens sportbeoefening zodanig geblesseerd geraakt dat u de wedstrijd of training moest staken of de volgende niet kon spelen? ja ☐$_1$ nee ☐$_2$
   Zo ja: welk lichaamsdeel? *(als u meerdere blessures heeft gehad, kruis dan de meest ernstige aan)*

☐$_1$ nek	☐$_1$ schouders	☐$_1$ heupen/dijen	☐$_1$ hoofd	☐$_1$ lies
☐$_1$ hoge rug	☐$_1$ ellebogen	☐$_1$ knieën	☐$_1$ armen	☐$_1$ benen
☐$_1$ lage rug	☐$_1$ polsen/handen	☐$_1$ enkels/voeten	☐$_1$ buik	

5. Heeft u de afgelopen 12 maanden moeten verzuimen van uw werk wegens een sportblessure? ja ☐$_1$ nee ☐$_2$
   Zo ja:
   – hoeveel werkdagen? — — — dagen

6. Bent u de afgelopen 12 maanden voor een sportblessure medisch behandeld? ja ☐$_1$ nee ☐$_2$

Rug (1)

Deze vragen hoeft u alleen in te vullen als u de afgelopen 12 maanden klachten onder in de rug heeft gehad.

1. Hoe oud was u toen u voor het eerst last onder in uw rug kreeg? Mijn leeftijd was: – – jaar

2. Was de directe oorzaak van uw rugklachten:
   - een sportblessure? ja ☐1 nee☐2
   - een ongeval? ja ☐1 nee☐2
   - een plotselinge beweging? ja ☐1 nee☐2
   - tillen van een zware last? ja ☐1 nee☐2
   - langdurig aangehouden slechte houding? ja ☐1 nee☐2
   - stress, spanningen? ja ☐1 nee☐2
   - het klimaat (vocht, tocht, kou)? ja ☐1 nee☐2

   (alleen te beantwoorden door vrouwen:)
   - een zwangerschap, een bevalling ja ☐1 nee☐2
   - de periodieke ongesteldheid? ja ☐1 nee☐2

3.
   - Hangen uw rugklachten met uw werk samen? ja ☐1 nee☐2
   - Hangen uw rugklachten met activiteiten in uw vrije tijd samen? ja ☐1 nee☐2
   - Zijn uw rugklachten tijdens uw huidige werk ontstaan? ja ☐1 nee☐2

4. Hoe vaak heeft u in de afgelopen 12 maanden afzonderlijke perioden van rugklachten gehad?
   - één keer ☐1
   - tussen 2-4 keer ☐2
   - tussen 5-10 keer ☐3
   - meer dan 10 keer ☐4
   - klachten zijn steeds aanwezig ☐5

5. Hoeveel dagen heeft u in de afgelopen 12 maanden moeten verzuimen wegens uw rugklachten?
   - geen enkele dag ☐1
   - 1-7 dagen ☐2
   - 8-14 dagen ☐3
   - 15-28 dagen ☐4
   - tussen 1-3 maanden ☐5
   - langer dan 3 maanden ☐6

6. Hoe lang duurde de langste periode van rugpijn in de afgelopen 12 maanden?
   - minder dan een dag ☐1
   - 1-7 dagen ☐2
   - 1-4 weken ☐3
   - 5-7 weken ☐4
   - 8 weken – 3 maanden ☐5
   - 3-12 maanden ☐6

7. Heeft u de afgelopen 12 maanden last gehad van **uitstralende** rugpijn (*dat wil zeggen rugpijn die doorloopt naar de benen)* naar:
   - de linker en/of rechter knie? ja ☐1 nee☐2
   - de linker en/of rechter enkel/voet? ja ☐1 nee☐2

Rug (2)

Deze vragen hoeft u alleen in te vullen als u de afgelopen 12 maanden klachten onder in de rug heeft gehad.

8. Hoe verliep de laatste periode van uw rugklachten?

vlot genezen binnen enkele dagen ☐1
volledig genezen, maar het duurde enkele weken ☐2
niet echt genezen, af en toe nog klachten ☐3
niet genezen, klachten blijven bestaan ☐4
niet genezen, maar klachten bestaan nog maar kort ☐5

9. – Zijn uw rugklachten in de loop der tijd verergerd? ja ☐1 nee☐2
– Wisselt/wisselde de ernst van uw rugklachten sterk? ja ☐1 nee☐2
– Begonnen uw rugklachten plotseling? ja ☐1 nee☐2
– Verstoren uw rugklachten uw slaap? ja ☐1 nee☐2
– Blijven uw rugklachten in de vakanties bestaan? ja ☐1 nee☐2
– Staat u 's ochtends meestal met een stijf gevoel in de rug op? ja ☐1 nee☐2
– Heeft u een doof, dood gevoel of tintelingen in de benen of voeten? ja ☐1 nee☐2
– Schiet de rugpijn in uw benen als u niest, hoest of perst? ja ☐1 nee☐2

10. Heeft u ooit:
– een spitaanval *(een rug die u niet meer kon bewegen van de pijn)* gehad? ja ☐1 nee☐2
– een hernia in de rug gehad? ja ☐1 nee☐2
– een behandeling ondergaan voor uw rugklachten? ja ☐1 nee☐2
– in het ziekenhuis gelegen vanwege uw rugklachten? ja ☐1 nee☐2

11. Hoeveel keer heeft u in de afgelopen 12 maanden in verband met uw rugklachten *(indien niet: vul een '0' in)*:
– een arts geraadpleegd? ja ☐1 nee☐2
– een fysiotherapeut of oefentherapeut bezocht? ja ☐1 nee☐2

12. Heeft u door uw rugklachten moeite met:

	doe ik nooit	**geen moeite**	**beetje moeite**	**veel moeite**
langdurig staand werken	☐1	☐2	☐3	☐4
langdurig zittend werken	☐1	☐2	☐3	☐4
lasten (meer dan 5 kg) verplaatsen	☐1	☐2	☐3	☐4
zware lasten (meer dan 20 kg) verplaatsen	☐1	☐2	☐3	☐4
kracht zetten met de armen of handen	☐1	☐2	☐3	☐4
met trillend of stotend gereedschap werken	☐1	☐2	☐3	☐4
in voertuigen rijden	☐1	☐2	☐3	☐4
in ongemakkelijke houdingen werken	☐1	☐2	☐3	☐4
langdurig in dezelfde houding werken	☐1	☐2	☐3	☐4

13. – Bent u wegens rugklachten gedeeltelijk afgekeurd? ja ☐1 nee☐2
– Bent u wegens rugklachten in het verleden van werk veranderd? ja ☐1 nee☐2
– Is uw werkplek, apparatuur, gereedschap of werktijd wegens rugklachten geheel of gedeeltelijk aangepast? ja ☐1 nee☐2

Nek en/of schouders (1)

Deze vragen alleen invullen als u de afgelopen 12 maanden klachten in de nek en/of schouders heeft gehad.

1. Hoe oud was u toen u voor het eerst last in uw nek of schouders kreeg? Mijn leeftijd was: _ _ jaar

2. Was de directe oorzaak van uw nek- of schouderklachten:
   – een sportblessure? ja ☐1 nee☐2
   – een ongeval? ja ☐1 nee☐2
   – een plotselinge beweging? ja ☐1 nee☐2
   – tillen van een zware last? ja ☐1 nee☐2
   – langdurig aangehouden slechte houding? ja ☐1 nee☐2
   – stress, spanningen? ja ☐1 nee☐2
   – het klimaat (vocht, tocht, kou)? ja ☐1 nee☐2

3. – Hangen uw nek en/of schouderklachten met uw werk samen? ja ☐1 nee☐2
   – Hangen uw nek en/of schouderklachten met activiteiten in uw vrije tijd samen? ja ☐1 nee☐2
   – Zijn uw nek en/of schouderklachten tijdens uw huidige werk ontstaan? ja ☐1 nee☐2

4. Hoe vaak heeft u in de afgelopen 12 maanden afzonderlijke perioden van nek en/of schouderklachten gehad?
   één keer ☐1
   tussen 2-4 keer☐2
   tussen 5-10 keer ☐3
   meer dan 10 keer ☐4
   klachten zijn steeds aanwezig ☐5

5. Hoeveel dagen heeft u in de afgelopen 12 maanden moeten verzuimen wegens uw nek en/of schouderklachten?
   geen enkele dag ☐1
   1-7 dagen ☐2
   8-14 dagen ☐3
   15-28 dagen ☐4
   tussen 1-3 maanden ☐5
   langer dan 3 maanden ☐6

6. Hoe lang duurde de langste periode van uw nek en/of schouderpijn in de afgelopen 12 maanden?
   minder dan een dag ☐1
   1-7 dagen ☐2
   1-4 weken ☐3
   5-7 weken ☐4
   8 weken – 3 maanden ☐5
   3-12 maanden ☐6

7. Heeft u de afgelopen 12 maanden last gehad van **uitstralende** nek en/of schouderpijn (*dat wil zeggen nek en/of schouderpijn die doorloopt naar de armen)* naar:
   – de linker en/of rechter elleboog? ja ☐1 nee☐2
   – de linker en/of rechter pols/hand? ja ☐1 nee☐2

8. – Bent u wegens nek en/of schouderklachten gedeeltelijk afgekeurd? ja ☐1 nee☐2
   – Bent u wegens nek en/of schouderklachten in het verleden van werk veranderd? ja ☐1 nee☐2
   – Is uw werkplek, apparatuur, gereedschap of werktijd wegens nek en/of schouderklachten geheel of gedeeltelijk aangepast? ja ☐1 nee☐2

Nek en/of schouders (2)

Deze vragen alleen invullen als u de afgelopen 12 maanden klachten in de nek en/of schouders heeft gehad.

9. Hoe verliep de laatste periode van uw nek en/of schouderklachten?

vlot genezen binnen enkele dagen ☐1
volledig genezen, maar het duurde enkele weken ☐2
niet echt genezen, af en toe nog klachten ☐3
niet genezen, klachten blijven bestaan ☐4
niet genezen, maar klachten bestaan nog maar kort ☐5

10. – Zijn uw nek en/of schouderklachten in de loop der tijd verergerd? ja ☐1 nee☐2
– Wisselt/wisselde de ernst van uw nek en/of schouderklachten sterk? ja ☐1 nee☐2
– Begonnen uw nek en/of schouderklachten plotseling? ja ☐1 nee☐2
– Verstoren uw nek en/of schouderklachten uw slaap? ja ☐1 nee☐2
– Blijven uw nek en/of schouderklachten in de vakanties bestaan? ja ☐1 nee☐2
– Staat u 's ochtends meestal met een stijf gevoel in de nek en/of schouders op? ja ☐1 nee☐2
– Heeft u een doof, dood gevoel of tintelingen in de armen of handen? ja ☐1 nee☐2
– Schiet de nek en/of schouderpijn in uw armen als u niest, hoest of perst? ja ☐1 nee☐2

11. Heeft u ooit:
– een 'bevroren' schouder *(die u niet meer kon bewegen van de pijn)* gehad? ja ☐1 nee☐2
– een hernia in de nek gehad? ja ☐1 nee☐2
– een behandeling ondergaan voor uw nek en/of schouderklachten? ja ☐1 nee☐2
– in het ziekenhuis gelegen vanwege uw nek en/of schouderklachten? ja ☐1 nee☐2

12. Hoeveel keer heeft u in de afgelopen 12 maanden in verband met uw nek en/of schouderklachten *(indien niet: vul een '0' in)*:
– een arts geraadpleegd? ja ☐1 nee☐2
– een fysiotherapeut of oefentherapeut bezocht? ja ☐1 nee☐2

13. Heeft u door uw nek en/of schouderklachten moeite met:

	doe ik nooit	**geen moeite**	**beetje moeite**	**veel moeite**
langdurig staand werken	☐1	☐2	☐3	☐4
langdurig zittend werken	☐1	☐2	☐3	☐4
langdurig werken achter een beeldscherm	☐1	☐2	☐3	☐4
lasten (meer dan 5 kg) verplaatsen	☐1	☐2	☐3	☐4
kracht zetten met de armen of handen	☐1	☐2	☐3	☐4
met trillend of stotend gereedschap werken	☐1	☐2	☐3	☐4
in voertuigen rijden	☐1	☐2	☐3	☐4
in ongemakkelijke houdingen werken	☐1	☐2	☐3	☐4
langdurig in dezelfde houding werken	☐1	☐2	☐3	☐4
vele malen per minuut dezelfde bewegingen maken met de armen en/of handen	☐1	☐2	☐3	☐4

Uw eigen mening (1)

Hieronder kunt u zelf aangeven welke werkzaamheden klachten veroorzaken. Ook zijn we benieuwd naar suggesties hoe die werkzaamheden verbeterd kunnen worden.

1. Wilt u hieronder opschrijven welke taken zwaar zijn voor de **(lage) rug** en hoe deze taken verbeterd kunnen worden?

zware taken voor de rug:	**hoe te verbeteren:**
taak 1.	taak 1.
taak 2.	taak 2.
taak 3.	taak 3.

2. Wilt u hieronder opschrijven welke taken zwaar zijn voor de **nek of schouders** en hoe deze taken verbeterd kunnen worden?

zware taken voor de nek of schouders:	**hoe te verbeteren:**
taak 1.	taak 1.
taak 2.	taak 2.
taak 3.	taak 3.

3. Wilt u hieronder opschrijven welke taken zwaar zijn voor de **armen (ellebogen, polsen/handen)** en hoe deze taken verbeterd kunnen worden?

zware taken voor de armen:	**hoe te verbeteren:**
taak 1.	taak 1.
taak 2.	taak 2.
taak 3.	taak 3.

4. Wilt u hieronder opschrijven welke taken zwaar zijn voor de **knieën** en hoe ze verbeterd kunnen worden?

zware taken voor de knieën:	**hoe te verbeteren:**
taak 1.	taak 1.
taak 2.	taak 2.
taak 3.	taak 3.

Uw eigen mening (2)

Hieronder kunt u zelf aangeven welke werkzaamheden klachten veroorzaken. Ook zijn we benieuwd naar suggesties hoe die werkzaamheden verbeterd kunnen worden.

5. Ieder werk kent **'zware of onaangename** klussen'. Wilt u hieronder opschrijven welke zware of onaangename klussen er in uw werk zijn en hoe deze verbeterd kunnen worden?

zware of onaangename klus:	hoe te verbeteren:
klus 1.	klus 1.
klus 2.	klus 2.
klus 3.	klus 3.

6. In veel werk komen af en toe **zeer zware** werkzaamheden voor die nauwelijks opvallen omdat ze **weinig** voorkomen of **heel kort** duren. Als dat ook in uw werk het geval is, wilt u hieronder opschrijven welke werkzaamheden dat zijn en hoe deze verbeterd kunnen worden?

soort werkzaamheid:	hoe te verbeteren:
taak 1.	taak 1.
taak 2.	taak 2.
taak 3.	taak 3.

7. Als u gereedschap of apparatuur gebruikt dat onvoldoende geschikt is om uw werk naar behoren uit te voeren, wilt u dan hieronder opschrijven:
   – welk gereedschap of apparatuur niet geschikt is en
   – eventuele suggesties hoe dit te verbeteren?

ongeschikt gereedschap/apparatuur:	hoe te verbeteren:
1.	1.
2.	2.
3.	3.

8. Als u nog andere, niet eerder aan de orde gekomen gezondheidsklachten heeft waarvan u denkt dat ze door uw werk veroorzaakt worden, wilt u dan hieronder opschrijven:
   – om welke gezondheidsklachten het gaat en
   – met welke werkzaamheden deze te maken hebben?

gezondheidsklacht:	te maken met:

Werk (1a)

Alleen bestemd voor de verkorte versie!

1. Moet u in uw werk vaak:
   - zware lasten (meer dan 5 kg) tillen, duwen, trekken of dragen? ja ☐1 nee☐2
   - zeer zware lasten (meer dan 20 kg) tillen, duwen, trekken of dragen? ja ☐1 nee☐2
   - grote kracht uitoefenen op gereedschappen of apparaten? ja ☐1 nee☐2

2. Moet u in uw werk vaak buigen of draaien met:
   - het bovenlichaam? ja ☐1 nee☐2
   - de nek? ja ☐1 nee☐2
   - de polsen/handen? ja ☐1 nee☐2

3. Moet u in uw werk vaak lang achtereen in voorovergebogen of gedraaide houding werken met:
   - het bovenlichaam? ja ☐1 nee☐2
   - de nek? ja ☐1 nee☐2
   - de polsen? ja ☐1 nee☐2

4. Moet u in uw werk vaak kortdurende, steeds terugkerende bewegingen maken met
   - het bovenlichaam? ja ☐1 nee☐2
   - de nek? ja ☐1 nee☐2
   - de polsen? ja ☐1 nee☐2

10. Moet u in uw werk vaak:
    - ver reiken met uw handen of armen? ja ☐1 nee☐2
    - uw armen geheven houden? ja ☐1 nee☐2
    - in ongemakkelijke houdingen werken? ja ☐1 nee☐2
    - langdurig in dezelfde houding werken? ja ☐1 nee☐2
    - vele malen per minuut dezelfde bewegingen maken met uw arm, hand of vingers? ja ☐1 nee☐2

11. Moet u in uw werk vaak lang achtereen:
    - staan? ja ☐1 nee☐2
    - zitten? ja ☐1 nee☐2
    - lopen? ja ☐1 nee☐2
    - geknield of gehurkt werken? ja ☐1 nee☐2

12. Heeft u in het werk vaak trillend(e) gereedschap of apparaten in uw handen? ja ☐1 nee☐2

13. Hoeveel minuten per dag werkt u doorgaans met uw handen:
    (indien niet van toepassing, vul dan '0' in)
    - boven schouderhoogte? ongeveer – – – minuten per dag
    - onder kniehoogte? ongeveer – – – minuten per dag