FOLLOW-UP STUDY INTO THE ETIOLOGIC AND PROGNOSTIC DETERMINANTS OF WORK RELATED BACK PAIN

Prof. Dr G. Moens
IDEWE, afdeling Onderzoek en Ontwikkeling

Prof. Dr R. Masschelein
Prof. Dr R. Lysens
Prof. Dr O. Van Den Bergh
Université Catholique de Louvain

Prof. Dr Ph. Mairiaux
Université de Liège

Prof. dr. G. Crombez
Universiteit Gent

TABLE OF CONTENTS

I. INTRODUCTION

I.1 Context and general framework of the study

Work-related back disorders have enormous human and financial costs. In the literature, individual factors, physical and psychosocial workload have consistently been associated with back disorders (Bongers et al 1993).
Although much research has been carried out into this problem, researchers still point to the low quality of many studies and to their cross-sectional and retrospective nature (Moens et al 1993, Moens et al 1994). Further it has become clear that a distinction has to be made between the objective ('disease'), subjective ('illness') and social dimensions ('sickness') of the problem, because each dimension is likely to be influenced by specific determinants (Burdorf et al 1997, Bombardier et al 1994, Waddell 1998).
Because the Belgian situation of occupational medicine could create a logistic opportunity to set up a follow-up study, the study has been designed as a prospective trial with three measurements: at baseline (t0), at one year (t1) and at two (t2) years after the initial measurement. The incidence, the characteristics and the consequences of low back pain, as well as the etiologic and prognostic determinants have been followed up by means of questionnaires and a standardized clinical examination. The physical exposure information in the questionnaire has been validated by selected direct observations at the workplace.

I.2 Goals of the study

<u>Goal:</u>
A prospective study was set up in several health care institutions and industrial enterprises from the distribution sector. In addition to the recording of the incidence of back pain (and of its consequences such as sick leave, chronic pain), also the occurrence of physical and psychosocial exposure factors have been assessed.

<u>Objectives:</u>
The selection of workers into the study population has been spread over one year and these employees have been followed up. The target was to attain a study population of 1200 workers. After the project period of 4 years, 2 years of follow-up would be available for each participant.
The analysis consisted of the calculation of associations between determinants and outcome variables. Through multivariate statistical analysis, confounding variables, such as extra-professional physical and psychosocial exposure, should be accounted for. To guarantee a wide variation in exposure, participants have been chosen in several occupational groups in two different sectors (health care and distribution sector).

<u>Scientific strategy and project objectives:</u>
For employees in several professional groups who fulfill specific inclusion criteria, the study aimed at assessing the respective influence or predictive value of:

a. Person-related factors, such as personal and familial antecedents, age, gender, psychological and personality factors, such as knowledge, feelings about back pain, coping and avoidance behavior, and psychosomatic complaints.
b. Physical and psychosocial occupational exposure.
c. Clinical abnormalities of the back.

on the incidence of low back pain (complaints, symptoms) and on its characteristics like frequency, severity, duration, localization, origin, frequency and duration of sick leave, therapeutic and occupational consequences.

For more information about the Aims, the reader is referred to the study protocol (OSTC Activity Report number 5) and intermediate project reports (OSTC Activity Report numbers 1-5).

II. THEORETICAL FRAMEWORK

II. 1. Epidemiological aspects

Low back pain is a frequently occurring problem. Lifetime prevalence of low back pain varies between 50 and 80% (Frank et al 1996, Riihimaki 1996, Hales 1996, Moens et al 1994, IDEWE 1993), lifetime prevalence of serious low back pain (defined as low back pain for at least two weeks) is about 14% (Frank et al 1996, Riihimaki 1996). It is important to know that only 20% of the employees experiencing low back pain looks for medical help (Hales 1996), while only 20% stays at home (Skovron 1992, Moens et al 1994, IDEWE 1993) and only 10% looks for compensation (Hales 1996). Most of them return to work within one month and only 10% are still at home after 6 months (Skovron 1992). These 10% of chronic back patients are responsible for 80 to 90% of medical expenses and recompensations (Waddell, 1998).
Apart from financial consequences, low back pain is also responsible for a lot of human suffering. For adults less than 45 years, low back pain is the most common cause of disability (defined as the impossibility to perform usual activities) (Frank et al 1996). Within the group of 45 to 65 years, low back pain comes second after arthrosis (Frank 1996). Although most episodes of low back pain are self-limiting (Hales 1996, Skovron 1992, Op De Beeck 2000) and most of them recover without function loss, the probability of relapse is relatively high. Over two years, the frequency of recurring episodes of low back pain is 60%.
In 90 to 95% of the cases, it concerns non-specific low back pain, i.e. low back pain for which no pathological cause (tumor, infection, ...) can be found (Haldeman 1999, Waddell 1998).

II.1.1. Risk factors for low back pain

Epidemiological studies distinguish three categories of risk factors for low back pain: individual, physical or biomechanical, and psychosocial risk factors (Frank et al 1996):

II.1.1.1. Individual factors: these include factors of demographic nature such as genetic factors, age, gender, length, weight, social class and factors regarding lifestyle e.g. smoking. Recently, also psychological variables have been paid attention to.

Genetic factors:
Genetic factors influence certain spinal disorders such as scoliosis, spondylolisthesis, ankylosing spondylitis and possibly also disc prolaps. However, this is of little relevance to non-specific low back pain (Waddell 1998).

Gender:
From a biological point of view, there is little evidence for a difference in back pain between men and women. An exception is low back pain during pregnancy. This is probably caused by a change in posture and hormonal effects in ligaments (Waddell 1998). The epidemiological evidence for gender as risk factor for low back pain remains inconsistent (Waddell 1998, Bongers 2000). Women report somewhat more non-specific low back complaints, men report somewhat more sciatica. This does not necessarily mean that there is a biological difference between men and women. In general, women report more physical complaints: this can be due to a difference in attention for the body, a different pain perception, or a difference in tendency to report. The difference in sciatica between men and women could be due to work related factors (Waddell 1998).

Age:
Biologically, age is a plausible factor for back complaints. With increasing age, degenerative changes do occur in the spinal column due to which the capacity of the back decreases. Also

epidemiological population studies indicate age as a risk factor for low back complaints (Waddell 1998, Bongers 2000). Back complaints usually start around adolescence or young adult age. The lifetime prevalence increases until 40-60 years, and decreases afterwards. However, point prevalence increases with age. The decrease in back complaints after the age of 60 years could be due to recall bias (Waddell 1998).

Length and weight:
Because load on the lumbar spine is higher in the upper body part, taller and heavier persons could have a higher risk to develop low back complaints. The results of epidemiological studies examining length and weight as risk factors for low back pain are contradictory. In real terms, it is assumed that length and weight are no risk factors for low back complaints (Skovron 1992, Bongers 2000).

Social class:
Epidemiological evidence for a relation between social class and low back pain is controversial and probably weak. Because social class reflect social as well as educational, economical, occupational and psychosocial aspects, the influence of these individual factors on low back pain is difficult to retrieve (Waddell 1998).

Smoking:
Different theories propose a possible association between smoking and back complaints through direct effects or through confounding. The first category includes the hypothesis that smoking related chronic bronchitis can give cause to sciatica or disc prolapse through coughing and increased intra-abdominal pressure. However, studies show no evidence for increased risk of sciatica by smoking. In animal experiments, smoking causes changes in disc nutrition. The second category supposes a relationship between smoking and a complex set of demographic, work related, psychosocial and lifestyle factors. It states that not smoking as such, but rather the underlying factors increase the risk of low back complaints (Waddell 1998). From epidemiological point of view, the evidence of smoking being a risk factor for low back complaints remains unclear (Skovron 1992, Waddell 1998, Bongers 2000).

Inactivity:
At present, there is considerable interest in the possible role of physical fitness regarding low back complaints. However, so far, only the prognostic factor could be explained: people in good physical condition will recover faster from acute back pain. A study frequently referred to involving firefighters suggests that physically active persons will have less low back pain (Nuwayhid et al 1993). More recent studies however show no or little effect. Therefore these results cannot be generalized (Waddell 1998).

Prior episodes of low back pain:
Different epidemiological studies show a strong relation between low back complaints and prior episodes of low back complaints (Bongers 2000). This is not surprising because these episodes indicate a sufficient cause for low back complaints in the past and thus show the presence of risk factors. Prior episodes could also introduce a higher susceptibility. Therefore, a certain combination of risk factors can then become a possible cause for low back complaints although this combination in the past was not causal.

Psychological factors:
Pain and pain disability are not only influenced by organic pathology, if found, but also by psychological and social factors (Vlaeyen et al 1995). So far, psychological factors have mainly been studied in chronic pain populations. A recent concept is “pain related fear” defined as fear for pain, physical activity or injury. Pain related fear is being developed when pain is interpreted as a threat. By anticipation and cognitive dysfunction this will lead to avoidance behavior: not only the activities seen as the reason for pain but also other activities will be avoided (generalisation). This results in disability, disuse and depression. These patients, also termed as ‘avoiders’, end up in a vicious circle of fear and avoidance. Patients

who see no threat in pain will recover and revert to normal activities more quickly (Vlaeyen & Crombez 1999).
In the literature that has emerged during the past 2 decades, catastrophising has risen to the status of one of the most important psychological predictors of pain experience (Sulivan et al 2001). Catastrophising has been broadly conceived as an exaggerated negative “mental set” brought to bear during actual or anticipated pain experience. Catastrophising consists of different dimensions: a tendency to increase attentional focus on pain-related thoughts, to exaggerate the threat value of pain stimuli and to adopt a helpless orientation to coping with painful situations (Sullivan et al 1995).
Negative affectivity is a psychological concept that is important in health research. It is a general dimension of subjective distress; it reflects stable and pervasive differences in negative mood and self-concept. High NA individuals are more likely to experience significant levels of distress and dissatisfaction at all times and in any given situation, even in the absence of any overt stress (Watson & Clark 1984). Negative affectivity is strongly and consistently correlated with health complaint scales. In other words, data suggest that physical symptoms and negative moods reflect a common, underlying disposition of somatopsychic distress. The perceptual/attention style of high NA individuals – introspective, apprehensive, negativistic and vigilant – may be largely responsible for their enhanced somatic complaining (Watson & Pennebaker 1989). A subjective health complaint measure was also included (based on the Nijmeegse questionnaire, Van Dixhoorn 1987) to search for relations of low back pain with other complaints

II.1.1.2. Biomechanical risk factors of low back pain

This overview is mainly based on three literature reviews: Burdorf and Sorock (1997), Hoogendoorn et al. (1999), and one carried out by INSERM (Derriennic F et al. 2000). Other more recent publications have also been taken into account. In those reviews, the biomechanical risk factors were divided into 4 categories: postural constraints, static work postures, manual load handling and whole body vibrations.

II.1.1.2.1. Postural constraints.

In the literature, postural constraints are defined as trunk flexion, trunk rotation, association of flexion and rotation, lateral inflexion and kneeling or squatting postures. The postural constraint, and particularly the trunk flexion and trunk flexion associated with rotation, presents a significant correlation to low back pain in almost every study. In the Burdorf and Sorock (1997) review, 9 studies out of 10 have identified as risk factor frequently bending forward and trunk rotations with odds-ratios (OR) varying from 1.29 to 1.80. Among more recent studies, Xu et al. (1997) confirmed these results by observing, in a population of employees, an OR of 1.71 for trunk flexions/rotations at least a quarter of the time. In the metallurgy sector, Wickström and Pentti (1998) also observed a relatively high risk for awkward postures (OR=1.95). The study led by Engels et al. (1996) on a nurse population showed an important low back pain risk for bending forward and adopting awkward postures (OR = 4.12 et 3.56). Similar results are reported in another study (Brulin et al. 1998).
In their literature review, Hoogendoorn et al. (1999) observed a significant relation between postural factors and the occurrence of low back pain in two studies with high methodological qualities. Bending forward sometimes or often, is also considered as a risk factor in the GAZEL cohort (Derriennic F et al. 2000). Finally, the Dutch cohort study that has followed, for 3 years, 835 workers from several industrial sectors showed that bending the trunk more than 60° forward during more than 5% of the working time constitutes a relative risk of 1.5 [1.0;2.1], while a more than 30° trunk rotation during at least 10% of the working time showed an almost significant influence (RR = 1.3 [0.9;1.9]) (Hoogendoorn et al. 2000).

II.1.1.2.2. Static work postures

According to some authors, staying for a long time in a sitting or immobile posture should contribute to the low back pain risk whereas walking a lot during the shift should have a

protective influence. In line with this hypothesis, experimental studies on dogs have highlighted the favorable influence of varying positions on the nutritional metabolism of the intervertebral disk (Holm and Nachemson 1983).
However, the Burdorf literature review (Burdorf and Sorock 1997) showed relatively controversial results: two studies presented a positive correlation between postural immobility and low back pain while 4 others showed no association at all. These contradictory results remain in more recent studies (Engels et al. 1996; Macfarlane et al. 1997; Wickstrom and Pentti 1998; Xu et al. 1997). In conclusion, the pathogenic hypothesis of a negative interaction between postural immobility and disk nutrition is currently not confirmed in epidemiological studies.

II.1.1.2.3. Manual handling of loads

Manual handling has been the most studied mechanical factor and most frequently linked to low back pain (Macfarlane et al. 1997). In the Burdorf and Sorock review (1997), out of 19 articles evaluating the risk associated with load lifting or carrying, 16 studies showed an increased risk for these tasks. As two others studies show, patient handling was also associated with a significant low back pain risk (Engels et al. 1996; Smedley et al. 1997).
In the Hoogendoorn et al review (1999), 3 studies out of 4 concluded to a significant relationship with OR varying from 1.5 to 3.1. Three recent studies confirmed this trend. In a study carried out in a Swedish county, Vingard et al. (2000) have compared 686 cases having consulted a medical doctor for low back pain to 1385 control subjects. In this study, a RR of 1.5 [1.1;2.1] was observed for subjects lifting 15 kg loads at least several times a day. Two other studies have been conducted within workers populations. The cohort study carried out in the Netherlands (Hoogendoorn et al. 2000) showed that lifting at least 25 kg, more than 15 times a day induces a low back pain relative risk of 1.6 [1.2;2.3]. Finally, in a case-control study in a Canadian automobile assembly factory (Kerr et al. 2001), biomechanical parameter measurements during work activities have shown that cumulated compression calculated at L4-L5 disk level constitute an important etiologic risk factor (OR = 2.0 [1.2;3.6]), just as the peak force manually exerted (OR= 1.9 [1.2;3.1]).
Recently, the perception of a load being too heavy to lift has been found to be significantly associated with the occurrence of low back pain (Masset et al. 1998).
Tasks of pushing/pulling a load, have seldom been studied in a specific way except by Hoozemans et al. (1998) who noted that these tasks lead to an important risk of low back pain.

II.1.1.2.4. Whole body vibration

This exposure, encountered in vehicle or device driving, has been widely studied and an association with low back complaints is found in a majority of studies.
In the Burdorf and Sorock (1997) review, 13 studies out of 14 involved a positive correlation between exposure to vibrations and low back pain. Other recent studies confirmed the association between low back pain and exposure to vibration (Fautrel et al. 1998; Levangie 1999); moreover, some studies showed that the risk increases with exposure intensity.
Krause et al. (1997), studying LPB risk among employees of a public transport company, observed an OR of 3.43 for those having a 10 years experience and an OR of 1.96 for those driving at least 20 hours a week ; however, they did not observe significant influence of the vehicle type. A recent review of Johanning (2000) showed that all terrain vehicles or construction devices presented vibration levels more hazardous for the back.
Recently, the study of Battié et al. (2002), carried out among monozygote twin population (one exposed, the other not) put into question the pathogenic hypothesis of discal degeneration to explain the association between LBP and vibrations.

II.1.1.3. Psychosocial factors at work

During the past years, there has been an increasing interest in the association between musculoskeletal symptoms and psychosocial factors at work. Psychosocial factors at work

include different aspects: the work pace, the qualitative demands, focused on conflicting demands, interruption of tasks and intensive concentration for long periods, the job content including monotonous work and work with few possibilities to learn new things and to develop knowledge and skills, the job control, the social support of coworkers and supervisors and the job satisfaction (Hoogendoorn et al 2000).
Karasek and Theorell (1990) developed an widely accepted model of work stress on health: high job demands, low control and low social support play together in their negative influence on health. The Job Content Questionnaire is a questionnaire based on this model, with 4 other subscales than the 3 dimensions mentioned.
Four explanations for the association between psychosocial work characteristics and musculoskeletal symptoms have been suggested (Hoogendoorn et al 2000, Bongers et al 1993):
Psychosocial work characteristics can:
- directly influence the biomechanical load through changes in posture, movement and exerted forces (etiologic factor).
- may trigger physiologic mechanisms such as increased muscle tension or increased hormonal excretion that may lead to organic changes and the development or intensification of musculoskeletal symptoms or may influence pain perception and thus symptoms (etiologic or prognostic determinant).
- may change the ability of an individual to cope with an illness which in turn could influence the reporting of musculoskeletal symptoms (prognostic factor).
- may be confounded by the effect of physical factors at work.

Epidemiological studies show evidence for an effect of psychosocial factors at work on the occurrence of back pain, but the evidence for the role of specific psychosocial factors has not been established yet (Hoogendoorn et al 2000, Bongers et al 1993).

II 1.2. Development of a self-administered questionnaire to assess physical workload

In order to develop a self-administered questionnaire, a literature review has been carried out to ensure the questionnaire's content validity and a critical analysis of 10 published and validated questionnaires has been carried out in order to optimize the question formulation and to select the most appropriate answering categories. A short overview of the conclusions of this review is given hereafter.

These ten validated questionnaires evaluating mechanical risk factors for musculoskeletal trouble, were published between 1987 and 1997. They differ in several ways: the sampling size (varying from 82 to 2480 subjects) and the nature of the study populations (involving a various number of job categories, from 1 to 55).

II.1.2.1. Content validity

Due to the specific objectives followed by the research teams, none of these questionnaires was exclusively focused on the evaluation of spinal biomechanical constraints at the workplace. Postural constraint, static work postures and manual handling were always recorded while whole body vibrations were only taken into account in 5 questionnaires. The proportion of questions devoted to each risk factors category varied from one questionnaire to another. The most studied risk factor was generally the manual handling of loads.

II.1.2.2. Answering modalities

The answering modalities consisted of a frequency scale for the majority of items. This scale can be ordinal (not at all, rarely, fairly often, often) or continuous (never--------------always), and can be expressed either in a subjective way (sometimes, often…) or in an objective way (one time an hour for instance). Moreover, several answers were dichotomized (yes or no).

Some authors used an intensity (to evaluate the weight for instance) or duration scale (Pope et al. 1998).

II.1.2.3. Exposure level

Postural constraint exposure is assessed by means of an amplitude level cut-off (in degrees) in 3 questionnaires, by a duration limit in 3 others and by a frequency cut-off over one hour in another questionnaire (Wiktorin et al. 1999). Hollmann et al. (1999) were the only ones to propose subjective items to define the exposure to trunk flexion. Three questionnaires did not define any exposure level. Concerning manual handling, a majority of authors proposed 2 to 4 exposure classes to evaluate load weight. The weight limits varied a lot from one author to another, particularly for the extreme values of the scale.

II.1.2.4. Time interval of evaluation

The time period taken into account varied from one questionnaire to another: one specific work hour (Pope et al. 1998; Torgen et al. 1999), an ordinary workday (Viikari-Juntura et al. 1996) or a work week (Campbell et al. 1997). Other instruments did not define precisely the period taken into account (Hollmann et al. 1999; Rossignol and Baetz 1987).

II.1.2.5. Questionnaire reproducibility

The reproducibility, using a test-retest methodology, has been tested in four questionnaires. The time interval between 2 administrations varied: 15 days, 4 months, one year or 6 years. The published data (Hollmann et al. 1999) showed that reproducibility is slightly influenced by the time interval between the 2 tests, and that memory difficulties had no important impact on reproducibility. Reproducibility can also vary depending on the variable examined. Generally, for sitting posture assessment the highest correlation coefficients were found (Torgen et al. 1997; Torgen et al. 1999; Wiktorin et al. 1996). Reproducibility of exposure to vibration was also satisfactory. For postural constraint reproducibility, correlations were weak (particularly for flexion and torsions) in two studies (Torgen et al. 1999; Wiktorin et al. 1996) but satisfactory in a third one (Torgen et al. 1997). For manual handling, reproducibility seems to deteriorate when the evaluation deals with light weights (less than 5 kg in that case) (Torgen et al. 1999).

II.1.2.6. Questionnaire external validity

This validity was studied in 8 questionnaires. When self-administered questionnaires were compared to the worker interviews (Wiktorin et al. 1999), strong correlations were observed for estimation of the time spent in sitting position and vehicle driving while the correlations were weaker for postural constraints such as trunk flexion. In a majority of the questionnaires, the chosen reference criterion was the direct observation (Pope et al. 1998; Rossignol and Baetz 1987; Torgen et al. 1999). Generally speaking, global and well-defined constraints such as time spent in a sitting position or exposure to vibration were generally well correlated to direct observations. Yet, the correlations were really less satisfactory for constraints like heavy load handlings or awkward postures (Pope et al. 1998; Rossignol and Baetz 1987; Torgen et al. 1999; Wiktorin et al. 1993). Agreement seems to be better for short duration and low frequency activities in regard to activities with varying duration and frequencies (Wiktorin et al. 1993). Finally, the use of a dichotomous answering mode seems to present a better concurrent validity than a more detailed evaluation of the constraints (Campbell et al. 1997).

II.2. Ergonomic aspects
Development of an ergonomic observation methodology

Whereas a questionnaire is easy to apply in a repeated measures design in a large sample of subjects, it is well-known that, in comparison to the observations, the collected data are not reliable enough to ensure a correct classification of subjects in different exposure groups (Van der Beek and Frings-Dresen 1998). An observation methodology needs thus to be developed. The design of such an observation protocol raises several methodological issues that are discussed hereunder.
Three recent reviews (Burdorf 1992; Kilbom 1994; Li and Buckle 1999) have first been analysed in order to define the observation protocol principles. Once these principles had been defined, six observation methods (Buchholtz et al. 1996; Fransson-Hall et al. 1995; Ridd et al. 1989; van der Beek et al. 1992; Wells et al. 1995; Wiktorin et al. 1995) have been analysed to find the best trade-off between the observation accuracy and the observer mental load. A last issue concerns the sampling strategy of the observation period: which of either a task-based approach or a randomised time-sampling technique would be the most accurate in assessing work activities?

II. 2.1. Observation principles

It first appeared in our review analysis that when using a computerised grid, the choice of a single observer can be made to avoid the inter-observer variability bias. However, according to Kilbom guidelines (1994), in that case the number of variables to be simultaneously observed should be lower than 10 and trunk posture variables should be assessed using a maximum of 3 categories. Moreover, the single observer must be well-trained to its grid and an intra observer reproducibility test should be made (Buchholtz et al. 1996). In order to ensure content validity, the grid must take into account the low back pain risk factors.
When choosing between direct or delayed observations (based on video recordings), it appears that, in comparison to direct observations, delayed observations allow a more precise measurement of duration and frequency of each activity. But these are time consuming, costly and lack the 3D vision of the worker posture. Direct observations could thus provide a better cost-effectiveness relationship (Kilbom 1994). If direct observations are selected, a choice has then to be made between a continuous or discontinuous capture mode. The continuous mode provides a better accuracy of duration and frequency measurements but increases the observer mental load and implies a reduction in the number of observed variables. So far the advantage of a continuous over discontinuous observation has not been demonstrated yet (Kilbom 1994). A discontinuous capture modality (time-sampling procedure like snap shot) seems to offer the best choice if one want to use an exhaustive grid.

II.2.2. Observation period definition

When choosing the discontinuous capture method, a trade-off has to be found between the observation accuracy (using the shortest possible time-sampling interval) and the observer mental load. In fact, lowering this interval allows the observer to observe more operations of each observed task but implies to limit the number of observed variables and to decrease the observation period duration.
In the literature, the time-sampling interval used varied from 15 sec (van der Beek et al. 1992) to 1 minute (Buchholtz et al. 1996). The PEO methodology (Fransson-Hall et al. 1995) used a 30 minutes observation period and the OWAS methodology guidelines (Karhu et al. 1977) requests a minimum of 100 capture points for each observation periods. On that basis, a 30 minutes observation period and a 15 sec time-sampling interval (120 capture points per period) were considered as being a good compromise.

II.2.3. Sampling of observation periods

Two approaches are possible to sample the work activities of a given job: using a task-based or a randomized time sampling technique. The first strategy involves the observation of each task of the job in the same way (for instance, one observation period per task) and then, weighting of the data collected taking into account the time proportion of each task so that each function can be compared (Wells et al. 1997). A task-based approach seems to be logical and accurate, but in fact it requires a large preliminary analysis to define the tasks' temporal distribution. For jobs involving varying tasks, such analysis is time consuming and will have a direct impact on the actual accuracy of the approach.

The second strategy consists of a randomised distribution of a fixed number of observation periods all over the shift, within each job or function, without taking into account the tasks' distribution. According to the literature, within-group variance seems to be less with a fixed number of observation periods randomly distributed over the work shift (Mathiassen et al. 2003) than when using a task by task approach. Hence the choice of using a randomised observation period distribution was made in the present study. In such an approach, it is absolutely necessary to define a fixed number of observation periods and a fixed number of observed subjects per function.

Recent studies using a bootstrapping technique provided several options to define these numbers. Hoozemans et al. (2001) have determined for a given number of observation periods the number of observed subject needed to ensure a 5% precision level in a 5-95 percentile range. For instance, to reach this precision level, either 8 subjects (at least) have to be observed during 8 periods or at least 12 subjects during 4 periods.

III. METHODS

III. 1. Epidemiological aspects

After extensive literature review, different questionnaires have been selected according to their international comparability.
In order to keep the questionnaires as short as possible, only specific changes in outcome variables and determinants have been asked for at the follow-up moments t1 and t2.
To reduce recall bias a short questionnaire was sent to all subjects at 6 and 18 months after inclusion in the study.
Initially, it was planned that the clinical back examination had to be performed at t0 for all participants and at t1 for those participants who had developed back problems during the first year. Because of practical and interpretation problems, the clinical back examination at t1 had to be suspended.
During the course of the study, outcome variables as incidence, recurrence and severity have been described more precisely. The analysis in this report will be limited to the determinants at t0 and outcome variables at t1 (and t2).

The initial aim was to include 1800 participants at t0. With an estimated "lost to follow-up" of 10% per year, we would have ended up with +/- 1458 participants for which data over 2 years would be available (see scheme 1). This would have been enough to statistically detect small differences (relative risks between 1.5 and 2.0). Partially the reduced funding but also the logistic problems encountered in setting up the study in the framework of routine occupational health service, forced us to reduce the number of participants to 1200 and thus to reduce the power of the study.

Specific procedures regarding the quality control of data collection, data entry and analysis have been agreed upon. Each centre was responsible for the correctness and completeness of the data collected. After collection, the questionnaires were sent to the coordinating centre. The questionnaires have been precoded, which allows entering codes directly. The coordinating center has created a basic file in which all data can be entered. For t0, data have been entered manually. Questionnaires t1 and t2 have been designed in 'Teleform'-format which allows data to be scanned automatically into a SPSS file (Norusis 1990).
The protocol of the study has been submitted to the Committee of Medical Ethics OM n° 117 for advice and approval.
For more details about the Developments, the reader is referred to the study protocol (OSTC Activity Report, number 5) and intermediate project reports (OSTC Activity Reports numbers 1-5).

Scheme 1

```
July 2000              July 2001              July 2002              July 2003
   X-------------------------X-------------------------X-------------------------

          intake             1° year follow-up         2° year follow-up
           (t0)                    (t1)                      (t2)
```

III.1.1. Sampling and Measuring Instruments

The following inclusion criteria have been chosen:

a. Employees who are recently recruited by their employer cannot be older than 30 years and must have a perspective on a steady job.

b. Employees undergoing their yearly medical examination within the occupational health service cannot be older than 30 years.

AND (this applies to both a and b)

c. Employees accepting to take part in the study may not have experienced a consecutive period of low back pain which lasted for seven days or longer during the past year.

Variables were measured using a self-administered questionnaire and a standardized clinical examination of the back (Van Cauwenbergh et al 2003). At the follow-up moments in the study, a similar questionnaire had to be completed but in this follow-up questionnaire mainly the changes in basic variables were investigated.
Moreover, questionnaire-based information about the physical workload would be validated by ergonomic observation following a standardized protocol (see OSTC Activity Report number 5).
Much effort has been invested in the construction of the questionnaires. Comparability with internationally used questionnaires was aimed at. For the design of the study, the protocol and the different questionnaires, expert advice has been obtained from various external research groups. Especially the choice of methods and study population has been discussed extensively with Dutch (P. Bongers, A. Burdorf, A. Vander Beek), Nordic (e.g. H. Riimaki), British (e.g. P. Buckle, D. Coggon) and American (e.g. L. Fine) experts in setting up prospective studies of occupational low back disorders.
Also for the statistical analysis of the data, expert advice has been obtained from G. Verbeke (Biostatistical Centre, Catholic University of Leuven).
During the course of the project, on several occasions formal and informal consultation was organized with some of the experts (e.g. in the framework of a congress or by e-mailing) about the specific contents of the instruments, about the analytic strategy etc… These were then accordingly adapted.
The logistical organization of the study (screening, inclusion, follow-up and 'lost to follow-up') has been described in a standardized scenario (see protocol in attachment to the Activity Report of IDEWE, number 5).

III.1.1.1. Questionnaires

The content of the questionnaire depends on the moment of follow-up.
The questionnaire involves the following parts:

a. Back complaints
   Parts of the Nordic Questionnaire (Kuorinka et al 1987), specifically the part regarding back pain. At t1 and t2 this part has been completed with detailed questions regarding severity (Numeric Rating Scale) and nature of back pain, duration of each pain episode, functional limitations (Quebec Back Pain Disability Questionnaire (Kopec et al 1995)), frequency and duration of sick leave.

b. Psychological attitudes and psychosocial factors
   - Assessment of the individual feelings about back pain at t0, t1 and t2 (Pain Catastrophizing Scale, PCS (Sullivan et al 1995, Crombez et al 1999))
   - For employees with complaints: fear of back pain (Tampa Scale Kinesiophobia, TSK (Miller et al 1991) and Fear Avoidance Beliefs Questionnaire (Waddell et al 1993)) at t1 and t2
   - Modified Tampa Scale of Kinesiophobia, MTSK (Vlaeyen et al 1998) at t0
   - Negative Affectivity (PANAS (Watson et al 1988))
   - Psychosomatic complaints at t0, t1, t2 (Nijmeegse Questionnaire (Van Dixhoorn et al 1987))
   - Job Content Questionnaire, JCQ (Karasek et al 1990): measurement of work stressors according to the 'demand-control-support' model

c. Person-related and demographic factors
Demographic variables like gender, weight, length, educational level, function, smoking and other health behaviors.

d. Physical workload
This is described in the following paragraph.

III.1.1.2. Questionnaire used to assess physical workload

As among the 10 questionnaires analysed (see section II.1.2.), none allowed to assess the whole set of LBP risk factors, it was decided to create a specific tool. This questionnaire corresponds to questions 33 to 72 of the questionnaire t0 presented in the Appendix.

Two principles, taken from the literature review, have been taken into account concerning the answering categories: a dichotomic answering mode is used in most of the items and, when duration or frequency estimation is deemed necessary, an ordinal and objective scale is used.

Using such answering modalities implies the choice of one (or more) exposure limits or cut-off values. Based on the literature, values were selected that showed strong associations between the studied factor and the health effects. Like in other studies exploring subject perceptions (Duquette et al. 1997; Masset et al. 1998), some questions are also asked in a subjective way (Q19 for instance) in order to explore the perceived heaviness of efforts and movements.

The time frame on which the subject is asked to evaluate its physical workload is a "typical workday", or in case of work varying from one day to another, "the activity or job the most often performed during the last month".

Exposure to whole body vibrations is assessed by question n°33 on the basis of 2 cut-off levels: a 2 hours cut-off as used by other authors (Mairiaux et al. 2000; Xu et al. 1997) and a 6 hours cut-off that aims to identify subjects for which driving is the major activity.

Static postures are evaluated by questions 34 to 36. Taking into account the results of several studies (Hollmann et al. 1999; Torgen et al. 1997; Wiktorin et al. 1999), it was not deemed pertinent to assess the duration of these postures; nevertheless, the ability to freely change posture during the day is explored.

Postural constraints are evaluated in questions 37 to 42. As in other studies (Rossignol & Baetz 1987; Wiktorin et al. 1999), a difference is made between movement (questions 41 and 42) and posture (questions 37 to 40). In order to assess trunk posture, the frequency scale used in the Viikari-Juntura questionnaire (Viikari-Juntura et al. 1996) has been selected. For trunk flexion, a limit of 45° is used like in other studies (Hollmann et al. 1999; Mairiaux et al. 1998).

Questions 43 to 51 assess manual handling of loads. For load lifting (and carrying), 10 and 25 kg limits are used like in other studies (Campbell et al. 1997; Hoogendoorn et al. 2000; Mairiaux et al. 2000) and in the European norm (CEN 2003). The 12 times an hour frequency cut-off is part of the Australian good practice code (1988) and of the European norm (CEN 2003). Two questions taken from the "FIFARIM" tool (Mairiaux et al. 1998) allow to supplement the analysis of lifting and carrying constraints.

Questions 49 and 50 specifically deal with pushing or pulling tasks, the last one being taken from the FIFARIM tool (Mairiaux et al. 1998) while question 51 evaluates the perceived heaviness of the load handled. To be exhaustive, questions 52 to 54 enable to know if other heavy physical exertions than manual handling of loads are done and to estimate their frequencies. These questions intend to take into account the occurrence of low back pain non related to manual handling (Mairiaux and Delavignette 1993).

Eventually, the Borg scale (Borg 1982) or "Rating of perceived exertion", in its last version (Category ratio scale, 1980) is used to obtain a subjective and global evaluation (Question 55) of the physical exertion level associated to the job.

A second part of the questionnaire (Q 56 to 65) analyses the exposure to biomechanical risk factors in past professional activities.

The third part of the questionnaire (Q 66 to 72) is devoted to leisure time activities that may introduce a bias when evaluating the effect of work related physical constraints: sport activities, other physical activities (domestic work, do-it-yourself-work…) and the time spent driving a car.

III.1.1.3. Standardized clinical back examination

Data regarding the clinical back examination have been recorded using a document developed by IDEWE, the External Service for Prevention and Protection at Work. The set of tests was constructed following the NIOSH Low Back Atlas (National Institute for Occupational Safety and Health 1988) and expert panel advice (Van Cauwenbergh et al 2003). Tests are fully described in a manual by IDEWE (IDEWE 1998). At t0, each subject underwent a clinical back examination based on this protocol.
The physicians performing the clinical examination have been trained intensively, and inter- as well as intra-observer variability has been investigated.

III.1.2. Analysis procedure

Depending on the type of variables, associations between outcome variables and determinants have been calculated.
Because the aim of the study is mainly prediction, only descriptive statistics have been calculated at baseline (t0).
Final results for t2 are not yet available, since data are still being collected at this moment.

Outcome variables could only be calculated as incidence risks or cumulative incidence rates (in percentage) because the number of person-years was not available. In this report only univariate statistical analyses after 1 year of follow-up (t1) will be presented. Indeed, multivariate analyses are still ongoing but could not be finished in the framework of this project, partly due to a lack of resources (see Discussion). Most associations were presented as relative risks, with there respective 95% Confidence Intervals (95% CI). These 95% were computed using the test-based method.
Confounders will be controlled for in a second stage of the analysis using multivariate statistical methods.

III.1.3. Validation protocol of the physical workload questionnaire.

While the questionnaire content validity has been ensured by a literature review, the external validity had to be assessed by comparing the questionnaire results to an external criterion taken as reference. Two criterion validity tests have been carried out: one against direct observation, the other against observer judgment.
While comparison to direct observations is frequently used in the literature (Campbell et al. 1997; Pope et al. 1998; Viikari-Juntura et al. 1996; Wiktorin et al. 1993), comparison of worker and observer judgments answering the same questionnaire is less often mentioned (Wells et al. 1997). Reproducibility of the questionnaire in time has also been assessed using the test-retest methodology (Torgen et al. 1997; Wiktorin et al. 1996).

III.1.3.1. Validation against direct observations

At the end of the shift, each observed worker was invited to answer the questions 30 to 55 of the t0 questionnaire, having in mind the tasks carried out during "the present workday if it is a typical workday".
From the stored observational data of continuous nature, secondary discrete variables were derived taking into account the cut-off used in the questionnaire, in order to allow a comparison of these two sets of information (see section III.2.3.2.). To test the statistical agreement, the Cohen's Kappa test was applied in all cases, and the Spearman's rank coefficient was calculated for variables having ordinal answering categories. Moreover, for these ordinal variables, supplementary Kappa tests have been done by grouping the last ranks to reduce the response scale first to a 3 point and then to a 2-point (dichotomous) scale.
This criterion validation method is close to the one used by Pope et al. (1998) who after a one hour observation period, gave the observed worker a questionnaire concerning the past hour.

III.1.3.2. Validation against observer judgment

The experimenter who had observed the worker for four periods of 30 minutes during the workday also answered at the end of the shift the questions 33 to 55 of the t0 questionnaire. A statistical comparison of both questionnaires was then made using the statistical tests described under section III.1.3.1.

III.1.3.3. Reproducibility

The workers included in the validation study (criterion validity population) did answer twice to the "physical workload" questions; first at the start of the study (baseline questionnaire t0) and secondly at the end of the observation day. Questionnaires of workers who did not change function can thus be compared to analyse the answers reproducibility, using Kappa tests for each variable and Spearman's rank coefficient for ordinal variables only.
However, it must be noticed that the interval between the two administrations of the questionnaire was variable for each subject as it depended on the inclusion time in the epidemiological study (12 months variation) and on the ergonomic observation period (8 months variation).

III.2. Ergonomic aspects

III 2.1. Ergonomic observation protocol

III.2.1.1. Methodology

Each worker was observed during 4 periods of 30 minutes randomly distributed along the shift. During each period, the observer followed the worker and, every 15 seconds, he looked at the worker and entered observational variables on the handheld PC. It was a kind of "snap shot" technique where the observer took a look at the worker 120 times during the observation period.

III.2.1.2. Material

The computerised coding support includes a sensitive-screen palm-top computer (Fujitsu Stylistic LT G-500*) with an Access* software program for direct data capture on the observation grid and processing of these data on a PC.

III.2.1.3. Observation grid

The grid involves 3 observable data categories: the basic motor action, the position and the load. The position category is further divided into global posture, trunk flexion and trunk rotation postures. This grid consists thus of 5 complementary columns including several items. The items in a same column are mutually exclusive. A 15 seconds countdown appears on the computerised grid and ends by a tone that informs the observer that it is time to look at the worker; the observer is then left with 15 seconds to enter one item in each column. The encoded data are considered as default values for the next encoding; this avoids the observer to code an unchanged situation since the last encoding. A “pause” command allows to interrupt the observation period and a “non available” command can be used for problematic items during the observation period.

Global posture	Flexion	Rotation	Basic motor action	Load
Standing	0-20°	0° Rot	No action/holding a load	0 kg
Sitting	21-45°	Rot +	Walking/carrying	1-10kg
Kneeling/squatting	>45		Driving	11-25kg
			Lifting/lowering	>25 kg
			Pushing/pulling	
			Throwing	
			Other action	

The observation protocol included a precise definition of each variable in order to keep the 5 columns complementary and to exclude potential overlap between items in a same column.

III 2.2. Sampling strategy

A cluster sampling technique was chosen. At the start of the observations, the study involved 884 workers and the time allocated for the observations allowed a 17% global sampling (or about 150 workers).

The cohort sampling has been carried out in 2 steps. It was first divided into the 5 participating firms (1st sampling level) and within each firm, subjects were classified into job categories, as described by the firm (2nd sampling level) as long as there were at least 6 subjects per function (17% of 6 subjects corresponding to about one subject). If this was not the case (less than 6 subjects), some grouping had to be done taking into account the team or unit manager advice. In the distribution sector, the majority of workers is polyvalent and has to do at least 2 functions the same month. For the sampling, each function was isolated and the proportion of time that these functions were filled in within the firm was defined with the

help of the firm human resources service. The 17 % sampling rate was then balanced in each function according to the defined time proportion.
In total, 72 job categories have been taken into account.

III.2.3. Data analysis of the ergonomic observations

III.2.3.1. Descriptive statistics

III.2.3.1.1. Quality control of the captured data
A quality control was carried out in order to check that each worker result table had 480 lines of 5 completed columns in total. Interrupted series have been cancelled and missing values have been replaced by logically deduced values when possible. In total, 324 recordings including at least one missing value have been found out of 72960 recordings, identifying an error rate of 0.4%.

III.2.3.1.2. Defining homogeneous exposure groups (HOG's)
On the basis of the discussion with team or sector managers and according to what has been observed in a qualitative way, the 72 job categories have been grouped into 23 homogeneous observation groups (HOG's) which in fact involve equivalent functions in Flanders and Wallonia. These 23 HOG's included 12 groups for the health care sector, 9 for the distribution sector and 2 for the home services.

III.2.3.1.3. Descriptive statistics for each HOG's
In order to establish the statistics, a complete list of all variables that could be derived from the input observational data was established. The 34 defined variables are distributed as follows:
-2 variables for whole body vibration exposure
-4 variables for static postures (sitting and standing postures)
-7 variables for postural constraints (trunk flexion and rotation)
-6 variables for combinations between postural constraints and manual handling
-12 variables for manual handling
-3 variables for actions with high physical exertion other than manual handling
For each worker, the encoding frequency of each variable (expressed in percentage of the total capture points -480) was calculated and the average coding frequency was available for each HOG.

III.2.3.2. Data analysis for the questionnaire validation

As explained previously (III.1.3.1.), questionnaire validation against direct observation imposes a definition of variables from the grid corresponding best to those of the questionnaire. Thirteen variables could be selected for the comparison.

Vehicle or device driving	Manual handling of loads > 1kg
Sitting position (except driving)	Lifting/carrying =1kg
Standing (without moving)	Lifting/carrying >10kg
Flexion >20 °	Lifting/carrying >25kg
Flexion > 45°	Pushing/pulling >10kg
Flexion >20 °/rotation	Other action >10 kg
Rotation	

For each of these variables, a frequency and/or duration calculation has been done from the coded data. The number of coded data per hour can be multiplied by 15 to give the duration (in seconds) over an hour. This duration can then be multiplied by the number of hours within the shift in order to obtain the duration over the workday. To be compared to the questionnaire, the data (durations and frequencies) have been classified according to the questionnaire answering modalities. However, there was an exception: for the sitting and standing positions, whose answering modality is dichotomous, no cut-off is given in the questionnaire. So, to distribute the subjects, a 2 hours exposure cut-off has been chosen on the basis of other validated questionnaires (Campbell et al. 1997; Viikari-Juntura et al. 1996), and more than 2 hours sitting was considered as “prolonged sitting position”.

III.2.3.3. Relationship between biomechanical variables and the occurrence of low back pain – analysis model

III 2.3.3.1. Variable number reduction

There was some overlap within the 34 variables defined in section III.2.3.1.3., and in addition, making an analysis on such a great number of variables was not realistic. It was thus important to identify the variables that discriminate the best between the 23 HOG’s. By making in the same time an ANOVA and a Kruskal-Wallis Chi square test, 9 variables have been selected out of the 34. The outcome analysis model has been based on these 9 exposure variables:

Driving in the sitting position
Sitting without driving
Trunk flexion > 20°
Trunk flexion > 20° with load
Trunk rotation
Trunk flexion and rotation > 20° with load
Lifting/carrying = 1kg
Lifting/carrying = 10kg
Pushing/pulling = 1kgF

III.2.3.3.2. Exposure groups (EG) definition.

To perform a dose-response analysis, each study subject must be allocated to only one exposure group. Yet as explained in section III.2.2., the 23 HOG's did not take into account the polyvalence system and a worker could not be included in several HOG's. So, for the polyvalent workers, some special exposure groups (EG) have been created by grouping the HOG's of the functions they perform (for the others workers, the EG corresponds to the HOG). A discussion with human resources managers of the concerned firms has allowed to take into account the percentage of time they spend in each function and a balance mean has been calculated for these new groups.

Example : The 6 following EG's concern polyvalent workers who are part time busy with the "préparateur" function and with another function for the other part.

Prépa10Quai90	Prépa20Terberg80	Prépa40Chargeur60
Prépa20Cariste80	Prépa30Cariste70	Prépa50Cariste50

The number indicates the time percentage that the workers of this EG spend approximately in each function.

In total, 31 exposure groups (EG) have been defined: 11 EG's in the health care sector (out of 12 HOG's), 2 EG's in the home services (identical to the 2 HOG's), and 18 EG's in the distribution sector (out of 9 HOG's).

III.2.3.3.3. Outcome measurements

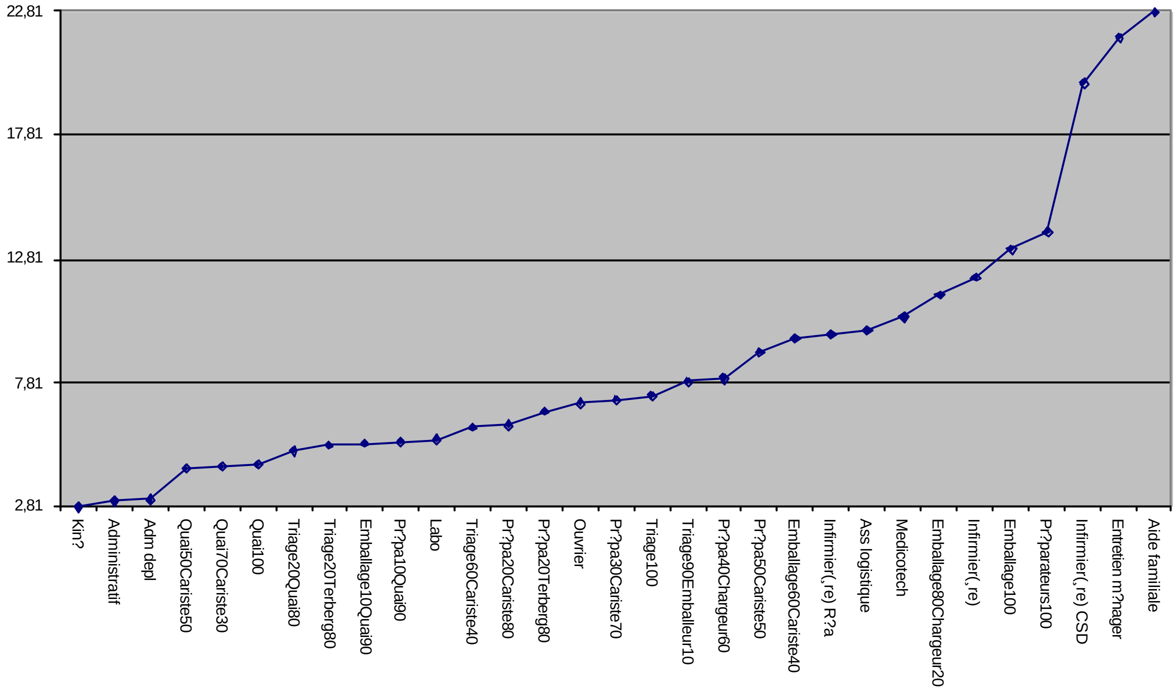
The occurrence of LBP was evaluated on the basis of the screening questionnaire at t1, by taking into account workers having presented LBP for more than 7 days continuously in the previous 12 months. In total, 800 did answer the screening questionnaire but 10 of them could not be allocated to one EG; hence, the outcome model does include 790 workers.

III.2.3.3.4. Relative risks related to exposure level

For each of the 9 exposure variables selected (see above section III.2.3.3.1.), the average encoding percentage values of the 31 EG's have been classified in increasing order, allowing the determination of the values range. As shown in figure 1 this range has been divided into four sections, separated by 3 equidistant exposure cut-offs. Relative Risks (RR) have then been calculated for each variable by comparing workers included in the EG's over the 3rd limit to those included in EG's under the 1st limit except if the minimum is = 0 (non exposed EG). In that case, the non-exposed workers are referent and not those placed under the 1st limit. In the example given in figure 1, for the variable "flexion>20°", it can be observed that 3 EG's are placed over the 17.8% cut-off and 17 EG's are under the 7.8% cut-off. So workers belonging to the 3 more exposed EG's will be compared to those of the 17 least exposed EG's.

However, this model has a weakness: for the 9 studied variables, a large disproportion was observed between the limited number of strongly exposed subjects in regard to the high number of non-exposed subjects. That is why the decision to compute RR related to the distribution of workers has been made

Figure 1. Exposure level (percentage of coding frequency) of 31 EG's for the variable "flexion > 20°"



III.2.3.3.5. Relative risks related to workers distribution

RR have been calculated for each of the nine exposure variable by comparing workers belonging to the 4th quartile of distribution to those belonging to the 1st quartile.

IV. RESULTS

IV.1. Epidemiological results

IV.1.1. Analysis at t0

IV.1.1.1. Questionnaire at baseline

Out of 1672 employees contacted for the study, 1200 (72%) were willing to participate. However, 159 workers had to be excluded based on inclusion criteria because they had suffered from low back pain during a continuous period of 7 days or more in the previous 12 months. Finally, 972 of 1041 workers (93%) returned their baseline questionnaire.
638 (65.6%) of them were Dutch speaking, the other 334 (34.4%) were French speaking.

Tables 1 and 2 present the distribution of the qualitative (table 1) and quantitative (table 2) health- and person-related variables in the study sample (n=972). Mean age was 25.9 years. 63% of the workers were women. 79% had a full-time job and more than 70% were on day duty. More than 80% followed at least higher secondary school.
From table 1 it becomes clear that the majority of the workers were in good health: almost 96% experienced their general health as fairly or very good, 62% never smoked and 57% had a normal BMI. Only 13% used medication on a regular basis and only 6% suffered from a chronic disease.

Although the goal was to start with a study population without a major history of low back pain in the year before inclusion, 55% had already experienced low back pain. 45% reported low back pain in the 12 months before inclusion of whom 14% had to interrupt their activities. The prevalence of other musculoskeletal complaints in the last year was clearly lower than for the low back complaints.

Table 3 describes the self-reported work-related physical factors in the actual job. To increase reporting reliability, these factors were queried only when the worker performed his job for at least 2 months at the time of inclusion (n=851). The mean seniority was 3.5 years. About 42% reported driving a vehicle at work. Only a minority of workers reported to sit (19%) or stand (26%) for longer periods of time. 13% did not have the opportunity to change posture regularly. About half of the sample reported to work with the trunk in awkward positions. Out of 84% workers exposed to the risk of manual material handling, 37% perceived the loads as too heavy or the frequency of handling as too high. More than 70% had to lift or transport weights of more than 10 kg and for almost 50% the weights even exceeded 25 kg. More than half of the workers had to push or pull loads. About one third scored the intensity of their physical load as “hard” or more on the Borg scale.

The physical constraints encountered in the former jobs are presented in table 4. 40.8% of the cohort workers (n=395) performed jobs before the actual one.

The physical activities carried out outside the job are given in table 5. More than half of the sample is involved in sports activities on a regular basis. About two thirds performed embellishment works and even 20% did construction works at home. The average number of km that participants drove a car in one year was 18482.

Table 6 presents the analyses on psychosocial workload and psychological factors. Mean, median, minimum and maximum scores were calculated for the following items: Pain-related fear (questioned by MTSK), pain catastrophizing (PCS), negative affectivity (PANAS), psychosomatic complaints (NVL) and the different aspects of the Demand-Control-Support model according to Karasek and Theorell (JCQ).

TABLE 1 : Descriptive qualitative statistics of health- and person- related variables of the study sample at baseline (n = 972)

Person-related variables :

Variable	Outcome	n	%
Gender	Male	359	36.9
	Female	613	63.1
Duty roster	Fixed day duty	324	33.8
	Fixed night duty	11	1.1
	Varying day duty	387	40.3
	Varying duty with night shift	238	24.8
Level of employment	Full-time (> 75%)	830	86.7
	Part-time (=75%)	127	13.3
Highest diploma	No diploma - primary education – lower secondary education	165	17.1
	Higher secondary school	368	38.1
	Higher education, no university (A1)	374	38.8
	University	58	6.0
Family situation	Married or living together	544	56.3
	Not married and not living together	404	41.8
	Divorced, not living together	11	1.1
	Widow/widower, not living together	7	0.7
	Having children	243	25.5
	Having in charge older or invalid persons	56	5.9

(to be continued)

TABLE 1 (ct'd) : Descriptive qualitative statistics of health- and person- related variables of the study sample at baseline (n = 972)

Health-related behaviors :

Variable	**Outcome**	**n**	**%**
Perceived general health	Very good	457	47.1
	Fairly good	474	48.8
	Moderate	39	4.0
	Fairly bad	1	0.1
Smoking	Never smoked	596	62.3
	Ex-smoker	124	13.0
	Current smoker	237	24.8
BMI	Too slim (BMI<20)	154	16.8
	Normal (BMI 20-24,99)	518	56.5
	Overweight (BMI 25-29,99)	176	19.2
	Obesity (BMI 30-39,99)	66	7.2
	Morbid obesity (BMI = 40)	3	0.3
Regular use of medication		126	13.1
Regular use of sleeping pills or sedatives		19	2.0
Chronic disease		60	6.2

(to be continued)

TABLE 1 (ct'd) : Descriptive qualitative statistics of health- and person- related variables of the study sample at baseline (n = 972)

Health-related variables: musculoskeletal complaints :

Low back complaints :

Variable		**n**	**%**
Ever low back complaints		531	55.3
Low back complaints in past 12 months		436	44.9
	Interrupted activities because of low back complaints in 12 months before study	59	13.9
Low back complaints more than 12 months ago		377	40.1
Hospitalization due to low back complaints		7	0.7
Back school/training		459	47.5
	Use back school training in the job	354	78.7

Other musculoskeletal complaints in past 12 months

Variable	**n**	**%**
Neck	266	27.4
Upper part of the back	102	10.5
Shoulders	117	12.0
Elbows	10	1.0
Wrists/Hands	70	7.2
Hips/Thighs	46	4.7
Knees	144	14.8
Ankles/Feet	84	8.6

TABLE 2 : Descriptive statistics of quantitative health-related and demographic variables of the study sample at baseline (n = 972)

Variable	Mean	SD	Median
Age (years)	25.9	2.8	26.0
BMI (kg/m2)	23.5	4.2	22.8
Health-related variables: general health			
Number of doctor's visits in past 12 months	2.8	2.7	2.0
Sick leave in past 12 months:			
- number of times	1.1	1.3	1.0
- number of days	7.2	15.9	3.0
Sick leave because of industrial accident in past 12 months:			
- number of times	0.1	0.3	0.0
- number of days	1.1	5.6	0.0

(to be continued)

TABLE 2 : Descriptive statistics of quantitative health-related and demographic variables of the study sample at baseline (n = 972)

Health-related variables: Low back complaints:

Variable	**Mean**	**SD**	**Median**
Low back complaints in past 12 months (number of days)	12.2	24.1	4.0
(Only for those having low back complaints : n = 436)			
Total duration of interruption of activities because of back complaints in past 12 months (number of days)	6	6.5	4.5
(Only for those who interrupted their activities because of low back complaints in past 12 months : n = 59)			
Age at onset of low back complaints (years)	20.2	4.2	20.0
(Only for those having low back complaints more than 12 months ago : n = 377)			

Other musculoskeletal complaints in past 12 months

		Number of days		
		Mean	**SD**	**Median**
Neck	(n = 266)	19.9	47.5	5.0
Upper part of back	(n = 102)	20.3	44.3	7.0
Shoulders	(n = 117)	24.7	57.1	7.0
Elbows	(n = 10)	57.8	124.7	13.5
Wrists/Hands	(n = 70)	22	48.3	10.0
Hips/Thighs	(n = 46)	26	63.3	7.0
Knees	(n = 144)	25.8	57.3	10.0
Ankles/Feet	(n = 84)	39.6	82.8	10.0

(Only for those experiencing trouble in the area in question in past 12 months)

(to be continued)

TABLE 3 : **Descriptive statistics of the current job-related qualitative variables of part of the study sample at baseline.**

Only those who practice their current job for at least 2 months (n = 851):

Variable	Outcome	n	%
Exposure to vibration			
Driving a vehicle or engine	No	490	58.2
	Yes, on average < 2 hours/day	94	11.2
	Yes, on average 2 –6 hours/day	73	8.7
	Yes, on average = 6 hours/day	185	22.0
Static postures			
Sitting job for long periods		158	18.7
Standing job for long periods		220	26.3
No possibility to change posture regularly		107	12.7
Postural constraints			
Bent position (= 45°) for long periods	No	386	45.6
	Yes, less than 1/2 hour	52	6.1
	Yes, 1/2 to 1 hour	111	13.1
	Yes, >1 to 2 hours	127	15.0
	Yes, more than 2 hours	170	20.1
Bent and rotated position for long periods	No	537	64.1
	Yes, less than 1/2 hour	79	9.4
	Yes, 1/2 to 1 hour	70	8.4
	Yes, >1 to 2 hour	62	7.4
	Yes, more than 2 hours	90	10.7
Flexion and rotation of the trunk (>12 times an hour)		581	68.8

(to be continued)

TABLE 3 (ct'd) : Descriptive statistics of the current job-related qualitative variables of part of the study sample at baseline.

Variable	Outcome	n	%
Manual handling			
Lifting, pushing, pulling or transportation of loads		714	83.9
	Loads too heavy or too many times lifting, pushing, pulling or transportation of loads	251	36.5
Lifting or transportation of loads		704	83.1
Lifting or transportation of loads of > 10 kg	No	239	28.4
	Yes, less than 1 time/hour	236	28.1
	Yes, 1-12 times/hour	246	29.3
	Yes, more than 12 times/hour	120	14.3
Lifting or transportation of loads of > 25 kg	No	444	53.0
	Yes, less than 1 time/hour	219	26.1
	Yes, 1-12 times/hour	162	19.3
	Yes, more than 12 times/hour	13	1.6
	No good position of the back	115	31.5
	Loads not close to the body	173	46.5
Important pushing or pulling effort	No	376	44.5
	Yes, less than 1 time/hour	240	28.4
	Yes, 1 time or more/hour	228	27.0
	Hindrance because of external elements	285	61.6
Rating of perceived exertion (Borg-score)	score 0 : none	30	3.7
	score 0.5 : very, very weak	32	3.9
	score 1 : very weak	35	4.3
	score 2 : weak	76	9.3
	score 3 : moderate	204	25.0
	score 4 : a little bit hard	165	20.2
	score 5 : hard	162	19.9
	score 6	50	6.1
	score 7 : very hard	42	5.1
	score 8	17	2.1
	score 9	1	0.1
	score 10 : very, very hard	2	0.2

TABLE 4: Descriptive statistics of the past job-related qualitative variables of the study sample at baseline (n = 972)

Variable	n	%
Earlier jobs	395	40.8
Driving a vehicle or engine	116	12.0
Sitting job for long periods	96	9.9
Standing job for long periods	152	15.8
Bent position (>45°) for long periods	180	18.7
Flexion of the trunk (>12 times an hour)	233	24.2
Lifting or transportation of loads of > 10 kg	248	25.7
Lifting or transportation of loads of > 25 kg	175	18.1
Important pushing or pulling effort	186	19.4

TABLE 5: Descriptive statistics of the qualitative variables related to the extra-professional physical load of the study sample at baseline (n = 972)

Variable	n	%
Regular sport (at least once a week)	521	53.7
Embellishment works at home	555	58.5
Construction works at home	180	20.0

TABLE 6 : Descriptive statistics of the quantitative variables of psychosocial and psychological aspects in the study sample at baseline (n = 972)

Variable	Mean	SD	Median	Min.	Max.
1. <u>MTSK</u>					
(Only for those who have = 25% missing items in total: n = 967)					
MTSK-total score	38.54	6.59	38.00	22.00	62.00
2. <u>PCS</u>					
(Only for those who have = 25% missing items in total: n = 966)					
PCS-total score	14.55	8.54	13.50	0.00	46.00
3. <u>PANAS</u>					
(Only for those who have = 25% missing items in total: n = 970)					
Score negative affectivity	18.64	5.42	18.00	10.00	39.00
Score positive affectivity	35.19	5.24	35.00	10.00	50.00
4. <u>'Nymeegse questionnaire'</u>					
(Only for those performing their current function for at least 2 months and having = 25% missing items in total : n = 850)					
'NVL' total score	53.94	12.67	53.00	29.00	105.00

(to be continued)

TABLE 6 (ct'd) : **Descriptive statistics of the quantitative variables of psychosocial and psychological aspects in the study sample at baseline (n=972)**

Variable		Mean	SD	Median	Min.	Max.
5. Job Content Questionnaire :						
(Only for those performing their current function for at least 2 months and having = 25% missing items in total: n = 845)						
A.	1. Skill discretion	33.18	6.46	34.00	12.00	48.00
	2. Decision authority	32.18	7.07	32.00	12.00	48.00
	1+2. Decision latitude	65.35	11.86	66.00	24.00	96.00
B.	Psychological job demands	32.04	5.78	32.00	16.00	48.00
C	1. Supervisor support	11.22	2.14	11.00	4.00	16.00
	2. Co worker support	12.43	1.73	12.00	6.00	16.00
	1+2. Social support	23.65	3.13	24.00	10.00	32.00
D.	Job insecurity	9.41	2.21	9.00	5.00	20.00
E.	Workload	8.24	2.15	8.00	3.00	12.00
F.	1.Hazardous conditions	10.19	3.15	10.00	5.00	20.00
	2. Toxic exposure	6.33	1.97	6.00	3.00	12.00
	1+2. Hazardous exposure	16.53	4.57	17.00	8.00	32.00
G.	Job dissatisfaction	9.83	2.96	10.00	5.00	20.00

IV.1.1.2. Clinical Back Examination

IV.1.1.2.1. Descriptive statistics

Out of the 972 workers having completed the baseline questionnaire, 942 (97%) also underwent a standardised clinical examination of the low back (CBE). Tables 7 and 8 present the descriptive statistics of the qualitative (table 7) and quantitative (table 8) variables. In general, the prevalence of abnormalities was low. Only 5 workers reported low back pain at the time of examination. Pelvic height asymmetry was observed in 19% and scoliosis in 13%. Forward bending, extension and lateral flexion provoked pain in 1.4%, 5.3% and 1.6%, respectively. Almost all workers reported pain in the back of the thigh or the knee in the single straight leg raising test. Sciatic pain was not observed. Hip mobility was abnormal in 5.8%. Out of those 54 workers, 28% complained of pain when moving the hip and in almost 80% a restricted mobility was diagnosed. Spinal and interspinal palpation, paraspinal palpation right, paraspinal palpation left and sacro-iliacal palpation elicited pain in 8.6%, 4.0%, 4.2% and 2.9%, respectively. Thoracolumbar rotation was abnormal in 10.5%. Out of those 98 workers, only a minority reported pain at rotation. However, a restricted range of rotation was observed in almost 90% of them. Neurological abnormalities were present in 3.3%. More than 80% of the workers were able to hold the legs outstretched for 30 sec when lying with only the trunk on a table. 260 participants were not able to reach the floor with the fingertip in forward bending. In this group, the mean distance between fingertip and floor was 11.2 cm, the mean Schöber was 14.7 cm. When the distance between the fingertip and the floor was more than 10 cm, lumbar flexion was measured with a bubble inclinometer: the mean range was 33.4°. Mean range of lumbar extension was 15.3°. For lateral flexion, the mean ranges were almost similar for the right (24.5 cm) and the left side (24.6 cm). In workers who reported pain in the single straight leg raising test, the pain was provoked at a mean of 84.2° for the right side and 85.1° for the left side.

IV.1.1.2.2. Inter-observer reliability of the different items of the clinical back examination

For organisational reasons, two occupational physicians and three research assistants carried out the clinical back examinations in the Belgian Low Back Cohort Study. All examiners were trained intensively.
Among the three research assistants, interexaminer repeatability of the different tests was assessed. For this purpose, one research assistant (AVN) examined 30 volunteers not participating in the study, with two other research assistants (AL and DP). The volunteers, aged 30 years or less and who had not suffered from low back pain for seven consecutive days or more in the twelve months before examination, were recruited from the Katholieke Hogeschool and the Katholieke Universiteit Leuven. As incentive a movie ticket was offered.

The tables in attachment 1 describe in detail the results of the inter-examiner reliability. Kappa's (K) and observed proportions (P) were calculated for the qualitative variables (table I), and intraclass correlation coefficients for the quantitative variables (table II). For many items, distributions were skewed. In this case, kappa's are not a good measure of agreement. With exception of the measurement of the range of lumbar extension, agreement among the three research assistants was rather good.

TABLE 7: Descriptive statistics of the qualitative variables of the clinical back examination (CBE) (n=942)

Variable	n	%
Pain at time of CBE	5	0.5
Pelvic height asymmetry	180	19.2
Scoliosis	121	12.9
Forward bending		
Elicited pain	13	1.4
Fingertip touching floor	681	72.4
Extension		
Pain	49	5.3
(Only for those with painful extension or total extension <17°: n = 124)		
Positive test of Kemp	19	18.3
Lateral flexion		
Pain	15	1.6
Right	14	93.3
Left	11	73.3
Single Straight Leg Raising		
Pain	600	**63.7**
Right	594	99.0
Sciatic pain	0	0.0
Lumbar region – buttock	7	1.2
Back of thigh – back of the knee	559	95.2
Other	21	3.6
Left	580	96.8
Sciatic pain	0	0.0
Lumbar region – buttock	6	1.1
Back of thigh – back of the knee	538	94.4
Other	26	4.6

(to be continued)

TABLE 7 (ct'd): Descriptive statistics of the qualitative variables of the clinical back examination (CBE) (n=942)

Variable	n	%
Hip mobility		
Abnormal	54	5.8
Pain	15	28.3
Right	10	66.7
Left	12	80.0
Restricted range	42	77.8
Right	35	83.3
Left	20	47.6
Pain on palpation		
Spinal - interspinal	80	8.6
Paraspinal right	37	4.0
Paraspinal left	39	4.2
Buttock	16	2.9
Thoracolumbar rotation		
Abnormal	98	10.5
Pain	18	18.4
Right	16	88.9
Left	12	61.7
Restricted	85	87.6
Right	74	87.1
Left	62	72.9
Neurological examination		
Abnormal	31	3.3
Motor examination	15	50.0
Right	11	73.3
Left	11	73.3
Sensory examination	15	48.4
Right	9	60.0
Left	6	40.0
Strength back extensors		
< 10 sec	41	4.4
10 – 29 sec	117	12.5
30 sec	775	83.1

(to be continued)

TABLE 8: Descriptive statistics of the quantitative variables of the clinical back examination (n=942).

Variable	Mean	SD	Med.
Pelvic position			
Measurement with boards (cm)	1.0	0.5	1.0
(Only for those with pelvic asymmetry: n = 180)			
Forward bending			
Fingertip to floor distance (cm)	11.2	5.8	10.0
Schöber (cm)	14.7	0.8	15.0
(Only for those with fingertip to floor distance > 0 cm: n = 260)			
Range of lumbar flexion (°)	33.4	11.8	30.0
(Only for those with fingertip to floor distance > 10cm: n = 127)			
Extension			
Range of lumbar extension (°)	15.3	8.9	15.0
Lateral flexion			
Range right (cm)	24.5	4.5	24.0
Range left (cm)	24.6	4.5	24.0
Single Straight Leg Raising			
Pain SSLR right (°)	84.2	11.2	85.0
(Only for those with painful SSLR right: n = 594)			
Pain SSLR left (°)	85.1	11.6	85.0
(Only for those with painful SSLR left: n = 580)			
Maximum SSLR right (°)	92.6	11.8	94.0
Maximum SSLR left (°)	93.2	12.1	95.0
Double Straight Leg Raising			
SLR with both legs (°)	93.5	12.4	90.0
Hamstrings			
Range right (°) (max. 90°)	83.6	9.1	90.0
Range left (°) (max. 90°)	83.6	9.1	90.0

(to be continued)

IV.1.2. Analysis at t1

IV.1.2.1. Lost to follow up

Out of the 972 workers who completed the baseline questionnaire, 800 completed the questionnaire at the first follow-up moment t1 (82%). The lost to follow up included those who quit their job (n=92) as well as the ones who did not want to participate any longer (n=80). The mean age was significantly higher for the group of responders (26 years) as compared to the non-responders (25.4 years, p=0.012). Mean seniority in the current function also was significantly different between responders and non-responders (3.6 years and 3.0 years respectively, p=0.015). For gender, the difference between the two groups was not statistically significant (p=0.336).
To assess possible selection bias because of the lost to follow-up, we tried to contact by phone those who left their job. Incidence of low back pain was asked for and whether the job was left because of low back pain. Forty-five % of the 172 lost to follow-up could be contacted: the incidence risk of low back pain for a continuous period of 7 days of more was 2.4% which is 5 times lower than for those who were followed up. For 2 workers, the decision to leave their job was related to low back pain.

IV.1.2.2. Outcome variables after 12 months of follow-up

<u>Cumulative incidence rate (incidence risk) of low back pain:</u>
The incidence risk of low back pain for a continuous period of 7 days or more in the first year of follow-up was 12.5%. There was no significant difference between men and women, nor between Dutch and French speaking workers (Table 9).

<u>Cumulative incidence rate (incidence risk) of sick leave because of low back pain:</u>
The incidence risk of sick leave because of low back pain was 5.5%. There was no significant difference between men and women, nor between Dutch and French speaking workers (Table 10).

<u>Characteristics and consequences of low back pain (table 11):</u>
For the 100 cohort workers who experienced low back pain for 7 consecutive days or more, the characteristics and consequences of this low back pain have been investigated in detail. Pain was present almost permanently in 14.6% and regularly recurrent in 46.9%; 27.1% suffered from low back pain occasionally and 11.5% experienced only one episode of low back pain. A sudden onset was observed in almost 41%. Radiating pain below the knee was present in 12%. More than 1/3 attributed their low back pain to the job. In this case, an adaptation of the work place was performed in only 12.5%. For another 1/3, no obvious cause could be given.
Almost 40% of the persons with low back pain stayed at home because of low back pain; 57% sought medical care of which the majority contacted their general practitioner. Only 1 worker needed hospitalization and surgery.

TABLE 9: Cumulative incidence rates (with 95% Confidence Intervals CI) of low back (LBP) for a continuous period of 7 days or more in the first year of follow-up (n = 800) stratified according to gender and language.

		LBP ^{3} 7 days (continuously)		
Variable	**Outcome**	**n**	**%**	**95% CI**
Gender	Total (n=800)	100	**12.5**	(10.2 ; 14.8)
	Men (n=301)	37	**12.3**	(8.6 ; 16.0)
	Women (n=499)	63	**12.7**	(9.7 ; 15.5)
Language & gender	Dutch (n=548)	62	**11.4**	(8.7 ; 14.0)
	Men (n=194)	20	**10.4**	(6.0 ; 14.6)
	Women (n=354)	42	**11.9**	(8.5 ; 15.2)
	French (n=252)	38	**15.1**	(10.7 ; 19.5)
	Men (n=107)	17	**15.9**	(9.0 ; 22.8)
	Women (n=145)	21	**14.5**	(8.8 ; 20.2)

TABLE 10: Cumulative incidence rates (with 95% Confidence Intervals CI) of sick leave because of low back pain in the first year of follow-up (n = 800) stratified according to gender and language.

		Sick leave		
Variable	**Outcome**	**n**	**%**	**95% CI**
Gender	Total (n=800)	44	**5.5**	(3.9 ; 7.1)
	Men (n=301)	21	**7.0**	(4.1 ; 9.9)
	Women (n=499)	23	**4.6**	(2.8 ; 6.4)
Language & gender	Dutch (n=548)	30	**5.5**	(3.6 ; 7.4)
	Men (n=194)	12	**6.2**	(2.8 ; 9.6)
	Women (n=354)	18	**5.1**	(2.8 ; 7.4)
	French (n=252)	14	**5.6**	(2.7 ; 8.4)
	Men (n=107)	9	**8.5**	(3.2 ; 13.7)
	Women (n=145)	5	**3.4**	(0.5 ; 6.4)

TABLE 11: Characteristics of low back pain (LBP) for those who experienced low back pain for at least 7 consecutive days (n=100) in the first year of follow-up

		LBP ≥ 7 consecutive days	
Variable	**Outcome**	**n**	**%**
Time pattern of complaints	Almost permanently		
	- Serious pain	4	4.2
	- Light/nagging pain	10	10.4
	Regularly recurrent several times a year		
	- Serious pain	14	14.6
	- Light/nagging pain	31	32.3
	Occasionally, a few times a year		
	- Serious pain	11	11.5
	- Light/nagging pain	15	15.6
	One episode	11	11.5
Onset	Sudden	40	40.8
	Gradually	58	59.2
Radiating pain			
- upper leg		30	32.6
- below the knee		10	12.0
Most important cause	No apparent reason	34	37.4
	Job	32	35.2
	Accident in the job	5	5.5
	Accident outside the job	2	2.2
	Sports	2	2.2
	Other activities in leisure time	6	6.6
	Pregnancy, delivery	6	6.6
	Menstruation	4	4.4
Medical care		56	57.1
	Consultation general practitioner	46	82.1
	Consultation specialist	19	33.9
	Consultation other experts (physiotherapist, chiropractor, ...)	21	37.5
Sick leave because of LBP		37	37.8

IV.1.2.3. Univariate analysis

IV.1.2.3.1. Cumulative incidence rates (incidence risks) of low back pain

The analysis was restricted to the subpopulation that performed their job for at least two months at baseline and participated in the follow-up moment at t1 (n=716).
Tables 12 and 13 present the univariate analyses for the health-related and demographic variables. These tables show that the following variables were significantly related to low back pain at t1: poorer perceived general health, history of low back pain and of interruption of activities because of low back pain, musculoskeletal co-morbidity (upper part of the back, wrists or hands, knees), sick leave and medical care seeking in the year before inclusion. No effect was observed for the variables smoking, BMI, back school training, gender, age, education level or the family situation.
For the work-related physical variables in the current job, table 16 shows that moderately elevated relative risks were observed for those who stated not to have the opportunity to change posture regularly, for bent and rotated position for more than 2 hours, for those who perceived the loads they have to handle as too heavy or the frequency of handling as too high, for lfting or transportation of loads more than 25 kg more than 12 times/hour, for pushing or pulling once or more an hour and for the perception of hard work (table 14). The mean seniority in the current job did not differ statistically between those who developed low back pain (3.8 years) and those who did not (3.6 years, p=0.287).
As far as the physical load in former jobs is concerned, elevated risks could be noted (see table 15) for driving a vehicle or engine, for standing for long periods, for working with the trunk in awkward positions and for lifting or transportation of loads of more than 10 kg.
For extra professional activities, no significant results were found (table 16).
When considering psychosocial and psychological variables pain related fear, as estimated by the MTSK questionnaire, turned out to be the only predictive psychological variable. Of the Job Content Questionnaire variables, the mean score of skill discretion was statistically lower for those who developed low back pain (score 31.66) than for those who did not (score 33.46; p=0.016) (table 17).

TABLE 12 : **Relative risks (with 95% Confidence Intervals CI) of a LBP episode lasting ≥ 7 consecutive days in relation to the health-related and demographic variables at baseline (n = 716).**

Health-related variables: health related behaviors:

Variable at t0	**Outcome**	**LBP at t1** (n=90)	**No LBP at t1** (n=626)	**RR**	**95% CI**
Perceived general health	Very good	30	309	1.00	
	Fairly good	54	295	**1.75**	**(1.15 ; 2.66)**
	Moderate	5	19	**2.35**	**(1.01 ; 5.53)**
Smoking	Never smoked	51	376	1.00	
	Ex-smoker	12	76	1.14	(0.64 ; 2.05)
	Current smoker	27	159	1.22	(0.79 ; 1.88)
BMI	Normal (BMI 20-24.99)	46	330	1.00	
	Too slim (BMI<20)	10	100	0.74	(0.39 ; 1.42)
	Overweight (BMI 25-29.99)	19	113	1.18	(0.72 ; 1.93)
	Obesity (BMI 30-39.99)	10	38	1.70	(0.92 ; 3.15)
	Morbid obesity (BMI =40)	1	2	2.73	(0.54 ; 13.89)
Regular use of medication	No	74	548	1.00	
	Yes	15	71	1.47	(0.88 ; 2.43)
Regular use of sleeping pills or sedatives	No	90	609	1.00	
	Yes	0	9	/	/
Chronic disease	No	83	583	1.00	
	Yes	7	38	1.25	(0.61 ; 2.54)

(to be continued)

TABLE 12 (ct'd) : Relative risks (with 95% Confidence Intervals CI) of a LBP episode lasting ^{3} 7 consecutive days in relation to the health-related and demographic variables at baseline (n = 716).

Health-related variables: low back complaints

Variable at t0	Outcome	LBP at t1 (n=90)	No LBP at t1 (n=626)	RR	95% CI
Ever low back complaints	No	29	289	1.00	
	Yes	60	327	**1.70**	**(1.12 ; 2.58)**
LBP in 12 months before t0	No	45	360	1.00	
	Yes	45	263	1.32	(0.89 ; 1.93)
LBP more than 12 months before t0	No	40	375	1.00	
	Yes	47	230	**1.76**	**(1.19 ; 2.61)**
Interrupted activities because of LBP in 12 months before the study	No	33	227	1.00	
	Yes	12	26	**2.49**	**(1.41 ; 4.38)**
(For those with LBP in 12 months before t0: n = 310)					
Back school/training	Yes	41	273	1.00	
	No	49	347	0.95	(0.64 ; 1.40)
Use back school training in the job	Yes	26	212	1.00	
	No	13	57	1.70	(0.92 ; 3.13)
(Only for those with back school/training: n = 317)					

(to be continued)

TABLE 12 (ct'd) : **Relative risks (with 95% Confidence Intervals CI) of a LBP episode lasting ³ 7 consecutive days in relation to the health-related and demographic variables at baseline (n = 716).**

Other musculoskeletal complaints:

Variable at t0	**Outcome**	**LBP at t1** (n=90)	**No LBP at t1** (n=626)	**RR**	**95% CI**
Trouble in the 12 months before t0:					
Neck	No	66	454	1.00	
	Yes	24	169	0.98	(0.63 ; 1.52)
Upper part of the back	No	73	568	1.00	
	Yes	17	55	**2.07**	**(1.30 ; 3.31)**
Shoulders	No	75	558	1.00	
	Yes	15	65	1.58	(0.96 ; 2.62)
Elbows	No	88	618	1.00	
	Yes	2	5	2.29	(0.70 ; 7.52)
Wrists/Hands	No	78	578	1.00	
	Yes	12	45	**1.77**	**(1.03 ; 3.05)**
Hips/thighs	No	83	594	1.00	
	Yes	7	29	1.59	(0.79 ; 3.18)
Knees	No	69	533	1.00	
	Yes	21	90	**1.65**	**(1.06 ; 2.58)**
Ankles/feet	No	83	571	1.00	

	Yes	7	52	0.94	(0.45 ; 1.93)

(to be continued)

TABLE 12 (ct'd) : **Relative risks (with 95% Confidence Intervals CI) of a LBP episode lasting ≥ 7 consecutive days in relation to the health-related and demographic variables at baseline (n = 716).**

Demographic variables:

Variable at t0	**Outcome**	**LBP at t1** (n=90)	**No LBP at t1** (n=626)	**RR**	**95% CI**
Gender	Male	35	247	1.00	
	Female	55	376	1.03	(0.69 ; 1.53)
Duty roster	Fixed day duty	34	207	1.00	
	Fixed night duty	2	4	2.36	(0.73 ; 7.63)
	Varying day duty	34	245	0.86	(0.56 ; 1.35)
	Varying duty with night shift	18	160	0.72	(0.42 ; 1.23)
Level of employment	Part-time (≤ 75%)	10	72	1.00	
	Full-time (> 75%)	80	544	1.05	(0.57 ; 1.95)
Highest diploma	University	3	38	1.00	
	Higher education, no university	30	233	1.56	(0.50 ; 4.88)
	Higher secondary school	37	242	1.81	(0.59 ; 5.61)
	No diploma-primary education-lower secondary education	19	106	2.08	(0.65 ; 6.66)

(to be continued)

TABLE 12 (ct'd) : **Relative risks (with 95% Confidence Intervals CI) of a LBP episode lasting ³ 7 consecutive days in relation to the health-related and demographic variables at baseline (n = 716).**

Variable at t0	**Outcome**	**LBP at t1** (n=90)	**No LBP at t1** (n=626)	**RR**	**95% CI**
Family situation	Married or living together	60	349	1.00	
	Not married or living together	29	257	0.69	(0.46 ; 1.05)
	Divorced, not living together	1	7	0.85	(0.13 ; 5.41)
	Widow/widower, not living together	0	4	/	/
Children	No	60	449	1.00	
	Yes	29	162	1.29	(0.85 ; 1.94)
Older or invalid persons	No	84	570	1.00	
	Yes	5	40	0.87	(0.37 ; 2.02)

TABLE 13: Association of the quantitative health-related and demographic variables at baseline with the occurrence of a LBP episode lasting ^{3} 7 consecutive days in the first year of follow-up (n = 716)

Variable	LBP at t1 Mean (SD)	No LBP at t1 Mean (SD)	Test	p-value
Age (years)	26.69 (2.56)	26.14 (2.73)	MWU	0.075
BMI (kg/m^2)	24.43 (4.61)	23.46 (4.15)	MWU	0.079
Number of doctor's visits in past 12 months	3.39 (3.29)	2.60 (2.52)	MWU	**0.003**
Sick leave in past 12 months				
- number of times	1.68 (1.71)	1.08 (1.21)	MWU	**0.000**
- number of days	11.03 (17.72)	7.26 (17.56)	MWU	**0.000**
Sick leave because of industrial accidents in past 12 months				
- number of times	0.14 (0.41)	9.17E-02 (0.31)	MWU	0.418
- number of days	1.91 (7.91)	1.12 (5.63)	MWU	0.371

MWU=Mann-Whitney U test

TABLE 14 : **Relative risks (with the 95% Confidence Interval CI) of a LBP episode lasting ≥ 7 consecutive days in relation to the work related physical variables in the current job at baseline (n = 716)**

Variable	**Outcome**	**LBP at t1**	**No LBP at t1**	**RR**	**95% CI**
Driving a vehicle or engine	No	46	359	1.00	
	Yes, on average < 2 hours/day	12	66	1.36	(0.75 ; 2.44)
	Yes, on average 2-6 hours/day	10	53	1.40	(0.74 ; 2.63)
	Yes, on average ≥ 6 hours/day	22	136	1.23	(0.76 ; 1.97)
Sitting job for long periods	No	73	497	1.00	
	Yes	16	122	0.91	(0.55 ; 1.51)
Standing job for long periods	No	60	458	1.00	
	Yes	28	154	1.33	(0.88 ; 2.01)
Possibility to change posture regularly	Yes	66	550	1.00	
	No	24	66	**2.49**	**(1.65 ; 3.76)**
Bent position (≥45°) for long periods	No	36	289	1.00	
	Yes, less than 1/2 hour	11	32	**2.31**	**(1.27 ; 4.18)**
	Yes, 1/2 to 1 hour	10	85	0.95	(0.49 ; 1.84)
	Yes, 1 to 2 hours	12	94	1.02	(0.55 ; 1.89)
	Yes, more than 2 hours	21	118	1.36	(0.83 ; 2.25)
Bent and rotated position for long periods	No	49	397	1.00	
	Yes, less than 1/2 hour	11	56	1.50	(0.82 ; 2.73)
	Yes, 1/2 to 1 hour	9	55	1.28	(0.66 ; 2.48)
	Yes, 1 to 2 hours	5	45	0.91	(0.38 ; 2.18)
	Yes, more than 2 hours	16	59	**1.94**	**(1.17 ; 3.23)**

(to be continued)

TABLE 14 : Relative risks (with the 95% Confidence Interval CI) of a LBP episode lasting ≥ 7 consecutive days in relation to the work related physical variables in the current job at baseline (n = 716)

Variable	Outcome	LBP at t1	No LBP at t1	RR	95% CI
Flexion of the trunk	No	30	233	1.00	
(>12 times /hour)	Yes	60	380	1.20	(0.79 ; 1.80)
Rotation of the trunk	No	35	278	1.00	
(>12 times/hour)	Yes	54	337	1.24	(0.83 ; 1.84)
Lifting, pushing, pulling or	No	12	104	1.00	
transportation of loads	Yes	77	518	1.25	(0.70 ; 2.22)
Loads too heavy or too many times lifting, pushing, pulling	No	39	334	1.00	
or transportation of loads	Yes	35	167	**1.66**	**(1.09 ; 2.53)**
(Only for those who need to lift, push, pull or transport loads: n = 597)					
Lifting or transportation of	No	12	110	1.00	
loads	Yes	77	510	1.33	(0.75 ; 2.37)
Lifting or transportation of	No	23	182	1.00	
loads > 10 kg	Yes, less than 1 time/hour	21	169	0.99	(0.56 ; 1.72)
	Yes, 1-12 times/hour	28	177	1.22	(0.73 ; 2.04)
	Yes, more than 12 times/hour	16	87	1.39	(0.77 ; 2.51)

(to be continued)

TABLE 14 : Relative risks (with the 95% Confidence Interval CI) of a LBP episode lasting ≥ 7 consecutive days in relation to the work related physical variables in the current job at baseline (n = 716)

Variable	Outcome	LBP at t1	No LBP at t1	RR	95% CI
Lifting or transportation of loads > 25 kg	No	45	332	1.00	
	Yes, less than 1 time/hour	23	159	1.06	(0.66 ; 1.70)
	Yes, 1-12 times/hour	16	112	1.05	(0.61 ; 1.79)
	Yes, more than 12 times/hour	4	9	**2.58**	**(1.09 ; 6.10)**
(Only for those who need to lift or transport loads > 25 kg: n = 324)					
Good position of the back	Yes	26	181	1.00	
	No	13	78	1.14	(0.61 ; 2.11)
Loads close to the body	Yes	20	145	1.00	
	No	19	119	1.14	(0.63 ; 2.04)
Important pushing or pulling effort	No	31	291	1.00	
	Yess, less than 1 time/hour	27	174	1.40	(0.86 ; 2.27)
	Yess, 1 time or more/hour	30	153	**1.70**	**(1.07 ; 2.72)**
(Only for those with important pushing or pulling effort: n = 385)					
Hindrance because of external elements	No	23	126	1.00	
	Yes	34	196	0.96	(0.59 ; 1.56)
Rating of perceived exertion (Borg-score)	Less than hard	50	413	1.00	
	Hard or more	37	183	**1.56**	**(1.05 ; 2.31)**
	Less than very hard	80	558	1.00	

Very hard or more	7	38	1.24	(0.61 ; 2.53)

TABLE 15 Relative risks (with 95% Confidence Intervals CI) of a LBP episode lasting ≥ 7 consecutive days in relation to work related variables in the former job at baseline (n = 716)

Variable	Outcome	LBP at t1	No LBP at t1	RR	95% CI
Earlier jobs	No	46	384	1.00	
	Yes	44	238	1.46	(0.99 ; 2.14)
Driving a vehicle or engine	No	72	555	1.00	
	Yes	18	67	**1.84**	**(1.16 ; 2.93)**
Sitting job for long periods	No	78	562	1.00	
	Yes	12	58	1.41	(0.81 ; 2.45)
Standing job for long periods	No	65	527	1.00	
	Yes	23	94	**1.79**	**(1.16 ; 2.76)**
Bent position (>45°) for long periods	No	61	512	1.00	
	Yes	27	110	**1.85**	**(1.23 ; 2.80)**
Flexion of the trunk (>12 times/hour)	No	58	482	1.00	
	Yes	30	139	**1.65**	**(1.10 ; 2.48)**
Lifting or transportation of loads of > 10 kg	No	58	470	1.00	
	Yes	31	150	**1.56**	**(1.04 ; 2.33)**
Lifting or transportation of loads of > 25 kg	No	72	515	1.00	
	Yes	17	106	1.13	(0.69 ; 1.84)
Important pushing or pulling effort	No	67	504	1.00	

	Yes	22	115	1.37	(0.88 ; 2.13)

TABLE 16 Relative risks (with 95% Confidence Intervals CI) of a LBP episode lasting ^{3} 7 consecutive days in relation to the extra-professional load at baseline (n = 716)

Variable	Outcome	LBP at t1	No LBP at t1	RR	95% CI
Regular sport (at least once a week)	Yes	41	345	1.00	
	No	49	276	1.42	(0.96 ; 2.09)
Embellishment works at home	No	30	250	1.00	
	Yes	57	360	1.28	(0.84 ; 1.93)
Construction works at home	No	69	445	1.00	
	Yes	15	130	0.77	(0.46 ; 1.31)

TABLE 17 : **Association of the quantitative psychosocial and psychological variables at baseline with the occurence of a LBP episode lasting ^{3} 7 consecutive days in the first year of follow-up (n = 716)**

Variable	Outcome	LBP at t1 Mean (SD)	No LBP at t1 Mean (SD)	Test	p-value
1. <u>MTSK</u>					
(Only for those who have = 25% missing items in total: n = 713)					
MTSK-total score		39.76 (7.20)	38.23 (6.71)	MWU	**0.044**
2. <u>PCS</u>					
(Only for those who have = 25% missing items in total: n = 713)					
PCS-total score		16.04 (9.88)	14.23 (8.29)	MWU	0.170
3. <u>PANAS</u>					
(Only for those who have = 25% missing items in total: n = 715)					
Score negative affectivity		19.21 (5.89)	18.45 (5.31)	MWU	0.380
Score positive affectivity		35.09 (4.89)	35.10 (5.38)	MWU	0.906
4. <u>NVL</u>					
(Only for those who have = 25% missing items in total: n = 715)					
'NVL'-total score		56.46 (14.21)	53.49 (11.96)	MWU	0.090

MWU= Mann-Whitney U test
(to be continued)

TABLE 17 (ct'd) : Association of the quantitative psychosocial and psychological variables at baseline with the occurence of a LBP episode lasting ≥ 7 consecutive days in the first year of follow-up (n = 716)

Variable	Outcome	LBP at t1 Mean (SD)	No LBP at t1 Mean (SD)	Test	p-value
5.	**<u>Job Content Questionnaire</u>**				
A.	1. Skill discretion	31.66 (6.74)	33.46 (6.26)	MWU	**0.016**
	2. Decision authority	32.23 (7.11)	32.25 (7.06)	MWU	0.955
	1+2. Decision latitude	63.61 (11.75)	65.69 (11.72)	MWU	0.138
B.	Psychological job demands	31.78 (6.88)	32.16 (5.53)	MWU	0.817
C.	1. Supervisor support	11.07 (2.35)	11.28 (2.07)	MWU	0.450
	2. Co worker support	12.54 (1.66)	12.43 (1.73)	MWU	0.606
	1+2. Social support	23.67 (3.37)	23.72 (3.10)	MWU	0.584
D.	Job insecurity	9.61 (2.42)	9.31 (2.15)	MWU	0.168
E.	Workload	8.58 (2.12)	8.13 (2.18)	MWU	0.059
F.	1. Hazardous conditions	10.54 (3.36)	10.20 (3.12)	MWU	0.407
	2. Toxic exposure	6.51 (2.13)	6.29 (1.96)	MWU	0.327
	1+2. Hazardous exposure	17.02 (4.89)	16.49 (4.54)	MWU	0.334
G.	Job dissatisfaction	9.94 (3.03)	9.75 (2.84)	MWU	0.351

MWU= Mann-Whitney U test

IV.1.2.3.2. Cumulative incidence rates (incidence risks) of sick leave because of low back pain

The analysis was also restricted to the subpopulation that performed their job for at least two months at baseline and participated in the follow-up moment at t1 (n=716).
Tables 18 and 19 present the univariate analysis for the health related and demographic variables. From this tables the following variables were significantly related to sick leave because of low back pain: poorer perceived general health, obesity and morbid obesity, interruption of activities because of low back pain in the twelve months before the study, musculoskeletal co-morbidity (wrists or hands) having children, general sick leave and medical care seeking in the year before inclusion.
For the work-related physical variables in the current job, driving a vehicle or engine less than 2 hours/day was statistically related to sick leave because of low back pain (table 20).
As far as the physical charge in former jobs is concerned, elevated risks could be noted for standing for long periods, for working with the trunk in awkward positions and for lifting or transportation of loads of more than 10 kg (table 21).
For extra-professional activities, no significant results were found for the categorical variables (table 22). However, the mean number of kilometers that participants drove a car the last year was statistically higher for those with sick leave (21 577 kilometers) than for those without sick leave (18 473 kilometers, p=0.018).
None of the psychological variables was predictive for sick leave. The mean score of skill discretion differed statistically between those who were absent because of low back pain (score 31.05) and those who were not (score 33.41, p=0.006). Lower psychological job demands were predictive for sick leave one year later (p=0.023) (table 23).

TABLE 18 : Relative risks (with 95% Confidence Intervals CI) of a sick leave (SL) episode because of low back pain in relation to the health-related and demographic variables at baseline (n = 716).

Health-related variables: general health:

Variable at t0	**Outcome**	**SL at t1** (n=42)	**No SL at t1** (n=674)	**RR**	**95% CI**
General health	Very good	10	329	1.00	
	Fairly good	27	322	**2.63**	**(1.29 ; 5.35)**
	Moderate	4	20	**5.65**	**(1.91 ; 16.67)**
Smoking	Never smoked	21	409	1.00	
	Ex-smoker	7	81	1.63	(0.71 ; 3.72)
	Current smoker	14	169	1.57	(0.82 ; 3.01)
BMI	Normal (BMI 20-24.99)	18	360	1.00	
	Too slim (BMI<20)	3	106	0.58	(0.17 ; 1.93)
	Overweight (BMI 25-29.99)	10	122	1.59	(0.75 ; 3.36)
	Obesity (BMI 30-39.99)	6	41	**2.68**	**(1.12 ; 6.41)**
	Morbid obesity (BMI =40)	1	2	**6.99**	**(1.33 ; 37.04)**
Regular use of medication	No	33	590	1.00	
	Yes	9	76	2.00	(0.99 ; 4.03)
Regular use of sleeping pills or sedatives	No	42	656	1.00	
	Yes	0	10	/	/
Chronic disease	No	39	628	1.00	
	Yes	3	41	1.17	(0.38 ; 3.62)

(to be continued)

TABLE 18 (ct'd) : Relative risks (with 95% Confidence Intervals CI) of a sick leave (SL) episode because of low back pain in relation to the health-related and demographic variables at baseline (n = 716).

Health-related variables: low back complaints

Variable at t0	**Outcome**	**SL at t1** (n=42)	**No SL at t1** (n=674)	**RR**	**95% CI**
Ever low back complaints	No	14	302	1.00	
	Yes	28	360	1.63	(0.87 ; 3.04)
Low back complaints in 12 months before t0	No	23	381	1.00	
	Yes	19	290	1.08	(0.60 ; 1.95)
Low back complaints more than 12 months ago	No	19	393	1.00	
	Yes	23	255	1.79	(1.00 ; 3.23)
Hospitalization due to low back complaints	No	42	664	1.00	
	Yes	0	3	/	/
Back school/training	Yes	17	300	1.00	
	No	25	368	1.19	(0.65 ; 2.16)
Interrupted activities because of low back complaints in 12 months before the study	No	12	249	1.00	
	Yes	7	31	**4.01**	**(1.68 ; 9.54)**
(Only for those with low back complaints in 12 months before t0: n = 310)					
Use back school training in the job	Yes	4	66	1.00	
	No	13	228	1.06	(0.36 ; 3.15)

(Only for those with back school/training: n = 317)

(to be continued)

TABLE 18 (ct'd) : Relative risks (with 95% Confidence Intervals CI) of a sick leave (SL) episode because of low back pain in relation to the health-related and demographic variables at baseline (n = 716).

Other musculoskeletal complaints: **Variable at t0**	**Outcome**	**SL at t1** (n=42)	**No SL at t1** (n=674)	**RR**	**95% CI**
Trouble in the 12 months before t0:					
Neck	No	33	487	1.00	
	Yes	9	184	0.74	(0.36 ; 1.51)
Upper part of the back	No	36	606	1.00	
	Yes	6	65	1.51	(0.66 ; 3.45)
Shoulders	No	36	597	1.00	
	Yes	6	74	1.32	(0.57 ; 3.03)
Elbows	No	41	665	1.00	
	Yes	1	6	2.46	(0.39 ; 15.47)
Wrists/Hands	No	34	622	1.00	
	Yes	8	49	**2.71**	**(1.32 ; 5.57)**
Hips/thighs	No	38	639	1.00	
	Yes	4	32	1.98	(0.75 ; 5.24)
Knees	No	36	567	1.00	
	Yes	6	104	0.91	(0.39 ; 2.12)
Ankles/feet	No	40	616	1.00	

	Yes	2	55	0.58	(0.14 ; 2.32)

(to be continued)

TABLE 18 (ct'd) : **Relative risks (with 95% Confidence Intervals CI) of a sick leave (SL) episode because of low back pain in relation to the health-related and demographic variables at baseline (n = 716).**

Demographic variables:

Variable at t0	**Outcome**	**SL at t1** (n=42)	**No SL at t1** (n=674)	**RR**	**95% CI**
Gender	Female	21	410	1.00	
	Male	21	261	1.53	(0.85 ; 2.75)
Duty roster	Fixed day duty	19	221	1.00	
	Fixed night dutyt	1	5	2.11	(0.33 ; 13.33)
	Varying day duty	12	267	0.54	(0.27 ; 1.10)
	Varying duty with night shift	8	171	0.57	(0.25 ; 1.26)
Level of employment	Part-time (≤ 75%)	5	77	1.00	
	Full-time (> 75%)	37	587	1.00	(0.95 ; 1.06)
Highest diploma	University	3	38	1.00	
	Higher education, no university	8	255	0.42	(0.12 ; 1.50)
	Higher secondary school	18	261	0.88	(0.27 ; 2.86)
	No diploma-primary education-lower secondary education	12	113	1.31	(0.39 ; 4.42)

(to be continued)

TABLE 18 (ct'd): **Relative risks (with 95% Confidence Intervals CI) of a sick leave (SL) episode because of low back pain in relation to the health-related and demographic variables at baseline (n = 716).**

Variable at t0	Outcome	SL at t1 (n=42)	No SL at t1 (n=674)	RR	95% CI
Family situation	Married or living together	30	377	1.00	
	Not married and not living together	12	275	0.57	(0.30 ; 1.09)
	Divorced, not living together	0	9	/	/
	Widow/widower, not living together	0	4	/	/
Children	No	24	485	1.00	
	Yes	17	174	**1.89**	**(1.04 ; 3.44)**
Older or invalid persons	No	41	613	1.00	
	Yes	1	44	0.35	(0.05 ; 2.52)

TABLE 19: Association of a sick leave (SL) episode because of low back pain in relation with the quantitative health-related variables at baseline (n = 716)

Variable	SL at t1 Mean (SD)	No SL at t1 Mean (SD)	Test	p-value
Age (years)	26.64 (2.51)	26.18 (2.74)	MWU	0.307
BMI (kg/m^2)	25.50 (5.32)	23.46 (4.11)	MWU	**0.017**
Number of doctor's visits in past 12 months	4.17 (4.19)	2.61 (2.49)	MWU	**0.001**
Sick leave in past 12 months				
- number of times	1.98 (1.47)	1.09 (1.24)	MWU	**0.000**
- number of days	11.31 (13.37)	7.51 (17.83)	MWU	**0.000**
Sick leave because of industrial accidents in past 12 months				
- number of times	0.28 (0.56)	8.51E-02 (0.30)	MWU	**0.001**
- number of days	3.79 (10.88)	1.04 (5.45)	MWU	**0.001**

MWU= Mann Whitney U test

TABLE 20 : Relative risks (with 95% Confidence Intervals CI) for a sick leave (SL) episode because of low back pain in relation to the qualitative current job-related variables at baseline (n = 716)

Variable	Outcome	SL at t1	No SL at t1	RR	95% CI
Driving a vehicle or engine	No	16	390	1.00	
	Yes, on average < 2 hours/day	10	68	**3.26**	**(1.53 ; 6.90)**
	Yes, on average 2-6 hours/day	4	58	1.64	(0.57 ; 4.74)
	Yes, on average ≥ 6 hours/day	11	147	1.77	(0.84 ; 3.72)
Sitting job for long periods	No	36	534	1.00	
	Yes	5	133	0.57	(0.23 ; 1.44)
Standing job for long periods	No	31	490	1.00	
	Yes	10	169	0.94	(0.47 ; 1.88)
Possibility to change posture regularly	Yes	33	584	1.00	
	No	9	80	1.89	(0.94 ; 3.82)
Bent position (≥45°) for long periods	No	18	308	1.00	
	Yes, less than 1/2 hour	5	39	2.06	(0.81 ; 5.26)
	Yes, 1/2 to 1 hour	6	88	1.16	(0.47 ; 2.83)
	Yes, 1 to 2 hours	3	102	0.52	(0.16 ; 1.72)
	Yes, more than 2 hours	10	129	1.30	(0.62 ; 2.75)
Bent and rotated position for long periods	No	23	425	1.00	
	Yes, less than 1/2 hour	6	61	1.75	(0.74 ; 4.13)
	Yes, 1/2 to 1 hour	3	60	0.93	(0.29 ; 3.00)
	Yes, 1 to 2 hours	2	47	0.80	(0.19 ; 3.27)
	Yes, more than 2 hours	8	67	2.08	(0.97 ; 4.46)

(to be continued)

TABLE 20 : Relative risks (with 95% Confidence Intervals CI) for a sick leave (SL) episode because of low back pain in relation to the qualitative current job-related variables at baseline (n = 716)

Variable	Outcome	SL at t1	No SL at t1	RR	95% CI
Flexion of the trunk (>12 times /hour)	No	10	255	1.00	
	Yes	32	406	1.94	(0.97 ; 3.87)
Rotation of the trunk (>12 times/hour)	No	17	298	1.00	
	Yes	25	364	1.19	(0.66 ; 2.17)
Lifting, pushing, pulling or transportation of loads	No	5	112	1.00	
	Yes	36	558	1.42	(0.57 ; 3.54)
Loads too heavy or too many times lifting, pushing, pulling or transportation of loads	No	19	352	1.00	
	Yes	15	188	1.44	(0.75 ; 2.78)
(Only for those who need to lift, push, pull or transport loads: n = 597)					
Lifting or transportation of loads	No	5	118	1.00	
	Yes	36	550	1.51	(0.61 ; 3.77)
Lifting or transportation of loads > 10 kg	No	12	195	1.00	
	Yes, less than 1 time/hour	11	178	1.00	(0.45 ; 2.22)
	Yes, 1-12 times/hour	12	193	1.01	(0.46 ; 2.19)
	Yes, more than 12 times/hour	6	96	1.01	(0.39 ; 2.63)

(to be continued)

TABLE 20 : Relative risks (with 95% Confidence Intervals CI) for a sick leave (SL) episode because of low back pain in relation to the qualitative current job-related variables at baseline (n = 716)

Variable	Outcome		SL at t1	No SL at t1	RR	95% CI
Lifting or transportation of loads > 25 kg	No		26	352	1.00	
	Yes, less than 1 time/hour		9	172	0.72	(0.35 ; 1.51)
	Yes, 1-12 times/hour		4	125	0.45	(0.16 ; 1.27)
	Yes, more than 12 times/hour		2	10	2.42	(0.65 ; 9.09)
(Only for those who need to lift or transport loads > 25 kg: n = 324)						
Good position of the back		Yes	7	199	1.00	
		No	6	85	1.94	(0.67 ; 5.62)
Loads close to the body		Yes	7	157	1.00	
		No	8	130	1.36	(0.51 ; 3.65)
Important pushing or pulling effort	No		15	309	1.00	
	Yes, less than 1 time/hour		15	185	1.62	(0.81 ; 3.25)
	Yes, 1 time or more/hour		11	171	1.31	(0.61 ; 2.79)
(Only for those with important pushing or pulling effort: n = 385)						
Hindrance because of external elements		No	10	137	1.00	
		Yes	16	214	1.02	(0.48 ; 2.19)
Intensity physical load (Borg-score)	Less than hard		27	436	1.00	
	Hard or more		13	207	1.01	(0.53 ; 1.93)
	Less than very hard		40	598	1.00	

	Very hard or more	0	45	/	/

TABEL 21 : Relative risks (with 95% Confidence Intervals CI) for a sick leave (SL) episode because of low back pain in relation to the qualitative former job-related variables at baseline (n = 716)

Variable	**Outcome**	**SL at t1**	**No SL at t1**	**RR**	**95% CI**
Earlier jobs	No	19	411	1.00	
	Yes	23	259	**1.85**	**(1.02 ; 3.33)**
Driving a vehicle or engine	No	33	593	1.00	
	Yes	9	77	1.99	(0.98 ; 4.01)
Sitting job for long periods	No	37	603	1.00	
	Yes	5	65	1.24	(0.50 ; 3.04)
Standing job for long periods	No	26	565	1.00	
	Yes	15	103	**2.89**	**(1.58 ; 5.29)**
Bent position (>45°) for long periods	No	23	550	1.00	
	Yes	19	118	**3.46**	**(1.94 ; 6.16)**
Flexion of the trunk (>12 times/hour)	No	24	516	1.00	
	Yes	18	151	**2.40**	**(1.33 ; 4.31)**
Lifting or transportation of loads of > 10 kg	No	25	503	1.00	
	Yes	17	164	**1.98**	**(1.10 ; 3.59)**
Lifting or transportation of loads of > 25 kg	No	31	556	1.00	
	Yes	11	112	1.69	(0.88 ; 3.28)

Important pushing or pulling effort	No	29	542	1.00	
	Yes	13	124	1.87	(1.00 ; 3.50)

TABLE 22 : Relative risks (with 95% Confidence Intervals CI) for a sick leave (SL) episode because of low back pain in relation to the qualitative variables of extra-professional load at baseline (n = 716)

Variable	Outcome	SL at t1	No SL at t1	RR	95% CI
Regular sport (at least once a week)	Yes	20	366	1.00	
	No	22	303	1.31	(0.73 ; 2.35)
Embellishment works at home	No	12	269	1.00	
	Yes	28	388	1.58	(0.82 ; 3.05)
Structure of the house	No	31	483	1.00	
	Yes	7	138	0.80	(0.36 ; 1.78)

TABLE 23 : Association of a sick leave (SL) episode because of low back pain with the quantitative psychosocial and psychological variables at baseline (n = 716)

Variable	Outcome	SL at t1 Mean (SD)	No SL at t1 Mean (SD)	Test	p-value
1. MTSK					
(Only for those who have = 25% missing items in total: n = 710)					
MTSK-total score		39.25 (8.00)	38.33 (6.71)	MWU	0.406
2. PCS					
(Only for those who have = 25% missing items in total: n = 710)					
PCS-total score		16.39 (8.90)	14.32 (8.46)	MWU	0.128
3. PANAS					
(Only for those who have = 25% missing items in total: n = 712)					
Score negative affectivity		17.85 (5.71)	18.59 (5.38)	MWU	0.223
Score positive affectivity		35.12 (5.00)	35.12 (5.33)	MWU	0.590
4. NVL					
(Only for those who have = 25% missing items in total: n = 715)					
‘NVL’-total score		53.43 (12.55)	53.82 (12.09)	MWU	0.643

MWU=Mann-Whitney U test
(to be continued)

TABLE 23 (ct'd): **Association of a sick leave (SL) episode because of low back pain with the quantitative psychosocial and psychological variables at baseline (n = 716)**

Variable		Outcome	SL at t1 Mean (SD)	No SL at t1 Mean (SD)	Test	p-value
5.	**JOB CONTENT QUESTIONNAIRE**					
A.		1. Skill discretion	31.05 (5.08)	33.41 (6.36)	MWU	**0.006**
		2. Decision authority	32.98 (6.74)	32.23 (7.07)	MWU	0.487
		1+2. Decision latitude	63.65 (10.31)	65.61 (11.78)	MWU	0.297
B.		Psychological job demands	29.84 (6.30)	32.23 (5.61)	MWU	**0.023**
C.		1. Supervisor support	11.08 (1.79)	11.27 (2.11)	MWU	0.334
		2. Co worker support	12.28 (1.49)	12.47 (1.73)	MWU	0.310
		1+2. Social support	23.45 (2.50)	23.74 (3.16)	MWU	0.349
D.		Job insecurity	9.59 (2.05)	9.33 (2.20)	MWU	0.299
E.		Workload	8.29 (1.79)	8.17 (2.20)	MWU	0.794
F.		1. Hazardous conditions	10.35 (3.52)	10.23 (3.12)	MWU	0.913
		2. Toxic exposure	6.18 (2.06)	6.33 (1.98)	MWU	0.567
		1+2. Hazardous exposure	16.56 (5.17)	16.57 (4.54)	MWU	0.857
G.		Job dissatisfaction	9.73 (2.86)	9.77 (2.85)	MWU	0.913

MWU=Mann-Whitney U test

IV.1.2.4. Predictive value of clinical back examination

This analysis was restricted to the group of workers with clinical examination at baseline and who filled in the follow-up questionnaire one year later (n=776). Tables 24 and 25 present the predictive value of the clinical back examination for the qualitative (table 24) and the quantitative (table 25) variables. Pain at the time of clinical back examination and pain elicited in extension, lateral flexion and buttock palpation were the only qualitative variables statistically related to low back pain. For the quantitative variables, the mean range of lumbar extension was higher for those who developed low back pain (16.90°) than for those who did not (14.82°, p=0.011). However, this last item was not measured reliably among the different examiners.

TABLE 24: Relative risks (with 95% Confidence Intervals CI) between qualitative variables of clinical back examination (CBE) at t0 and a low back episode for a consecutive period of 7 days or more at t1 (n = 776).

Variable at t0	Outcome	N	LBP at t1 N	LBP at t1 %	RR	95% CI
Pain at time of CBE	No pain	768	93	12.1	1.00	
	Pain	5	3	60.0	4.95	**[2.36 ; 10.42]**
Pelvic position	Normal	612	81	13.2	1.00	
	Abnormal	158	15	9.5	0.72	[0.43 ; 1.21]
Scoliosis	No	665	85	12.8	1.00	
	Yes	107	11	10.3	0.81	[0.44 ; 1.46]
Forward bending						
Pain	No pain	756	94	12.4	1.00	
	Pain	11	1	9.1	0.73	[0.11 ; 4.79]
Fingertip to floor	No	215	23	10.7	1.00	
	Yes	557	73	13.1	1.23	[0.79 ; 1.91]
Extension	No pain	720	83	11.5	1.00	
	Pain	37	9	24.3	2.11	**[1.16 ; 3.86]**

(to be continued)

TABLE 24: Relative risks (with 95% Confidence Intervals CI) between qualitative variables of clinical back examination (CBE) at t0 and a low back episode for a consecutive period of 7 days or more at t1 (n = 776).

Variable at t0	Outcome	N	LBP at t1 N	LBP at t1 %	RR	95% CI
Lateral flexion						
Right	No pain	759	92	12.1	1.00	
	Pain	12	4	33.3	2.75	**[1.21 ; 6.25]**
Left	No Pain	761	92	12.1	1.00	
	Pain	9	4	44.4	3.68	**[1.73 ; 7.81]**
Single Straight Leg Raising						
Right	No Pain	261	36	13.8	1.00	
	Pain	512	60	11.7	0.85	[0.58 ; 1.25]
Left	No Pain	273	39	14.3	1.00	
	Pain	499	57	11.4	0.80	[0.55 ; 1.17]

(to be continued)

TABLE 24: Relative risks (with 95% Confidence Intervals CI) between qualitative variables of clinical back examination (CBE) at t0 and a low back episode for a consecutive period of 7 days or more at t1 (n = 776).

Variable at t0	Outcome	N	LBP at t1 N	LBP at t1 %	RR	95% CI
Hip mobility	Not painful or not retricted	724	89	12.3	1.00	
	Painful or restricted	45	5	11.1	0.90	[0.39 ; 2.11]
Pain on palpation						
Spinal-interspinal	No pain	707	84	11.9	1.00	
	Pain	61	11	18.0	1.52	[0.86 ; 2.69]
Paraspinal ri	No pain	735	91	12.4	1.00	
	Pain	32	4	12.5	1.01	[0.40 ; 2.58]
Paraspinal le	No pain	737	90	12.2	1.00	
	Pain	31	5	16.1	1.32	[0.58 ; 3.01]
Buttock	No pain	466	50	10.7	1.00	
	Pain	13	5	38.5	3.58	**[1.72 ; 7.46]**
Thoracolumbar rotation	Not painful or not retricted	690	84	12.2	1.00	
	Painful or restricted	79	11	13.9	1.14	[0.64 ; 2.05]
Neurological examination						
Sensory and motorial	Normal	744	91	12.2	1.00	
	Abnormal	27	4	14.8	1.21	[0.48 ; 3.06]
Strenght back extensors	30 sec	643	76	11.8	1.00	
	10 – 29 sec	94	14	14.9	1.26	[0.74 ; 2.14]

< 10 sec	29	4	13.8	1.17	[0.46 ; 2.97]

TABLE 25: Association between quantitative variables of the clinical back examination (CBE) at t0 and low back pain (LBP) for a consecutive period of 7 days or more in the first year of follow-up (n=776)

Variable at t0	LBP at t1		No LBP at t1		
	n	Mean (SD)	n	Mean (SD)	p-value
Forward bending					
Fingertip to floor distance (cm)	96	2.83 (5.88)	674	3.00 (5.48)	0.471
Extension					
Range of lumbar extension (°)	96	16.90 (9.10)	675	14.82 (8.74)	**0.011**
Lateral flexion					
Range right (cm)	96	25.40 (4.80)	675	24.34 (4.42)	0.072
Range left (cm)	96	25.38 (5.06)	675	24.48 (4.41)	0.075
Single Straight Leg Raising					
Maximum SSLR right (°)	94	94.60 (13.12)	671	92.27 (11.82)	0.320
Maximum SSLR left (°)	94	95.15 (13.78)	669	92.66 (11.97)	0.278

(to be continued)

TABLE 25: Association between quantitative variables of the clinical back examination (CBE) at t0 and low back pain (LBP) for a consecutive period of 7 days or more in the first year of follow-up (n=776)

Variable at t0	LBP at t1		No LBP at t1		
	n	Mean (SD)	n	Mean (SD)	p-value
Double Straight Leg Raising					
SLR with both legs (°)	93	94.39 (17.28)	667	93.31 (11.98)	0.753
Hamstrings					
Range right (°)	94	84.47 (9.10)	653	83.29 (9.33)	0.207
Range left (°)	93	84.52 (8.48)	654	83.22 (9.27)	0.258

IV.1.3. Validation of the physical workload questionnaire

Table 26 focuses on the 11 questionnaire variables whose answering modality is dichotomic (yes/no). Agreement tests are presented (Kappa at $p<0.05$ level and full agreement percentage) between direct observation and the questionnaire and between observer and worker judgments. The sample size of these tests includes 147 workers for which work activities have been observed. The third section of the table concerns reproducibility tests between the questionnaire given at t0 and the same questionnaire filled in on average 17 ± 4 month later by the observed workers; the 71 participants who did not change function during this period are included in the sample of this test.

Concerning the questionnaire validation, the variation in population size between questions is related to the content of the question; for instance, only 76 workers had to push or pull loads during the observation periods. It must be noticed that 5 subjective questions (non measurable by observation) could not be validated by this method. The table shows that Kappa values are always higher when the questionnaire is compared to the observer judgment than when it is compared to observations. No Kappa values can be judged as excellent. The best values concern manual handling activities and particularly load lifting and carrying. Concerning subjective questions where worker opinion is compared to the observer one, agreement is acceptable for the perceived constraint associated to the manual handling of loads (Q51) and the ability to hold the charge close to the body (Q48). However, agreement is weak for the quality estimation of the manual handling posture (Q49) and the difficulties of the pushing/pulling activities (Q50) because of an external element. Concerning postural constraints, the agreement is acceptable for frequent bending in the validation test against observer judgment but is poor when compared to observations. Agreement for rotation is poor in both cases. Concerning the static postures, agreement between worker and observer opinion is satisfactory for the prolonged sitting position but poor when worker opinions are compared to observations. There is no good agreement for standing position; however, the ability to vary posture shows a fair to good agreement.

Concerning reproducibility tests, variations in population size are explained by non-answered items by the worker in one of both questionnaires. Results are relatively similar to the validation tests: reproducibility is good for manual handling tasks evaluation and particularly for the lifting/carrying tasks. Subjective questions concerning manual handling show a low reproducibility except for the quality estimation of the manual handling posture and the difficulties of the pushing/pulling activities because of an external element (Kappa value almost satisfactory). Frequent trunk bending shows an acceptable Kappa whereas agreement is low for trunk rotation. Postural immobility also shows an acceptable agreement for prolonged sitting work and the ability to vary posture while agreement is poor for standing work without moving.

Table 27 concerns the 8 variables whose answering mode was ordinal. In this case, a Spearman rank correlation coefficient has been calculated for the 3 tests and Kappa coefficients have been calculated not only for the scales as used in the questionnaire but also for reduced scales (3 point and dichotomous scales). As shown by the table, this scale reduction is associated with an increasing Kappa and a better agreement percentage.

Concerning questionnaire validation against direct observation, all values are unsatisfactory and even non-significant except driving a vehicle that presents a satisfactory to excellent agreement when the scale is reduced. For vehicle driving, similar results are found against observer judgment. Concerning the holding of trunk bended posture, agreement with observer judgment is close to satisfaction for a dichotomous classification; for the flexion/rotation association the level of agreement remains insufficient in all cases. For lifting a charge > 10kg agreement becomes acceptable at a 3 point scale and is good for a dichotomous scale; however, levels of agreement are always unsatisfactory for > 25kg charges. Pushing/pulling a load presents an agreement already satisfactory at a 3-point scale. The other tasks with high physical exertion remain non-significant in this test. Finally, the 10 points Borg scale shows a good Spearman coefficient.

Concerning reproducibility tests, the driving activity shows a good to excellent reproducibility. The trunk flexion holding presents an already satisfactory reproducibility for the 3 points scale; yet, the flexion/rotation association is poorly reproducible. Concerning manual handling of loads, reproducibility is fair to good for > 25 kg charges while it is insufficient for charges of 10 kg or more. Reproducibility of pushing/pulling effort is almost satisfactory. Other tasks than manual handling with high physical exertion present an acceptable agreement at a 3-point scale and becomes fair to good if answering modality is dichotomous. Finally, Borg scale presents a lower Spearman correlation coefficient than with the validation against observer judgment test.

Table 26: Agreement tests for dichotomous variables (Kappa at p<0.05 level and full agreement percentage) between direct observation and the questionnaire, between observer and worker judgments, and between the baseline questionnaire and the same questionnaire filed up 17 ± 4 month later.

Variables	Questionnaire compared to Observation			Questionnaire compared to Observer judgment			Questionnaire t0 compared to 2nd Questionnaire		
	n	Kappa	Full %	n	Kappa	Full %	n	Kappa	Full %
Work a long time in a sitting position ? (Q34)	147	0.29	69	147	0.52	78	69	0.49	83
Standing a long time (without walking) ? (Q35)	147	NS	NS	147	0.25	57	69	0.22	65
Ability to vary posture ? (Q36)	147	NA	NA	147	0.47	93	70	0.45	91
Frequent trunk bending (more than 12 time per hour) ? (Q41)	147	0.33	73	147	0.55	80	69	0.49	77
Frequent trunk rotation (more than 12 time per hour)? (Q42)	147	0.15	52	147	0.34	65	70	0.26	63
Manual handling (lifting. carrying, pushing or pulling a load) ? (Q43)	147	0.51	87	147	0.65	90	70	0.66	90
Lifting or carrying charges ? (Q44)	147	0.56	88	147	0.68	90	70	0.59	87
Good posture while lifting or carrying a load ? (Q47)	115	NA	NA	115	0.28	63	36	0.37	72
Load close to the body while lifting or carrying ? (Q48)	115	NA	NA	115	0.46	73	38	0.32	68
Efforts of pushing/pulling more difficult because of an independent element of the load ? (Q50)	76	NA	NA	76	0.17	50	33	0.37	73
Is the load (to lift, carry push or pull) excessive because of his weight or handling frequency ? (Q51)	117	NA	NA	117	0.49	75	51	0.29	65

NA= Non Available; NS = Non Significant

Table 27: Agreement tests for ordinal variables (Spearmann's rank coefficient, Kappa at p<0.05 level and full agreement percentage) between direct observation and the questionnaire, between observer and worker judgments, and between the baseline questionnaire and the same questionnaire filed up 17 ± 4 month later.

Variables	Classification	Questionnaire compared to Observation				Questionnaire compared to Observer judgment				Questionnaire t0 compared to 2nd Questionnaire			
		n	r_s	Kappa	Full %	n	r_s	Kappa	Full %	n	r_s	Kappa	Full %
Work with the trunk bended (> 45°) during a long period ? (Q 37-38)	5 point duration scale	147	0.39	0.09	27	147	0.5	0.14	33	71	0.35	0.22	44
	3 point duration scale			0.11	31			0.29	55			0.4	68
	Dichotomous scale			0.23	64			0.4	71			0.52	76
Work with the trunk bended and twisted during a long period? (Q 39-40)	5 point duration scale	147	NS	NS		147	0.4	0.18	46	69	0.35	0.17	51
	3 point duration scale			NS				0.22	50			0.31	62
	Dichotomous scale			NS				0.35	67			0.31	66
Lifting or carrying charges > 10 kg? (Q45)	4 point frequency scale	147	0.4	0.21	44	147	0.6	0.39	55	71	0.29	0.31	50
	3 point frequency scale			0.28	52			0.41	60			0.31	53
	Dichotomous scale			0.34	66			0.66	84			0.34	72
Lifting or carrying charges > 25 kg? (Q46)	4 point frequency scale	146	0.16	NS		146	0.4	0.26	61	61	0.73	NA	NA
	3 point frequency scale			NS				0.26	61			0.61	75
	Dichotomous scale			NS				0.34	69			0.67	84
Other tasks with high physical exertion? (Q52-54)	4 point frequency scale	147	NS	NS		147	NS	NS		67		0.33	79
	3 point frequency scale			NS				NS				0.33	79
	Dichotomous scale			NS				NS				0.49	85
Driving a vehicle or device? (Q33)	4 point duration scale	147	0.93	0.47	69	147	0.9	0.61	78	70	0.84	0.59	77
	3 point duration scale			0.73	86			0.72	85			0.67	83
	Dichotomous scale			0.93	97			0.94	97			0.82	91

High physical exertion to push/pull a load ? (Q49)	3 point frequency scale	147	0.33	0.21	52	147	0.6	0.44	62	55	0.45	0.4	60
	Dichotomous scale			0.25	61			0.57	80			0.38	74
Perceived general exertion? (Q55)	Borg in 10 points	NA				147	0.72	NA	NA	68	0.54	NA	NA

IV.2. Ergonomic aspects

IV.2.1. Observation evaluation

Table 28: **Participation in ergonomic observations**

	Distribution sector		Hospitals		Home care services	**Total**
	Wallonia	Flanders	Wallonia	Flanders	Wallonia	
Workers at t_0	23	282	218	324	39	972
Workers at beginning of observations	23	251	206	288	29	884
Observed workers	6	42	46	44	16	154
Sampling rate	26%	16.7%	22.3%	15.3%	55.2%	17.4%

Table 28 shows that a total of 154 workers have participated to the ergonomic observations; these were carried out during 85 days between 25th of February 2002 and 17th of January 2003.
The total number of workers included in the cohort at t0 (n=972), does not correspond to the arithmetic sum of the 5 columns, because 86 workers of a Flemish hospital must be added. No observations have been made for these workers because the functions with other hospitals having a larger sample size, were about similar.

IV.2.2. Descriptive statistics

The descriptive statistics are presented in figures 1 to 3 of Appendix 2. For each sector, the graph shows for each HOG and for each variable the average frequency (expressed in percentage) of coded data. As shown by the three graphs, some variables discriminate very little between the various HOG's. From these observations, it was clear that a reduction in the variables to be taken into account in the outcome model was needed (see III.2.3.3.1.).

IV.2.3. Relationship between biomechanical factors and the occurrence of low back pain

Table 29 presents for the 9 selected variables the relative risks (RR) related to worker exposure level following the methodology described in section III 2.3.3.3. For the rotation constraint, the RR calculation could not have been realised because among non-exposed worker nobody had suffered from LBP. Yet, it is to be noted that 16% of the 790 exposed subjects suffered from LBP during the first 12 month of follow-up (evaluation at t1). An increased risk of developing a LBP episode is associated with exposures to postures with the trunk bended more than 20° forward (RR=2.59).

Table 29. **Relative risks (RR) and 95 % confidence interval (95% CI) for the 9 exposure variables related to workers' exposure level.**

Variable	**Classification**	**RR**	**95 CI%**
Driving in a sitting position	>35.5% vs 0	0.75	[0.36;1.59]
Sitting position (except driving)	>62.9% vs <27.4%	1.07	[0.49;2.29]
Trunk flexion > 20°	**>17.8% vs <7.1%**	**2.59**	**[1.47;4.59]**
Trunk flexion > 20° with a load	>7.1% vs <2.4%	1.55	[0.86;2.77]
Trunk rotation	>7.9% vs 0	NA	
Trunk flexion > 20° and rotation with a load	>1.4% vs 0	2.02	[0.73;5.61]
Lifting/carrying = 1kg	>23.7% vs <8.1%	1.54	[0.62;3.83]

Lifting/carrying = 10kg	>3.4% vs 0	2.03	[0.87;4.74]
Pushing/pulling = 1kgF	>8.3% vs 0	0.93	[0.23;3.75]

Table 30 presents RR related to workers' distribution comparing workers of the 4th quartile of exposure to those of the 1st quartile. Trunk flexion >20° also presents an important and significant relative risk for LBP; this risk remains significant when this postural constraint is associated to the handling of a load. These results strongly suggest a protective effect of sitting position. the RR value (0.57) being almost significant.

Table 30: Relative risks (RR) and 95 % confidence interval (CI 95%) for the 9 exposure variables related to workers' distribution.

Variable	**Classification**	**RR**	**CI 95%**
Driving in a sitting position	>P75 vs <P25	1.35	[0.92;1.96]
Sitting position (except driving)	>P75 vs <P25	0.57	[0.33;1.01]
Trunk flexion > 20°	**>P75 vs <P25**	**2.36**	**[1.35;4.15]**
Trunk flexion > 20° with a load	**>P75 vs <P25**	**1.97**	**[1.13;3.44]**
Trunk rotation	>P75 vs <P25	1.84	[1.04;3.24]
Trunk flexion > 20° and rotation with a load	>P75 vs <P25	1.68	[0.98;2.89]
Lifting/carrying = 1kg	>P75 vs <P25	1.49	[0.86;2.58]
Lifting/carrying = 10kg	>P75 vs <P25	1.57	[0.89;2.77]
Pushing/pulling = 1kgF	>P75 vs <P25	1.22	[0.75;2.03]

V. DISCUSSION

V.1. Discussion including social-economic consequences

In this part we sumarize the most obvious findings and compare these with other study results.

V.1.1. Epidemiological aspects

V.1.1.1. Risk factors for low back pain after one year of follow-up: results of univariate analyses

V.1.1.1.1. Individual factors

Five individual characteristics were statistically related to the occurrence of low back pain in the first year of follow-up:

- History of low back pain and sick leave due to low back pain in the year before the start of the study
- Musculoskeletal comorbidity of the upper part of the back, the wrists or hands, or the knees in the twelve months before the start of the study
- Poorer perceived general health
- Sick leave and medical care seeking in the twelve months before the start of the study
- Pain-related fear (as measured by Tampa scale of kinesiophobia)

It must be underlined that the study design aimed at decreasing the effect of prior episodes of low back pain, and therefore workers who had suffered from low back pain for seven consecutive days or more during the past year were excluded. Despite this exclusion criterion, more than half of the study sample reported low back pain ever and 45% even suffered from minor low back pain in the year before intake. From the literature, it is known that a prior history of low back disorders, the length of time since the last low back episode, the duration of work absence, a history of treatment for pain or chiropractic visits, previous laminectomy, previous sciatica, and the number and frequency of previous low back episodes are related to future reports of low back pain (Dempsey et al 1997). The results of the present study are in agreement with those observations.
As in other studies, musculoskeletal complaints in other body regions were statistically associated with future low back pain. This association may reflect (a) jobs in which risk factors for low back pain and for other musculoskeletal complaints are present simultaneously, (b) a higher susceptibility of some subjects for musculoskeletal complaints, or (c) a higher tendency of some subjects to report musculoskeletal pain.

Previous epidemiological studies have shown a relationship between poor perceived health status and low back pain. In a recent prospective cohort study in scaffolders, Elders et al. (2003) also found a similar association. It can be hypothesised that a poor health status makes a worker more vulnerable for musculoskeletal pain (Elders et al submitted). Sick leave and medical care seeking may be associated with poor general health.

In a population-based cohort of the general Dutch population, a high level of pain catastrophizing or kinesiophobia predicted low back pain with disability during follow-up in subjects without low back pain at baseline (Picavet et al 2002).

V.1.1.1.2. Physical factors

Physical factors in the current function

For the physical variables in the current function, moderately elevated risks of low back pain occurence were observed for:

- Working with the trunk in bent and twisted position for more than two hours a day,
- Inability to change posture regularly,

- The perception of hard work,
- Manual materials handling:
    - The perception of having to handle too heavy loads or to handle loads too frequently,
    - Pushing or pulling at least once every hour,
    - Lifting or transportation of loads more than 25 kg more than 12 times per hour.

Sitting or standing for long periods and exposure to whole-body vibration were not statistically related to low back pain.

With the exception of whole-body vibration exposure, these results are in agreement with recent epidemiological reviews on work-related physical factors as summarized in the following table.

Risk factor	**NIOSH 1997**	**Burdorf 1997**	**Hoogendoorn 1999**
Bending and twisting/ awkward postures	evidence	strong evidence	strong evidence
Manual materials handling, forceful movements, lifting	strong evidence	strong evidence	strong evidence
Patient handling	_	_	moderate evidence
Heavy physical work	evidence	_	moderate evidence
Standing or walking	no evidence		
Sitting	no evidence		
Whole-body vibration	strong evidence	strong evidence	strong evidence

(Hoogendoorn et al 1999, Burdorf et al 1997, Bernard 1997)

For the lack of an effect of exposure to whole-body vibration, we can put forward two hypotheses:

- Whole-body vibration has been shown to be a risk factor among occupational drivers. In our population, this exposure was present only in workers driving forklifts or transpalets and in workers driving trucks for a short time in the two participating distribution companies and in nurses driving cars in the home care sector. Thus, the exposure to whole-body vibration in our population was quite heterogeneous and not comparable to the exposure in studies were an effect was shown.

- The exposure was mainly present in the distribution companies, but (almost) not in the health care sector. Thus, the reference group with no exposure to whole-body vibration consisted (almost) completely of workers from the health care sector. Since both sectors may be quite different with respect to other risk factors, multivariate analyses need to be performed.

In addition, some experts argue that it may be premature to conclude that whole-body vibration per se is a risk factor for back pain. Whole-body vibration may not represent the crucial exposure because sudden starting and stopping, the transmission of road shocks, the lack of proper support for the back, and the position of the driver's leg simultaneously induce mechanical stresses on the lower back. Manual handling of materials and a lack of activities strengthening both musculature and connective tissues may also contribute to back complaints among occupational drivers (Heliövaara 1999).

For lifting or transportation of loads, a significant elevated risk was observed only for the highest exposure category: lifting or transportation of loads more than 25 kg more than 12 times *per hour*. For the other exposures, the relative risks were moderately elevated, but non-significant and there was no evidence for a dose-response relationship.
In comparison with for example the SMASH-study in which elevated risks were observed for workers lifting at least 25 kg more than 15 times *per working day*, the exposure at which we observed elevated risks is very high.
(Hoogendoorn et al. 2000)

- One explanation may be the choice of our study-population and our inclusion criteria. Our participants were recruited among the employees of health care institutions and distribution companies. Both sectors are known for their heavy physical workload. Consequently, only 'stronger workers' will start working in these jobs (possible bias due to self-selection). From this group of 'stronger' workers, we only included those with no severe episodes of low back pain. Thus again, the more susceptible were excluded.
- Another explanation may be misclassification bias: as shown in the validity study, the reliability of self-reported workload was low when estimating weight or frequencies (and workers tend to overestimate their exposure). The workers who reported lifting or transportation of loads more than 25 kg more than 12 times an hour all belong to one company. In this company, the ergonomic observations at the workplace showed that the weight of almost all loads is lower than 25 kg, but that handling frequency is often much higher than 12 times an hour. The overestimation of self-reported workload may indicate that the risk already exists at lower exposures, but may also be due to confounding by other factors. If this is the case, multivariate analyses may clarify what is going on.
- From a statistical point of view, the significant effect on low back pain should be interpreted with care as:
  - the group of workers reporting such high exposures was very small (n=13);
  - since many variables were tested, we have to be aware of the problem of multiple testing. The variable lifting or transportation of loads as a whole was found reliable but not statistically related to low back pain (p=0.430).

For the lower exposures, the relative risks were moderately elevated, but non-significant and there was no evidence for a dose-response relationship.

- On the one hand, it may be that there is some kind of threshold (in our case more than 25 kg more than 12 times per hour), above which the risk tends to increase dramatically.
- On the other hand, possible misclassification bias has to be taken into account. As mentioned above, the validity of self-reported physical workload is low: questionnaires offer the possibility to investigate many subjects at a reasonable cost, but most estimates of external exposure are imprecise and inaccurate (Van der Beek et al 1998). Since our questions on manual materials handling were rather detailed, possible misclassification bias has to be taken into account. Non-differential misclassification leads to a dilution of an effect and, as explained above, to lower relative risks, a possible lack of a dose-response relationship and a diminution of the power to show a significant effect.

Physical factors in the past jobs
Workers with past jobs or functions proved to be at risk for reporting future low back pain. Of the eight queried physical factors in past jobs, five were statistically significant. Moderately elevated risks were observed for:

- Exposure to whole-body vibration;
- Standing for long periods;
- Working with the trunk in awkward positions;
- Lifting or transportation of loads of more than 10 kg. For lifting or transportation of loads of more than 25 kg the risk was lower, but the result was not significant.

Our study population consisted of young workers (mean age of 26 years) and 41% of them performed jobs before the actual one. Surprisingly, a substantial part of those past physical exposures were associated with low back pain. However, the interpretation of these findings is not clear:
The reliability of the data collected in the baseline questionnaire about past exposures may be compromised to a great extent by recall bias.
The association between former jobs and future low back pain may reflect the importance of cumulative exposure. It may also reflect that these young workers were exposed to more hazardous conditions in the past, at the start of their professional activities (e.g. interim work, etc.).

Physical factors during leisure time
Neither sports nor other activities during leisure time were statistically related to the occurrence of low back pain. This is in agreement with the review of Hoogendoorn et al. (1999) where no evidence was found for sports and total leisure-time physical activity.

V.1.1.1.3. Psychosocial factors
Of the psychosocial variables in the Demand-Control-Support model of Karasek and Theorell, only lower possibilities to develop skills turned out to be predictive for low back pain. Concerning the association between psychosocial work characteristics and low back pain, epidemiological reviews show rather heterogeneous results:
- Bongers et al. (1993) concluded that there is evidence for monotonous work or poor work content and poor support by colleagues as risk factors for back pain.
- Burdorf and Sorock (1997) concluded that job dissatisfaction and monotonous work were important factors.
- Bernard (1997) showed that there was evidence for intensified workload as a risk factor, and limited evidence for low job control and job dissatisfaction.
- In 2000, Hoogendoorn et al. published a systematic review of psychosocial factors at work in relation to low back pain. In this review, only cohort and case-control studies were included. Although they found evidence for an effect of low workplace social support and low job satisfaction, they conclude that, based on their review, there is evidence for an effect of work-related psychosocial factors, but the evidence for the role of specific factors has not been established yet (Hoogendoorn et al 2000).

V.1.1.2. Risk factors for sick leave due to low back pain after one year of follow-up: univariate analyses.

Although 36.9 % of the workers developed low back pain that lasted for longer than 1 day during the first year of follow-up, only 5.5% stayed at home because of low back pain. This suggests that a substantial proportion of workers continued working while experiencing pain (Frank et al. 1996). However, since data on sick leave were based on self-reports rather than sickness absence registries, some underreporting may have occurred (Burdorf et al. 1998).

V.1.1.2.1. Individual factors
The following individual characteristics were statistically related to the occurrence of sick leave due to low back pain in the first year of follow-up:
- Poorer perceived general health;
- Obesity;
- Interruption of activities because of low back pain in the twelve months before the start of the study;
- Musculoskeletal complaints in the wrists or hands in the twelve months before the start of the study;

- Having children;
- Sick leave and medical care seeking in the twelve months before the start of the study.

In contrast with the literature (Tubach F.), a history of low back pain was not related to sickness absence. This may be due to the exclusion of workers with severe antecedents of low back pain in the year before the study. For low back complaints more than 12 months before the start of the study, an elevated, and nearly significant risk was observed. Musculoskeletal morbidity of the wrists or hands was associated with low back pain and with sick leave due to low back pain. As discussed in the previous section, it seems unlikely that this association is causal. Sick leave in the year before the start of the study was predictive for future sick leave. Thus, workers with absence due to musculoskeletal pain seem to be at higher risk of subsequent sickness absence in the following year (Burdorf et al. 1998). Estimates of the recurrence rates of absence from work due to low back pain vary between 20 and 44% (Frank et al. 1996).

The association between sick leave and obesity seems to confirm the results of previous cross-sectional studies of IDEWE (Mylle et al. 1998, Moens et al. 1999). Based on data from IDEWE, these authors found an increasing prevalence of sick leave with increasing BMI.

V.1.1.2.2. Physical factors

Physical factors in the current function and during leisure time

For the physical variables, exposures to whole-body vibration at work and during leisure time were statistically related to sick leave. Epidemiological studies have identified several physical factors as risk factors for sick leave: working with the trunk in awkward postures (Hoogendoorn et al. 1999, Tubach et al. 2002), lifting (Hoogendoorn et al. 2000), and harmful biomechanical loads (Wickstrom et al. 1998).

There seems to be no evidence for whole-body vibration as a risk factor. Although related to sick leave in our study, whole-body vibration was not related to low back pain itself. Since both whole-body vibration at work and during leisure time were associated with sick leave in our study, it seems less likely that these associations are due to multiple testing. These may be the result of confounding by other factors. In this case, multivariate analyses may clarify the matter.

V.1.1.2.3. Psychosocial factors

For the psychosocial variables model, lower possibilities to develop skills and lower psychological job demands were related to sick leave. In the literature, various psychosocial factors have been found to be related with sick leave: low job satisfaction (Hoogendoorn et al. 2002), low social support (Hoogendoorn et al. 2000, Tubach et al. 2002), a lack of recognition and respect at work (Wickstrom 1998), and low decision latitude (Hemingway et al. 1997). In a 3-year follow-up study among scaffolders, psychosocial factors did not predict the occurrence of LBP sickness absence (Elders et al. 2003). Since decision latitude is a combined measure of decision authority and skill discretion, our results are in agreement with the study of Hemingway et al. The association between sick leave and low psychological demands seems strange. We have two hypotheses:

- On the one hand, the association might indicate that our workers feel bored because demands are too low. Since participants were recruited in health care institutions and distribution companies, both sectors known for high demands, this explanation seems unlikely.
- On the other hand, since psychosocial factors were ascertained with a questionnaire, it may be that not low psychological demands, but a perception of low demands is a risk factor for sick leave. Workers, who feel they are able to cope with the demands of their job, will not fill in that their job demands are too high. In this case, the association may reflect young and motivated workers who think they can cope with the job and maybe overestimate themselves.

Conclusion

Based on univariate analyses, individual factors seem predominantly associated with sick leave. We found only limited evidence for work-related risk factors. Since very few workers (n=44, 5.5% of the study population) reported sick leave due to low back pain, the power to reach significant results may be limited.

V.1.1.3. Validation of the physical workload questionnaire

V.1.1.3.1. External validity

The pattern of agreement between the data collected through the questionnaire and the observations fits to results of other studies (Campbell et al. 1997; Pope et al. 1998; Rossignol and Baetz 1987; Torgen et al. 1999; Wiktorin et al. 1993) (see II.1.2.6.). Dichotomous variables show a better agreement than ordinal variables. Agreement is stronger for well-defined activities such as vehicle driving, manual handling without estimation of weight and frequencies, or trunk flexion compared to the flexion/rotation association. Concerning weight estimation of handled loads, Kappa values are better for the lightest weight category (more than 10 kg).

However, in contradiction with the literature, there is a poor agreement between questionnaire and observation for static postures (prolonged sitting posture and immobile standing position). This observation could be explained by the fact that a 2 hours cut-off was selected to divide the observed worker into exposed and non-exposed subjects while no duration limit was formulated in the questionnaire.

Moreover, the agreement values between observed and self-reported activities found in the present study are generally lower than in other validation studies. Two hypotheses may be put forward: first, the evaluation period "the day of today if it is a typical workday" may have been wrongly interpreted by some workers as an average working day. Second, the circumstances for completing the questionnaire have varied: while a majority of observed workers have answered the questionnaire at their workplace at the end of the shift, some workers have taken the questionnaire home to deliver it the next day.

V.1.1.3.2. Reproducibility of the questionnaire

Concerning the reproducibility test, results are also in agreement with the literature (Torgen et al. 1997; Torgen et al. 1999; Wiktorin et al. 1996) (see II.1.2.5.). Reproducibility is good for whole body vibration exposure, better for trunk flexion without combination to rotation and better for the heaviest loads. However, whereas prolonged sitting position was expected to show the best agreement according to literature, the reproducibility of the sitting position estimation was rather poor in the present study. This may be due to the fact that no precise cut-off values have been proposed in the questionnaire and that the worker had to interpret the "prolonged" term to qualify his exposure.

Moreover, in this reproducibility study, agreement values are also a little weaker than in other studies. This could be ascribed to the fact that, in the baseline questionnaire, the worker was invited to complete the questionnaire when thinking of "a typical working day" while in the questionnaire submitted at the end of the observation day he had to have in mind "the present workday, if it is a typical workday". For instance, how can for the 13 polyvalent workers who were included in the reproducibility study, be estimated whether their conception of "a typical workday" at baseline can be compared to the activities carried out on the observation day, even if they stated that it was a typical workday?

V.1.1.3.3. Conclusions and guidelines

Important efforts have been devoted in this study for designing a physical workload assessment questionnaire and to validate it. The observation collected in the validation study may now be used to propose some guidelines for a further use of such an evaluation tool. First of all, exposure to vibration was well estimated by workers when using a 3 points scale (no, yes less than 2 hours, yes more than 2 hours); the 6 hours cut-off should thus be dropped.

Concerning the evaluation of static postures, the choice not to propose a duration cut-off seemed inefficient. However, the subjective question concerning the ability (of not) to vary posture showed a good agreement in both the validation against observer judgement test and the reproducibility test. This question has to be kept.

Concerning postural constraints, the combination of flexion/rotation is apparently difficult to be perceived by the worker and this was also noticed in other studies. Moreover, using a

frequency scale did not bring about more accurate and valid data. No proposal can be put forward to address this limitation in the subject own movement perception, but combining different trunk postures in a single question should be avoided.
Concerning manual handling, using in the same time a weight limit and a frequency scale is surely asking too much information in the same question. However, it has to be underlined that subjective assessment like perceived intensity of manual handling or the Borg scale showed a good agreement between observer and worker opinion.
In summary, the following guidelines can be drawn from this validation study: first of all, subjective questions concerning worker perceptions although seldom used in such a questionnaire, are to be recommended. The exposure variable must be well defined in the question formulation. A dichotomous answering mode provided a better validity and reproducibility but some remarks concerning the use of a cut-off value must be stressed. In the question where answering can be "yes" or "no", the use of a single cut-off value will automatically divide subjects into exposed (those over cut-off) and less exposed (those under the cut-off) subjects. So, no difference can be made between "non exposed" subjects and subjects exposed under the cut off value. Hence, when using a cut-off value such as an exposure frequency or duration, answering modality should consist of a 3 points scale: no, yes under cut-off, yes over cut-off. However, a cut-off point considered as the exposure limit, such as the weight of handled loads or the trunk flexion amplitude, could remain in the question formulation

V.1.2. Ergonomic aspects

Relationship between observed biomechanical factors and the occurrence of low back pain during the first year of follow-up

According to the literature review about biomechanical risk factors of low back pain, strong evidence is demonstrated for a positive effect of manual handlings of loads, bending and twisting postures and exposure to whole body vibration. Inconsistent results were found for the effect of a prolonged sitting position.
The present study confirms these conclusions with regard to bending and twisting postures but not for the other risk factors. Whole body vibration exposure had no effect on LBP outcome in this study but this can be related to the fact that only a minority of the workers in the cohort were exposed for long periods (mostly in the distribution sector). In addition, the exposed workers were driving vehicles with different engine types (thermic or electric) and thus with different exposure characteristics.
The absence of a relationship between the health outcome and manual handling was not expected and differs from the association found when considering self-reported handling activities. Non significant results for lifting more than 10 kg loads could be ascribed to a possible underestimation of the true exposure to manual handling; in fact, in some tasks characterised by a very short cycle time, the actual handling frequency could not be accurately measured because of the 15 seconds sampling interval used in the observation protocol.
Finally, the observed protective effect associated to working in sitting position must be interpreted with caution as the exposure assessment methodology did not allow measuring a continuous duration in the sitting position but only a cumulative exposure to this variable.

V.1.3. General limitations of the study

Apart from the epidemiological and ergonomic limitations discussed before, some general limitations of the study have to be summarized when interpreting the findings. These limitations relate especially to selection bias, observation bias and confounding.

First, our sample is not representative for the working population as a whole and even not for the young health care neither for the young distribution workers. Within the inclusion criteria, selection was avoided in the sampling procedure but due to practical and logistic constraints no real random sampling could be performed. Moreover, the healthy worker bias has been mentioned before and the rationale for the selection of young relatively pain free workers has been argued. Extrapolation of these results should therefore be done with caution.

Observation bias could occur on numerous occasions and its effect has been discussed before: at the exposure assessment, in the recall of back pain or the reporting of other characteristics, in the observer variation in clinical back abnormalities etc.

Confounding will be dealt with in multivariate analyses but due to time constraints, only univariate results have been presented.

V.2. Future prospects

A large amount of new information became available through the collection of data in this study. The prospective nature of the study design, the ergonomic validation of the exposure data, the choice of a young, relatively pain free study population and the inclusion of psychological variables make this study unique. Although several studies on back pain have already been performed in the past, risk factors and their impact still remain unclear. This can partially be attributed to the complexity of the problem, and partially to the weakness of many studies.

Our study can be an asset to this problem, and companies are expected to benefit from the results. Especially in assessing the predictive value and the relative impact of preventable determinants of low back pain incidence, sick leave, severity and recurrence among pain free and young workers, the results should help occupational health professionals to direct preventive efforts more precisely.

The cooperation between the different research centers, each with its own specific expertise working together in one multidisciplinary team offers the opportunity of thoroughly studying the multifactorial determinants.

Valorisation of the results

Several participants have presented or are preparing publications, lectures or other presentations, presenting results in their own field (epidemiological, ergonomic and psychological). Finally, attempts will be made to produce multidisciplinary publications, lectures and presentations. These will be addressed as well to the scientific and professional communities as to the lay public.

As a matter of fact, results per company will be reported to each participating company and the practical consequences will be discussed.

Funding for this study has stopped at the end of September 2003. This means that analysis of the second follow-up moment (t2) will have to be performed after discontinuation of the financing or with new funds to be pursued. Expected results however can be very important for the implementation of preventive measures in companies. For example, the determinants of sick leave, recurrence and chronicity of pain, and the interaction between physical, psychosocial and psychological characteristics still have to be analysed in a multivariate way.

In the future, one could also monitor specific subgroups within this cohort (e.g. chronic or recurrent LBP sufferers) and perform more precise analyses taking into account changes over time in the predictive factors.

Low back pain constitutes a large, expensive and complex multifactorial problem. Identification of specific, modifiable factors causally associated with low back pain constitutes the key to an effective prevention and intervention policy. Socio-economic implications of a more directed preventive policy could be large and intervention studies have to be set up to assess the cost-effectiveness of this prevention.

Therefore, the promotors of this project are looking for additional funding to ensure the continuation of the project.

Recommendations

Due to the time limitation of the project, and taking into account that important specific analyses still have to be performed (see higher), recommendations at this stage can only be vague. At any rate, the physical workload again turns out to be an important determinant of low back pain and lowering this load as much as possible seems imperative. However, the interaction with important psychosocial and psychological factors remains to be analysed.

VI. REFERENCES :

- Battie MC, Videman T, Gibbons LE, Manninen H, Gill K, Pope M et al. Occupational driving and lumbar disc degeneration: a case-control study. Lancet 2002; 360(9343):1369-1374.
- Bernard BP, ed. Musculoskeletal disorders and workplace factors. A critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back. Cincinnati: U.S. Department of Health and Human Services CDC (NIOSH), 1997. DHHS (NIOSH) Publication No. 97-141.
- Bombardier C, Kerr MS, Shannon HS, Frank JW. A guide to interpreting epidemiologic studies on the etiology of low back pain. Spine 1994; Suppl 19, 2047S-56S.
- Borg G. A category scale with ratio properties for intermodal and interindividual comparaisons. Psychophysical judgement and the process of perception. Amsterdam: 1982: 25-34.
- Bongers PM, de Winter CR, Kompier MAJ, Hildebrandt VH. Psychosocial factors at work and musculoskeletal disease. Scand J Work Environ Health 1993; 19: 297-312.
- Bongers P. Longitudinaal onderzoek naar rug-, nek- en schouderklachten. Deelrapport I: Opzet en uitvoering van het onderzoek 2000.
- Brulin C, Gerdle B, Granlund B, Hoog J, Knutson A, Sundelin G. Physical and psychosocial work-related risk factors associated with musculoskeletal symptoms among home care personnel. Scand J Caring Sci 1998; 12(2):104-110.
- Buchholtz B, Paquet V, Punnett L, Lee D, Moir S. PATH : awork sampling-based approach to ergonomic job analysis for construction and other non-repetitive work. Appl Ergon , 1996; 27(3):177-187.
- Burdorf A, Sorock G. Positive and negative evidence of risk factors for back disorders. Scand J Work Environ Health 1997; 23: 243-56.
- Burdorf A. Exposure assessment of risk factors for disorders of the back in occupational epidemiology. Scand J Work Environ Health 1992; 18: 1-9.
- Burdorf A. In musculoskeletal epidemiology are we asking the unaswerable in questionnaires on physical load? Scand J Work Environ Health 1999; 25: 81-83.
- Burdorf A, Naaktgeboren B, Post W. Prognostic factors for musculoskeletal sickness absence and return to work among welders and metal workers. Occup Environ Med 1998; 55: 490-495.
- Campbell L, Pannett B, Egger P, Cooper C, Coggon D. Validity of a questionnaire for assessing occupational activities. Am J Ind Med 1997; 31: 422-6.
- CEN. Safety of machinery - Human physical performance - Manual handling of machinery and component parts of machinery. 1999. Part 2, prEN 1005.
- Clayton D, Hills M. Statistical models in epidemiology. Oxford Univ Press, 1993.
- Crombez G, Vlaeyen JWS, Heuts PHTG, Lysens R. Pain-related fear is more disabling than pain itself: evidence on the role of pain-related fear in chronic back pain disability. Pain 1999; 80: 329-39.
- Dempsey P, Burdorf A, Webster B. The influence of personal variables on work-related low-back disorders and implications for future research. JOEM 1997; 39(8): 748-759.
- Derriennic F, Leclerc A, Mairiaux, Meyer JP, Ozguler A. Lombalgies en milieu professionnel : Quels facteurs de risque et quelle prévention ? Paris: INSERM, 2000.
- Duquette J, Lortie M, Rossignol M. Perception of difficulties for the back related to assembly work: general findings and impact of back health. Appl Ergon , 1997; 28(5-6):389-396.
- Elders LAM, Burdorf A. Prevalence, incidence, and recurrence of low back pain in scaffolders during a three year follow-up study. Spine, submitted.
- Elders LAM, Heinrich J, Burdorf A. Risk factors for sickness absence of low back pain among scaffolders: a 3-year follow-up study. Spine 2003; 28: 1340-1346.
- Engels JA, van der Gulden JW, Senden TF, van't Hof B. Work related risk factors for musculoskeletal complaints in the nursing profession: results of a questionnaire survey. Occup Environ Med 1996; 53(9):636-641.

- Fautrel B, Sauverzac C, Rozenberg S, ourgeois P. Facteur de risques professionnels d'origine biomécanique et physiologique et lombalgies. Revue du Rhumatisme 1998; 65(3 bis):7 s-10 s.
- Frank JW, Kerr M, Brooker AS, DeMaio S, Maetzel A et al. Disability resulting from occupational low back pain. Part I: What do we know about primary prevention? A review of the scientific evidence on prevention before disability begins. Spine 1996; 21: 2908-2917.
- Fransson-Hall C, Gloria R, Kilbom A, Winkel J. A portable ergonomic observation method (PEO) for computerized on-line recording of posture and manual handling. Appl Ergon , 1995; 26(2):93-100.
- Haldeman S. Low back pain: current physiologic concepts. Neurological clinics 1999; 17: 1-15.
- Hales TR. Epidemiology of work-related musculoskeletal disorders. Orthopedic Clinics of North America 1996; 27: 679-709.
- Heliövaara M. Workload and back pain. Scand J Work Environ Health 1999; 25(5): 385-386 (editorial).
- Hemingway H, Shipley MJ, Stansfeld S, Marmot M. Sickness absence from back pain, psychosocial work characteristics and employment grade among office workers. Scand J Work Environ Health 1997; 23(2): 121-129.
- Hollmann S, Klimmer F, Schmidt KH, Kylian H. Validation of a questionnaire for assessing physical work load. Scand J Work Environ Health, 1999; 25(2):105-114.
- Holm S, Nachemson A. Variation in nutrition of the canine intervertebral disc : induced by motion. Spine, 1983; 8(8):866-874.
- Hoogendoorn W, Bongers P, de Vet H, Douwes M, Koes B, Miedema M et al. Flexion and rotation of the trunk and lifting at work are risk factors for low back pain: results of a prospective cohort study. Spine, 2000; 25(23):3087-3092.
- Hoogendoorn W, Bongers P, de Vet H, Ariëns G, Van Mechelen W, Bouter L. High physical work load and low job satisfaction increase the risk of sickness absence due to low back pain; results of a prospective cohort study. Occup Environ Med 2002; 59: 323-328.
- Hoogendoorn W, Van Poppel M, Bongers P, Koes B, Bouter L. Physical load during work and leisure time as risk factors for back pain. Scand J Work Environ Health 1999; 25(5): 387-403.
- Hoogendoorn W, Van Poppel M, Bongers P, Koes B, Bouter L. Systematic review of psychosocial factors at work and private life as risks for back pain. Spine 2000; 25: 2114-2125.
- Hoozemans MJ, Burdorf A, Van der Beek AJ, Frings-Dresen MH, Mathiassen SE. Group-based measurement strategies in exposure assessment explored by bootstrapping. Scand J Work Environ Health, 2001; 27(2):125-132.
- Hoozemans MJ, van d, Beek AJ, Frings-Dresen MH, van Dijk FJ, van der Woude LH. Pushing and pulling in relation to musculoskeletal disorders: a review of risk factors. Ergonomics, 1998; 41(6):757-781.
- IDEWE: Het klinisch onderzoek van de lage rug in de arbeidsgeneeskunde (Handleiding). Leuven, IDEWE 1998.
- IDEWE: Ziekteverzuim, rugklachten, burn-out en arbeidsomstandigheden in de verzorgingssector (onderzoeksrapport). Leuven: IDEWE, 1993.
- International Committee of Medical Journal Editors. Uniform requirements for manuscripts submitted to biomedical journals. Ann Intern Med 1997; 126:36-47.
- Johanning E. Evaluation and management of occupational low back disorders. Am J Ind Med 2000; 37(1):94-111.
- Karasek R, Theorell T. Healthy work. Stress, productivity and the reconstruction of working life. New York: Basic book Inc, 1990.
- Karhu O, Kansi P, Kuornika I. Correcting working posture in industry: a practical method for analysis. Appl Ergon , 1977; 8:199-201.

- Kerr MS, Frank JW, Shannon HS, Norman RW, Wells RP, Neumann WP et al. Biomechanical and psychosocial risk factors for low back pain at work. Am J Public Health 2001; 91(7):1069-1075.
- Kilbom A. Assessment of physical exposure in relation to work-related musculoskeletal disorders--what information can be obtained from systematic observations?. [Review] [73 refs]. Scand J Work Environ Health, 1994; 20 Spec No:30-45.
- Kopec J, Esdaile JM, Abrahamowicz M, Abenhaim L, Wood-Dauphinee S, Lamping DL, Williams JI. The Quebec Back Pain Disability Scale. Measurement Properties. Spine 1995; 20: 341-52.
- Krause N, Ragland DR, Greiner BA, Fisher JM, Holman BL, Selvin S. Physical workload and ergonomic factors associated with prevalence of back and neck pain in urban transit operators. Spine, SPINE 1997; 22(18):2117-2126.
- Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sörensen F, et al. Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms. Applied Ergonomics 1987; 18: 233-7.
- Levangie PK. Association of low back pain with self-reported risk factors among patients seeking physical therapy services. Physical Therapy 1999; 79(8):757-766.
- Li G, Buckle P. Current techniques for assessing physical exposure to work-related musculoskeletal risks, with emphasis on posture-based methods. Ergonomics, ERGONOMICS 1999; 42(5):674-695.
- Macfarlane GJ, Thomas E, Papageorgiou AC, Croft PR, Jayson MI, Silman et al. Employment and physical work activities as predictors of future low back pain. Spine, 1997; 22(10):1143-1149.
- Mairiaux P, Albert A, Delavignette JP. Evaluation prospective d'un programme structuré de revalidation collective pour travailleurs lombalgique. Rapport de recherche CECA 7280-04-052. CEE Luxembourg ed. 2000.
- Mairiaux Ph, Delavignette J. Prévention des lésions de l'appareil locomoteur résultant d'un accident du travail. Cahiers de médecine du travail 1993; 30: 85-9.
- Mairiaux Ph, Demaret JP, Masset D, Vandoorne C. Manutentions manuelles – Guide pour évaluer et prévenir les risques. C.G.P.T. Bruxelles,1998.
- Mairiaux Ph. Stratégie de prévention du risque dorso-lombaire. Arbeidsgezondheidszorg en Ergonomie 1997; 34: 167-72.
- Masset DF, Piette AG, Malchaire JB. Relation between functional characteristics of the trunk and the occurrence of low back pain. Associated risk factors. Spine, 1998; 23(3):359-365.
- Mathiassen SE, Möller T, Forsman M. Variability in mechanical exposure within and between individuals performing a strictly controlled industrial work task. Am J Ind Med 2003.
- Miller RP, Kori SH, Todd DD. Tampa Scale of Kinesiophobia, 1991.
- Moens GF, Dohogne TH, Jacques PJ. Rugklachten bij werknemers in de gezondheidszorg. Tijdschr Soc Gezondheidsz 1993; 6: 333-8.
- Moens GF, Dohogne TH, Jacques PJ, Van Helshoecht P. Back pain and its correlates among workers in family care. Occupational Medicine 1993; 43: 78-84.
- Moens GF, Dohogne TH, Jacques PJ. Occupation and the prevalence of back pain among employees in health care. Arch Public Health 1994; 52: 189-201.
- Moens G, Van Gaal L, Muls E, Viaene B, Jacques P. Body mass index and health among the working population: epidemiologic data from Belgium. Eur J Public Health 1999; 9: 119-123.
- Mylle G, Moens G, De Raeve H, Viaene B, Lahaye D. Body mass index, industrial accidents and sick leave: further evidence of an association. Arch Public Health 1998; 56: 81-91.
- NIOSH Low Back Atlas of Standardized Tests/Measures. U.S. Department of Health and Human Services, NIOSH, Division of Safety Research, Morgantown, West Virginia 26505, 1988.
- Nordin M, Frankel V. Basic biomechanics of the musculoskeletal system. Lippincott Williams & Wilkins 2001.

- Norusis MJ. SPSS Advanced statistics users's guide. Illinois: SPSS Inc; 1990.
- Nuwayhid IA, Stewart W, Johnson JV. Work activities and the onset of first-time low back pain among New York City fire fighters. Am J Epidemiol 1993; 137: 539-548.
- Op De Beeck R. Research on work-related low back disorders. Report from the European Agency for safety and health at work, 2000.
- OSTC Activity Report for OSTC project PS/93/25 for the period of 01/10/1999 - 15/09/2000, IDEWE, number 1, Sep 2000.
- OSTC Activity Report for OSTC project PS/93/25 for the period of 16/09/2000 - 31/03/2001, IDEWE, number 2, March 2001.
- OSTC Activity Report for OSTC project PS/93/25 for the period of 16/09/2000 - 15/09/2001, IDEWE, number 3, Sep 2001.
- OSTC Activity Report for OSTC project PS/93/25 for the period of 16/09/2001 - 31/03/2002, IDEWE, number 4, March 2002.
- OSTC Activity Report for OSTC project PS/93/25 for the period of 16/09/2001 - 15/09/2002, IDEWE, number 5, Sep 2002.
- Picavet HS, Vlaeyen JW, Schouten JS. Pain catastrophizing and kinesiophobia: predictors of chronic low back pain. Am J Epidemiol 2002; 156(11): 1028-1034.
- Pope DP, Silman AJ, Cherry NM, Pritchard C, Macfarlane GJ. Validity of a self-completed questionnaire measuring the physical demands at work. Scand J Work Environ Health 1998; 24: 376-85.
- Questionnaire on musculoskeletal symptoms and posture, movements, force exertions at work. Leiden, The Netherlands: NIPG-TNO (Institute of Preventive Health Care), 1992.
- Ridd J, Nicholson A, Montan A. A portable microcomputer based system for "on-site" activity and posture recording. In: Taylor and Francis, editor. Ergonomics-designing process. London: 1989: 366-369.
- Riihimaki H. Epidemiology and pathogenesis of non-specific low back pain: what does the epidemiology tell us? Bull Hosp for Joint Diseases 1996; 55: 197-198.
- Rossignol M, Baetz J. Task-related risk factors for spinal injury: validation of a self-administered questionnaire on hospital employees. Ergonomics, 1987; 30(11):1531-1540.
- Skovron ML. Epidemiologhy of low back pain. Baillière's Clinical rheumatology 1992; 6: 559-573.
- Smedley J, Egger P, Cooper C, Coggon D. Prospective cohort study of predictors of incident low back pain in nurses. BMJ 1997; 314(7089):1225-1228.
- Sullivan MJL, Bishops R, Pivik J. The pain catastrophizing scale: development and validation. Psychological Assessment 1995; 7: 524-32.
- Sullivan M, Thorn B, Haythornwaite J, Keefe F, Martin M, Bradley L, Lefevre J. Theoretical perspectives on the relation between catastrophizing and pain. Clin J of Pain 2001; 17: 52-64.
- Torgen M, Alfredsson L, Koster M, Wiktorin C, Smith KF, Kilbom A. Reproducibility of a questionnaire for assessment of present and past physical activities. Int Arch Occup Environ Health 1997; 70(2):107-118.
- Torgen M, Winkel J, Alfredsson L, Kilbom A. Evaluation of questionnaire-based information on previous physical work loads. Stockholm MUSIC 1 Study Group. Musculoskeletal Intervention Center. Scand J Work Environ Health, 1999; 25(3):246-254.
- Tubach F, Leclerc A, Landre M, Pietri-Taleb F. Risk factors for sick leave due to low back pain: a prospective study. JOEM 2002; 44(5): 451-458.
- Van Cauwenbergh A, Vandersmissen G, Dohogne T, Jacques P, Moens G. The selection of clinical tests to be assessed in a prospective investigation aiming at predicting back problems among healthy workers. Arch Public Health 2003; 61: 215-222.
- Van der Beek A, Van Gaalen L, Frings-Dresen MH. Working posures and activities of lorry drivers : a reliability study of on-site observation and recording on a pocket computer. Appl Ergon , APPL 1992; 23(5):331-336.

- Van der Beek AJ, Frings-Dresen MH. Assessment of mechanical exposure in ergonomic epidemiology. Occup Environ Med 1998; 55(5):291-299.
- Van Dixhoorn J, Duivendoorden HJ. Efficacy of Nijmegen Questionnaire in recognition of the hyperventilation syndrome. J Psychosom Res 1987; 29: 199-206.
- Van Nieuwenhuyse A, Moens G, Somville PR, Johannik K, Pirenne D, Mairiaux Ph, Masschelein R, Crombez G, Van Den Bergh O. Prognostic and etiologic determinants of low back pain in a cohort of Belgian Workers: results after one year of follow-up. La Medicina del Lavoro 2002: 375.
- Viikari-Juntura E, Rauas S, Martikainen R, Kuosma E, Riihimaki H, Takala et al. Validity of self-reported physical work load in epidemiologic studies on musculoskeletal disorders. Scand J Work Environ Health, 1996; 22(4):251-259.
- Vingard E, Alfredsson L, Hagberg M, Kilbom A, Theorell T, Waldenstrom M et al. To what extent do current and past physical and psychosocial occupational factors explain care-seeking for low back pain in a working population? Results from the Musculoskeletal Intervention Center-Norrtalje Study. Spine, 2000; 25(4):493-500.
- Vlaeyen JWS, Crombez G. Fear of movement/(re)injury, avoidance and pain disability in chronic low back patients. Man Ther 1999; 4: 187-195.
- Vlaeyen JWS, Crombez G. The modified Tampa Scale for Kinesiophobia for use in a non-pain population. Unpublished authorized Dutch/Flemish version, 1998.
- Vlaeyen J, Kole-snijders A, Rotteveel A, Reusink R, Heuts P. The role of fear of movement/(re)injury in pain disability. J of Occ Rehabilitation 1995; 5: 235-251.
- Waddell G, Newton M, Henderson I, Somerville D, Main CJ. A Fear-Avoidance Beliefs Questionnaire (FABQ) and the role of fear-avoidance beliefs in chronic low back pain and disability. Pain 1993; 29: 157-68.
- Waddell G. The back pain revolution. Churchill Livingstone 1998.
- Watson D, Clark LA. Negative affectivity: the disposition to experience aversive emotional states. Psychological Bulletin 1984; 9: 465-490.
- Watson D, Clark LA, Tellegen A. Development and validation of brief measures of positive and negative affect: the PANAS scales. J Personality Soc Psychol 1988; 54: 1063-70.
- Watson D, Pennebaker J. Health complaints, stress and distress: Exploring the role of negative affectivity. Psychological Review 1989; 96: 234-254.
- Wells R, Moore A, Norman R, Neumann P, Andrews D. Development and implementation of SAM, a pen based computer system for work sampling. PREMUS 95, Second international scientific conference on prevention of work-related musculoskeletal disorders, Monreal, Canada, 1995.
- Wells R, Norman R, Neumann P, Andrews D, Frank J, Shannon H et al. Assessment of physical work load in epidemiologic studies: common measurement metrics for exposure assessment. Ergonomics, 1997; 40(1):51-61.
- Wickstrom GJ, Pentti J. Occupational factors affecting sick leave attributed to low-back pain. Scand J Work Environ Health, 1998; 24(2):145-152.
- Wientjes C, Grossman P. Overreactivity of the psyche or the soma? Interindividual associations between psychosomatic symptoms, anxiety, heart rate and end-tidal partial carbon dioxide pressure. Psychosomatic Medicine 1994; 56: 533-540.
- Wiktorin C, Hjelm EW, Winkel J, Köster M. Reproducibility of a questionnaire for assessment of physical load during work and leisure time. JOM 1996; 38: 190-201.
- Wiktorin C, Karlqvist L, Winkel J. Validity of self-reported exposures to work postures and manual materials handling. Stockholm MUSIC I Study Group. Scand J Work Environ Health 1993; 19: 208-14.
- Wiktorin C, Mortimer M, Ekenvall L, Kilbom A, Hjelm EW. HARBO, a simple computer-aided observation method for recording work postures. Scand J Work Environ Health, 1995; 21(6):440-449.
- Wiktorin C, Vingard E, Mortimer M, Pernold G, Wigaeus-Hjelm E, Kilbom A et al. Interview versus questionnaire for assessing physical loads in the population-based MUSIC-Norrtalje Study. Am J Ind Med 1999; 35(5):441-455.

- Xu Y, Bach E, Orhede E. Work environment and low back pain: the influence of occupational activities. Occup Environ Med 1997; 54(10):741-745.

VII. ATTACHMENTS:

1) Attachment 1:
   Interobserver variation of standard clinical back examination

2) Attachment 2:
   Construction of Homogeneous Observation Groups for the ergonomic observations

3) Attachment 3:
   New publications
   (Former publications were submitted with the interim reports 1 to 5)

PS: Questionnaires and other measuring instruments can be obtained from the authors.

ATTACHMENT 1:

Interobserver variation of standard clinical back examination

TABLE I: Inter-observer reliability for the qualitative items of the clinical back examination

Variable	Outcome	Agreement between AVN-AL (n=30): 2x2 table			Measure of agreement	Agreement between AVN-DP (n=30): 2x2 table			Measure of agreement
Pelvic position	Normal/Abnormal		No	Abno	K = 0.39		No	Abno	K=0.09
		No	19	2	P = 0.77	No	22	3	P=0.77
		Abno	5	4		Abno	4	1	
Scoliosis	No/Yes		No	Yes	K = 0.63		No	Yes	K=0.53
		No	21	1	P = 0.87	No	25	0	P=0.90
		Yes	3	5		Yes	3	2	
Forward bending									
Pain	No/Yes		No	Yes	K = 1.00		No	Yes	K=0.00
		No	28	0	P = 1.00	No	29	0	P=0.97
		Yes	0	1		Yes	1	0	
Fingertip to floor	No/Yes		No	Yes	K = 0.76		No	Yes	K=1.00
		No	7	3	P = 0.90	No	17	0	P=1.00
		Yes	0	20		Yes	0	17	

TABLE I (ct'd): Inter-observer reliability for the qualitative items of the clinical back examination

		Agreement between AVN-AL (n=30)				Agreement between AVN-DP (n=30)			
Variable	**Outcome**	**2x2 table**			**Measure of agreement**	**2x2 table**			**Measure of agreement**
Extension									
Pain	No/Yes		No	Yes	K = 0.61		No	Yes	K=0.65
		No	23	1	P = 0.90	No	28	0	P=0.97
		Yes	2	3		Yes	1	1	
Lateral flexion									
Pain right	No/Yes		No	Yes	K = 0.35		No	Yes	K=0.00
		No	26	1	P = 0.90	No	28	0	P=0.97
		Yes	2	1		Yes	1	0	
Pain left	No/Yes		No	Yes	K = 0.46		No	Yes	K=0.65
		No	27	1	P = 0.93	No	28	0	P=0.97
		Yes	1	1		Yes	1	1	

TABLE I (ct'd): Inter-observer reliability for the qualitative items of the clinical back examination

		Agreement between AVN-AL (n=30)				Agreement between AVN-DP (n=30)			
Variable	**Outcome**	**2x2 table**			**Measure of agreement**	**2x2 table**			**Measure of agreement**
Single Straight Leg Raising									
Pain right	No/Yes		No	Yes	K = 0.19		No	Yes	K=0.59
		No	3	8	P = 0.67	No	9	1	P=0.80
		Yes	2	17		Yes	5	15	
Pain left	No/Yes		No	Yes	K = 0.42		No	Yes	K=0.45
		No	4	7	P = 0.77	No	7	1	P=0.73
		Yes	0	19		Yes	7	15	
Hip mobility									
Hip mobility	Normal/Abnormal		No	Abno	K = 0.50		No	Abno	K=0.00
		No	30	0	P = 1.00	No	27	0	P=0.90
		Abno	0	0		Abno	3	0	

TABLE I (ct'd): Inter-observer reliability for the qualitative items of the clinical back examination

		Agreement between AVN-AL (n=30)				Agreement between AVN-DP (n=30)			
Variable	Outcome	2x2 table			Measure of agreement	2x2 table			Measure of agreement
Pain on palpation									
Spinal-interspinal	No/Yes		No	Yes	K = 0.36		No	Yes	K=0.63
		No	23	4	P = 0.83	No	26	0	P=0.93
		Yes	1	2		Yes	2	2	
Paraspinal right	No/Yes		No	Yes	K = 0.00		No	Yes	K=-0.03
		No	28	0	P = 0.93	No	28	1	P=0.93
		Yes	2	0		Yes	1	0	
Paraspinal left	No/Yes		No	Yes	K = 0.00		No	Yes	K=0.00
		No	28	0	P = 0.93	No	29	1	P=0.97
		Yes	2	0		Yes	0	0	
Buttock	No/Yes		No	Yes	K = 1.00		No	Yes	K=0.50
		No	28	0	P = 1.00	No	30	0	P=1.00
		Yes	0	2		Yes	0	0	

TABLE I (ct'd): Inter-observer reliability for the qualitative items of the clinical back examination

		Agreement between AVN-AL (n=30)				Agreement between AVN-DP (n=30)			
Variable	**Outcome**	**2x2 table**			**Measure of agreement**	**2x2 table**			**Measure of agreement**
Thoracolumbar rotation									
Pain right	No/Yes		No	Yes	K = 0.00		No	Yes	K=0.50
		No	29	1	P = 0.97	No	30	0	P=1.00
		Yes	0	0		Yes	0	0	
Pain left	No/Yes		No	Yes	K = 0.00		No	Yes	K=0.00
		No	29	1	P = 0.97	No	29	1	P=0.97
		Yes	0	0		Yes	0	0	
Range right	Normal/Abnormal		No	Abno	K = 0.00		No	Abno	K=0.00
		No	29	0	P = 0.97	No	27	3	P=0.90
		Abno	1	0		Abno	0	0	
Range left	Normal/Abnormal		No	Abno	K = 0.00		No	Abno	K=-0.05
		No	29	0	P = 0.97	No	26	3	P=0.87
		Abno	1	0		Abno	1	0	

TABLE I (ct'd): Inter-observer reliability for the qualitative items of the clinical back examination

<table>
<tr><th></th><th></th><th colspan="2">Agreement between AVN-AL (n=30)</th><th colspan="2">Agreement between AVN-DP (n=30)</th></tr>
<tr><th>Variable</th><th>Outcome</th><th>2x2 table</th><th>Measure of agreement</th><th>2x2 table</th><th>Measure of agreement</th></tr>
<tr><td>Neurological examination</td><td>Normal/Abnormal</td><td><table><tr><td></td><td>No</td><td>Abno</td></tr><tr><td>No</td><td>30</td><td>0</td></tr><tr><td>Abno</td><td>0</td><td>0</td></tr></table></td><td>K = 0.50
P = 1.00</td><td><table><tr><td></td><td>No</td><td>Abno</td></tr><tr><td>No</td><td>30</td><td>0</td></tr><tr><td>Abno</td><td>0</td><td>0</td></tr></table></td><td>K=0.50
P=1.00</td></tr>
<tr><td>Strength back extensors</td><td><10/10-29/30 sec</td><td><table><tr><td></td><td><10</td><td>10-29</td><td>30</td></tr><tr><td><10</td><td>0</td><td>0</td><td>0</td></tr><tr><td>10-29</td><td>0</td><td>0</td><td>1</td></tr><tr><td>30</td><td>0</td><td>0</td><td>29</td></tr></table></td><td>K = 0.00
P = 0.97</td><td><table><tr><td></td><td><10</td><td>10-29</td><td>30</td></tr><tr><td><10</td><td>0</td><td>0</td><td>0</td></tr><tr><td>10-29</td><td>1</td><td>1</td><td>2</td></tr><tr><td>30</td><td>0</td><td>0</td><td>26</td></tr></table></td><td>K=0.46
P=0.90</td></tr>
</table>

TABLE II: Inter-observer reliability for the quantitative items of the clinical back examination

Variable	Outcome	Agreement between AVN-AL (n=30)	Agreement between AVN-DP (n=30)
		Measure of agreement	
Forward bending			
Fingertip to floor distance	cm	ICC=0.81	ICC=0.98
Extension			
Range of lumbar extension	degrees	ICC=0.54	ICC=0.56
Lateral flexion			
Range right	cm	ICC=0.83	ICC=0.90
Range left	cm	ICC=0.88	ICC=0.83

TABLE II (ct'd): Inter-observer reliability for the quantitative items of the clinical back examination

		Agreement between AVN-AL (n=30)	Agreement between AVN-DP (n=30)
Variable	**Outcome**	**Measure of agreement**	**Measure of agreement**
Single Straight Leg Raising			
Maximum SSLR right	degrees	ICC=0.90	ICC=0.94
Maximum SSLR left	degrees	ICC=0.93	ICC=0.92
Double Straight Leg Raising			
SLR with both legs	degrees	ICC=0.92	ICC=0.90
Hamstrings			
Range right	degrees (max 90°)	ICC=0.94	ICC=0.94
Range left	degrees (max 90°)	ICC=0.91	ICC=0.91

ATTACHMENT 2:

Construction of Homogeneous Observation Groups for the ergonomic observations

Figure 1. Average percentage of encoding frequency of 34 exposure variables (constraints) for each Homogeneous Observation Group (HOG) in the health care sector.

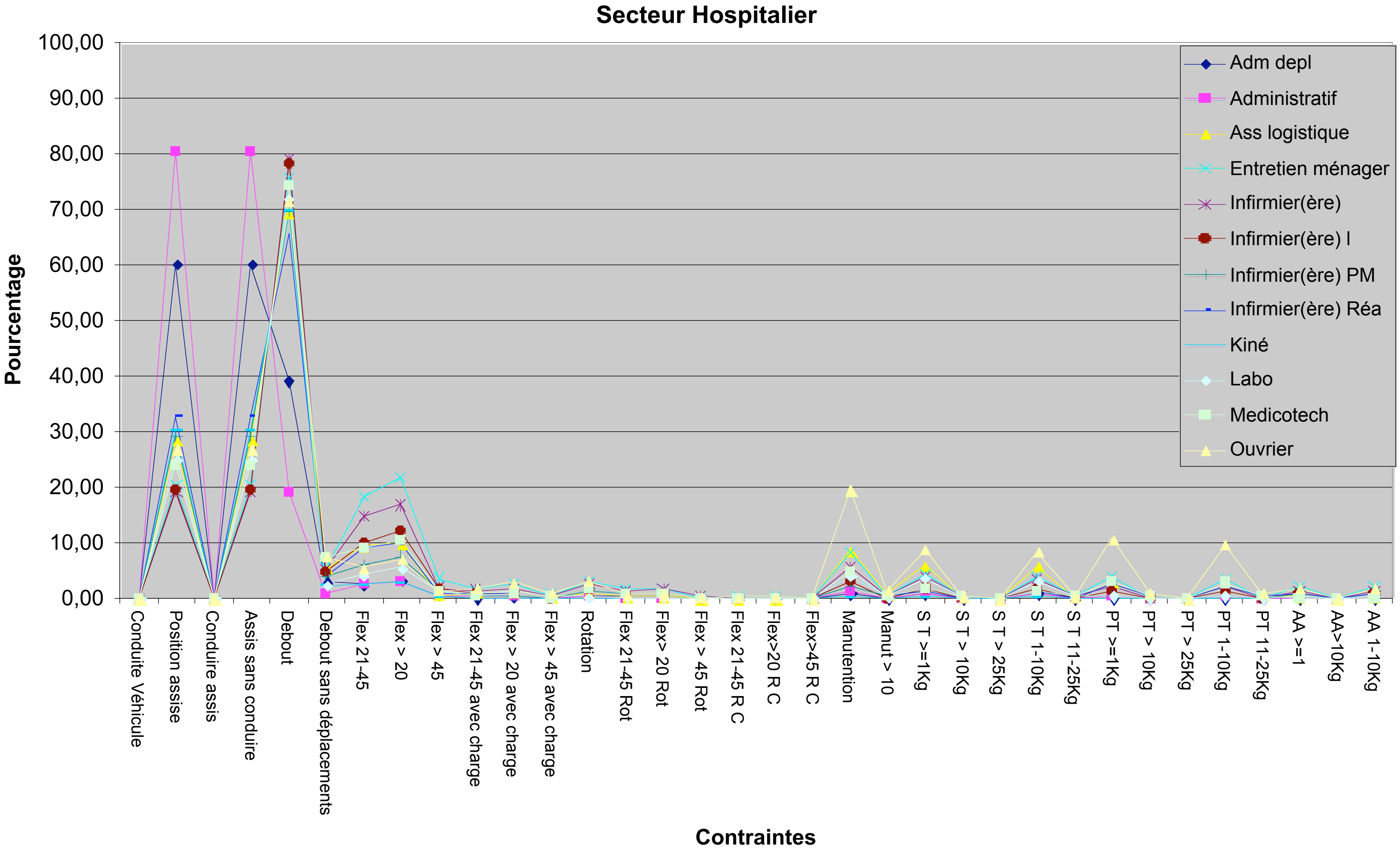


Figure 2. Average percentage of encoding frequency of 34 exposure variables (constraints) for each Homogeneous Observation Group (HOG) in the distribution sector.

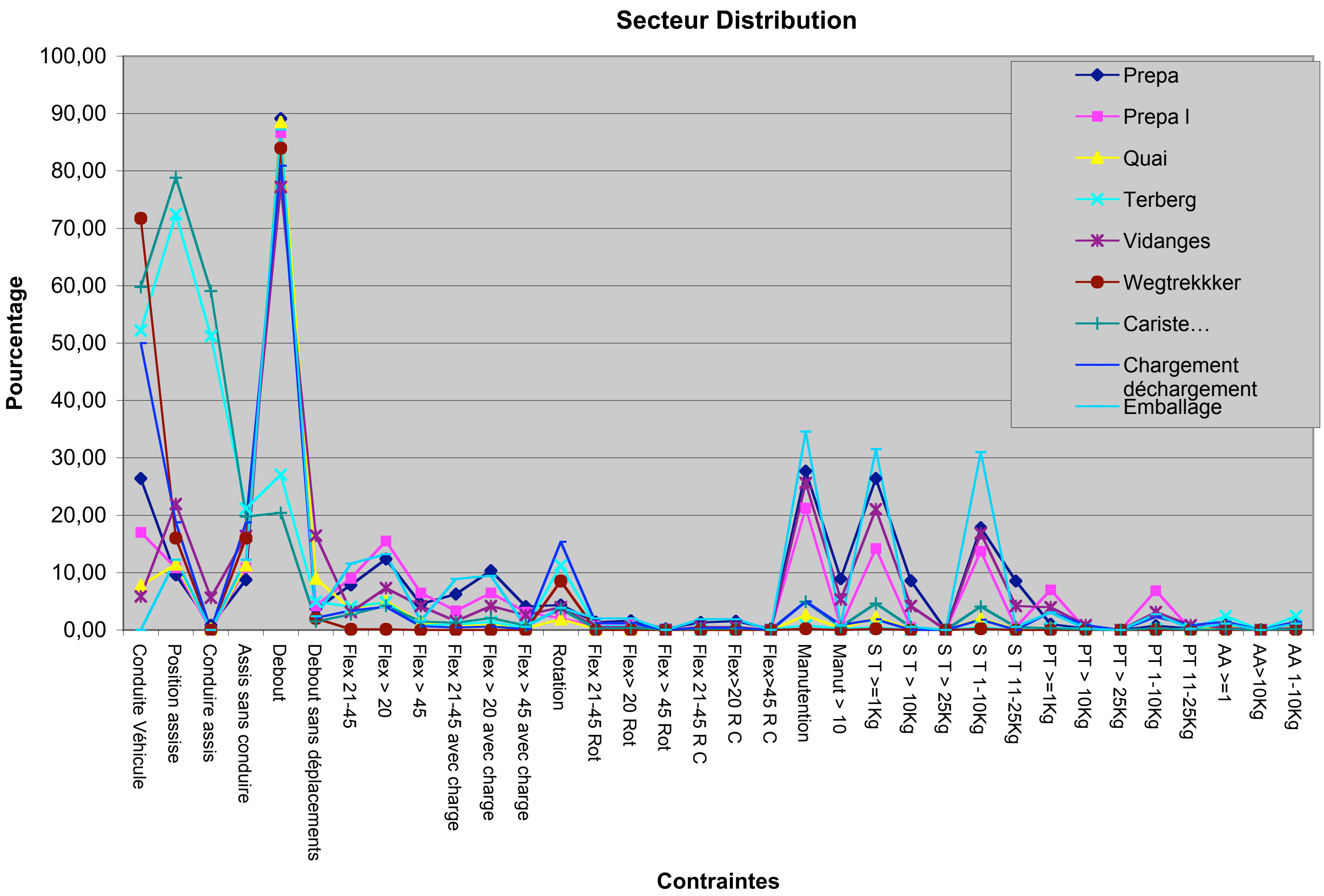
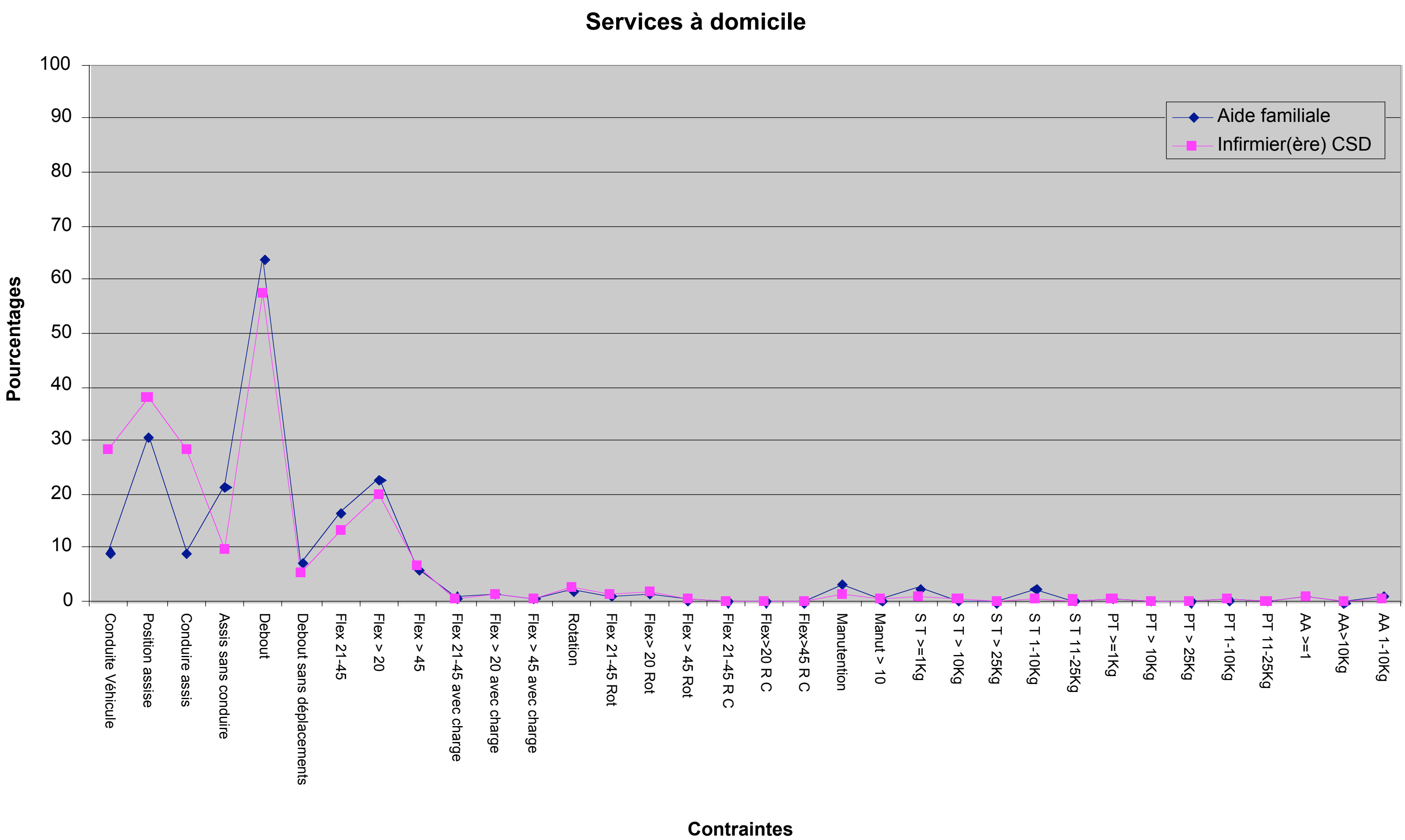


Figure 3. Average percentage of encoding frequency of 34 exposure variables (constraints) for each Homogeneous Observation Group (HOG) in at home services sector.



ATTACHMENT 3:

New publications
(Former publications submitted in the interim reports 1 to 5)

Abstract Number (leave blank)

A prospective cohort study to identify risk factors for low back pain in occupational settings: results after one year of follow-up

An VAN NIEUWENHUYSE[1], Pierre-René SOMVILLE[2], Danièle PIRENNE[2], Kristien JOHANNIK[3], Philippe MAIRIAUX[2], Raphael MASSCHELEIN[1], Geert CROMBEZ[4], Omer VAN DEN BERGH[5], Guido MOENS[1,3]

[1] *Department of Public Health, Section of Occupational, Environmental and Insurance Medicine, Katholieke Universiteit Leuven, Leuven, Belgium*

[2] *Occupational Health and Health Education unit, Department of Public Health, University of Liège, Liège, Belgium*

[3] *External Service for Prevention and Protection at Work IDEWE, Leuven, Belgium*

[4] *Department of Psychology, University of Ghent, Ghent, Belgium*

[5] *Department of Psychology, Katholieke Universiteit Leuven, Leuven, Belgium*

Topic classification: low back, prevention, health

Keywords: low back pain; prospective; young workers

1. *Introduction*

Low back pain is a frequently occurring health problem imposing an enormous burden on individuals and on society. Despite numerous scientific investigations, its aetiology and risk factors remain unclear. Methodological weaknesses constitute a major problem: most of the former epidemiological studies have been retrospective or cross-sectional in design and focus only on a limited number of risk factors. The Belgian Low Back Cohort Study was set up as a prospective and multidisciplinary project. Its aims are:

- To study the influence of work-related physical and psychosocial factors and individual characteristics on the occurrence of low back pain among young and pain-free workers.
- To assess the impact of prevention of variables that are found to constitute risk factors.
- To evaluate a standard physical examination of the low back with respect to its ability to identify individuals at risk for future reporting of back pain and to its reliability among different observers.

2. *Methods*

The Belgian Low Back Cohort Study was designed as a prospective study over three years. During the first year (2000-2001), participants were taken in and baseline measurements were carried out. Participants were recruited among the employees of four health care institutions and two distribution companies throughout Belgium. Only workers who fulfilled the following criteria were included: (1) to be no older than 30 years at the time of intake, (2) to hold a tenured position or equivalent, and (3) to have been free of episodes of low back pain of more than six consecutive days during the twelve months before the start of the study. These criteria aimed to minimise the healthy worker effect, the dropout and the influence of prior episodes of low back pain, respectively. Out of the 1672 employees invited to participate, 1200 (72%) agreed. 159 had to be excluded because they did not meet the third inclusion criterion. Thus, the initial cohort consisted of 1041 workers. Baseline measurements amounted to physical examinations of the low back and questionnaire-based self-reporting of physical exposures, work-related psychosocial factors and individual characteristics that might be related to low back disorders. Of the initial cohort of 1041 workers, 972 (93%) completed the questionnaire at baseline. 942 participants from the latter group also underwent a physical examination. To validate questionnaire information on work-related physical exposures, direct observations at the workplace were carried out.

The workers have been followed up for two years. Each year, the incidence of low back pain and its characteristics (e.g. duration, intensity, recurrence, sick leave, medical care seeking) as well as changes in the factors at baseline have been registered by means of a questionnaire. The first year of follow-up took place from 2001 to 2002. 800 (82%) of the 972 workers who responded at baseline returned the questionnaire at one year of follow-up. Since the second year of follow-up (2002-2003) is still ongoing, the presentation will be limited to the results after one year of follow-up.

3. Results

To assess the respective role of predictors at baseline on the occurrence of low back pain in the following year, a subcohort of 851 employees who had kept their function for at least two months at the beginning of the study was identified. From this subcohort, data at one year of follow-up were available for 716 (84%). Of them, 64% were recruited in health care institutions and 36% in distribution companies. 61% were women. The median age was 26 years (interquartile range of 5 years). For 70%, the native language was Dutch and for 30%, the native language was French. Out of the 716 workers, 12.6% (95%CI: 10.1-15.0) developed low back pain for more than six consecutive days during the first year of follow-up. There were no significant differences between men and women, or between Dutch and French speaking employees.

In univariate analyses, the five following individual characteristics were statistically related to the occurrence of low back pain in the following year: (1) fairly good and moderate general health, (2) history of low back pain before the start of the study, (3) musculoskeletal morbidity of the upper part of the back or upper limbs in the twelve months before the start of the study, (4) sick leave and medical care seeking in the twelve months before the start of the study and (5) pain-related fear. For the self-reported physical variables, moderately elevated risks were observed for (1) working with the back in bent and twisted position for more than two hours a day, (2) inability to change posture regularly, (3) the perception of heavy workload and (4) different aspects of manual materials handling, i.e. pushing or pulling at least once every hour, the subjective perception of having to handle too heavy loads or to handle loads too frequently and lifting or transportation of loads of more than 25 kg more than 12 times per hour. However, this last result has to be interpreted with care since the exposed group was very small (n=13). Of the psychosocial variables of the Demand-Control-Support model of Karasek and Theorell, only lower possibilities to develop skills was related with low back pain.

4. Conclusions

Based on univariate analysis, low back pain was predicted mainly by health-related and work-related physical factors. Although many psychosocial work characteristics were assessed, only one association (lower possibilities to develop skills) was significant. Of the psychological variables, fear of movement/injury (kinesiophobia) turned out to be important. Multivariate analyses are ongoing and will also be presented.

5. Acknowledgements

The Belgian Low Back Cohort Study is supported by the Belgian Federal Office for Scientific, Technical and Cultural Affairs (OSTC), projects PS/93/25, PS/12/26, PS/01/27.

PREMUS 2004
Fifth international Scientific Conference on Prevention of Workrelated Musculosceletal Disorders

Abstract Submission Guidelines

1.	Papers should conform to the theme of the Congress
2.	Abstracts should be written in English. The 2-page Abstract including this page should be submitted by December 1st, 2003 and should be sent as a MS-Word document by email to premus-abstract@bbscongress.ch.
3.	Submitted Abstracts will be peer-reviewed by the Scientific Committee.
4.	Selected authors will be notified on the 1st of March, 2004

Enter your personal information

** Required*

Corresponding Author

* Title	**MD**			
* Last Name	**Van Nieuwenhuyse**			
* First Name	An			
* Organization	**Department of Public Health, Section of Occupational, Environmental and Insurance Medicine, Katholieke Universiteit Leuven**			
* Mailing Address	**Kapucijnenvoer 35, 5th floor, B-3000 Leuven**			
* Country	**Belgium**			
* Postal Code	**3000**			
* Phone	Country Code	**32**	Number	**16 337080**
Fax	Country Code	**32**	Number	**16 336997**
* User ID[1]	**an.vannieuwenhuyse@med.kuleuven.ac.be**			

Authors

* Main author: Name	**An Van Nieuwenhuyse**
* Presenting author: Name (if different from main author)	**An Van Nieuwenhuyse**
Coauthor 1: Name	
Coauthor 2: Name	
Coauthor 3: Name	
Coauthor 4: Name	
Coauthor 5: Name	

Required information concerning your proposal

* Title of your abstract	**A prospective cohort study to identify risk factors for low back pain in occupational settings: results after one year of follow-up.**	
* Name of attached file (incl. extension)	**PREMUS2004LBP.doc**	
* Topics (see next page)	**low back, prevention, health**	
* Keywords (max. 3)	**low back pain, prospective, young workers**	
* Session Type	Oral Presentation: **yes**	Poster Presentation: **no**

[1] If you experience problems with registration, the abstract can be sent without User-ID. (but please don't!)

Abstract Number (leave blank)

A prospective evaluation of physical examinations of the low back in occupational medicine

An VAN NIEUWENHUYSE[1], Danièle PIRENNE[2], An LEYS[1], Lydia MOORS[1], Philippe MAIRIAUX[2], Raphael MASSCHELEIN[1], Guido MOENS[1,3]

[1] *Department of Public Health, Section of Occupational, Environmental and Insurance Medicine, Katholieke Universiteit Leuven, Leuven, Belgium*

[2] *Occupational Health and Health Education unit, Department of Public Health, University of Liège, Liège, Belgium*

[3] *External Service for Prevention and Protection at Work IDEWE, Leuven, Belgium*

Topic classification: low back, prevention, health

Keywords: predictive value; young workers; physical back examination

1. *Introduction*

Low back pain is a frequently occurring health problem imposing an enormous burden on individuals and society. It has consistently been associated with physical, psychosocial and individual factors. We investigated whether individual factors, as measured by a physical examination, may predict workers at risk for future reporting of back pain. The analysis is part of the Belgian Low Back Cohort Study, an epidemiological study to identify risk factors for low back pain in occupational settings.

2. *Methods*

Prospective value of the physical examination of the low back

The Belgian Low Back Cohort Study was designed as a prospective study. During the first year (2000-2001), baseline measurements were carried out. Participants were recruited among the employees of four health care institutions and two distribution companies throughout Belgium. Only workers who fulfilled the following criteria were included: (1) to be no older than 30 years at the time of intake, (2) to hold a tenured position or equivalent, and (3) to have been free of episodes of low back pain of more than six consecutive days during the twelve months before the start of the study. These criteria aimed to minimise the healthy worker effect, the dropout and the influence of prior episodes of low back pain, respectively. The baseline measurements consisted of physical examinations of the low back and questionnaire-based self-reporting of individual and work-related factors that might be related to low back disorders. 972 workers (93% of those who agreed to participate and fulfilled the inclusion criteria) completed the questionnaire at baseline. Out of them, 942 also underwent a physical examination. The standard examination protocol included the following tests: (1) visual assessment of pelvic height asymmetry, (2) visual assessment of scoliosis, (3) the range of forward flexion of the low back as measured by the fingertip-to-floor test, (4) pain in the low back or buttock in forward flexion, (5) the range of back extension as measured with a bubble inclinometer, (6) pain in the low back in passive back extension, (7) the range of lateral flexion as measured with a tape measure, (8) pain in the low back or buttock in lateral flexion, (9) the elevation angle of the leg in the straight leg raising (SLR) test as measured with a bubble inclinometer, (10) pain in the low back or buttock, in the thigh, or in the leg/foot in SLR, (11) passive hamstring length as measured with a bubble inclinometer, (12) pain in rotation or abduction of the hip, (13) pain in the low back or buttock at manual palpation, and (14) a peripheral neurological examination of the lower limbs.

The workers have been followed up for two years. Each year, the incidence of low back pain and its characteristics (e.g. duration, intensity, recurrence, sick leave, medical care seeking) have been registered by means of a questionnaire. The first year of follow-up took place from 2001 to 2002. Since the second year of follow-up (2002-2003) is still ongoing, the presentation will be limited to the results after one year of follow-up.

Inter-examiner repeatability of the different tests

For organisational reasons, the physical examinations in the Belgian Low Back Cohort Study were conducted by two occupational physicians and three research assistants (AVN, DP and AL). All examiners were trained intensively. Among the three research assistants, inter-examiner repeatability of the different tests was assessed. For this purpose, AVN examined 30 volunteers with DP as well as with AL. Volunteers of no more than 30 years had to be free of episodes of low back pain of more than six consecutive days during the twelve months before the examination.

3. Results

Of the 942 workers with physical examination at baseline, 776 (82%) returned their questionnaire at one year of follow-up. The median age was 26 years (interquartile range of 5 years), and 62% were women. The prevalence of clinical findings at baseline was very low. Out of these 776 workers, 12.4% (95%CI: 10.1-14.7) developed low back pain for more than six consecutive days during the first year of follow-up. This outcome was not significantly different between men and women.

With exception of the measurement of the range of back extension (intraclass correlation coefficients of 0.54 and 0.56), the agreement among the research assistants was rather good (observed proportions of agreement between 0.67 and 1.00, intraclass correlation coefficients between 0.83 and 0.94).

In univariate analyses, the four following findings of the physical examination were statistically related to low back pain after one year of follow-up: (1) pain provoked in lateral flexion (RR 3.20, 95%CI: 1.57-6.54), (2) buttock pain at manual palpation (RR 3.58, 95%CI: 1.72-7.46), (3) pain elicited in passive back extension (RR 2.11, 95%CI: 1.16-3.86) and (4) a higher range of passive back extension (p=0.011). As mentioned above, this last item was not measured reliably. However, the most significant predictor was pain the day of the examination and reported before the examination (RR 4.95, 95%CI: 2.36-10.42).

4. Conclusions

Although some pain provocation tests were associated with low back pain one year later, pain at the day of examination and reported before examination was far more significant than these clinical predictors. Even in a population with only minor antecedents of low back pain, an anamnesis of low back pain seems more important for screening subjects at risk for future back pain than physical examinations. Since the prevalence of findings was very low, the value of physical examinations as screening tool in occupational medicine seems questionable. Multivariate analyses are ongoing and will also be presented.

5. Acknowledgements

The Belgian Low Back Cohort Study is supported by the Belgian Federal Office for Scientific, Technical and Cultural Affairs (OSTC), projects PS/93/25, PS/12/26, PS/01/27.

PREMUS 2004
Fifth international Scientific Conference on Prevention of Workrelated Musculosceletal Disorders

Abstract Submission Guidelines

1.	Papers should conform to the theme of the Congress
2.	Abstracts should be written in English. The 2-page Abstract including this page should be submitted by December 1st, 2003 and should be sent as a MS-Word document by email to premus-abstract@bbscongress.ch.
3.	Submitted Abstracts will be peer-reviewed by the Scientific Committee.
4.	Selected authors will be notified on the 1st of March, 2004

Enter your personal information

** Required*

Corresponding Author

* Title	**MD**			
* Last Name	**Van Nieuwenhuyse**			
* First Name	An			
* Organization	**Department of Public Health, Section of Occupational, Environmental and Insurance Medicine, Katholieke Universiteit Leuven**			
* Mailing Address	**Kapucijnenvoer 35, 5th floor, B-3000 Leuven**			
* Country	**Belgium**			
* Postal Code	**3000**			
* Phone	Country Code	**32**	Number	**16 337080**
Fax	Country Code	**32**	Number	**16 336997**
* User ID[1]	**an.vannieuwenhuyse@med.kuleuven.ac.be**			

Authors

* Main author: Name	**An Van Nieuwenhuyse**
* Presenting author: Name (if different from main author)	**An Van Nieuwenhuyse**
Coauthor 1: Name	
Coauthor 2: Name	
Coauthor 3: Name	
Coauthor 4: Name	
Coauthor 5: Name	

Required information concerning your proposal

* Title of your abstract	**A prospective evaluation of physical examinations of the low back in occupational medicine.**	
* Name of attached file (incl. extension)	**PREMUS2004KRO.doc**	
* Topics (see next page)	**low back, prevention, health**	
* Keywords (max. 3)	**predictive value, young workers, physical back examination**	
* Session Type	Oral Presentation: **yes**	Poster Presentation: **yes**

[1] If you experience problems with registration, the abstract can be sent without User-ID. (but please don't!)

Abstract Number (leave blank)

Validation of a self-administrated questionnaire for exposure assessment to work related low back pain risk factors

Pierre-R. SOMVILLE, An Van NIEUWENHUYSE*, Danièle PIRENNE
Guido MOENS*‡, Philippe MAIRIAUX
Department of Public Health, University of Liège, Belgium
** Department of Occupational Health, Catholic University of Leuven, Belgium*
‡ IDEWE - Occupational Health Services, Leuven, Belgium

Topic classification: low back, exposure, biomechanics.

Keywords: questionnaire; low back pain; mechanical risk factors

1. Introduction

A self-administrated questionnaire methodology was selected to ensure the individual evaluation of exposure to mechanical risk factors in the Belgian Low Back Cohort Study (1).
To ensure content validity and select the most appropriate question and answer modalities, the questionnaire was designed on the basis of a literature review over low back pain (LBP) risk factors and validated questionnaires (2). Risk factors taken into account are manual load handling, postural constraints, whole body vibration and static work postures; answer modalities consist of a dichotomous scale in most cases and of an ordinal and objective scale when duration or frequency estimation was necessary. This paper aims at analysing the questionnaire external validity and its reproducibility.

2. Methods

Two criterion validity tests were carried out: one against direct observation, the other against the observer judgement. Reproducibility was assessed using a test retest methodology.
On-site observations were conducted on a 154 workers sample. A single analyst observed each worker during 4 periods of 30 minutes randomly distributed along the shift, and entered observational variables on a handheld PC every 15 seconds. At the end of the shift, each observed worker was invited to answer the questionnaire, having in mind the tasks carried out during that same day (if it was a typical work day). The analyst also answered this questionnaire at that moment.
From the stored observational data, secondary discrete variables were derived taking into account the cut-off used in the questionnaire, in order to allow a comparison of these two sets of information.
As the 154 workers included in the validation study did answer the questionnaire twice (first at the inclusion in the cohort study and secondly at the end of the observation day), questionnaires of workers who did not change function were compared to test for reproducibility.
In both criterion validity tests and in the reproducibility test, agreement was tested with the Cohen's Kappa in all cases, and with the rank Spearmann's coefficient for variables having an ordinal answer modality. Moreover, for ordinal variables, Kappa tests have also been carried out after grouping the last ranks to reduce the response scale first to a 3 points and then to a 2 points (dichotomous) scale.

3. Results

The validation tests eventually included 147 workers. Generally speaking, the agreement was always higher when the worker and the observer judgements were compared than when questionnaire was compared to observations. Answers to dichotomous questions always showed a

better agreement than answers on ordinal scales.
The reproducibility test included 71 workers. The interval between the two administrations of the questionnaire was 17 ± 4 month depending on the inclusion time in the epidemiological study and on the ergonomic observation time.
Manual handling estimation presents a good agreement with observations (k=0.51) and particularly lifting or carrying a load without information about weight or frequency (k=0.57). Reproducibility of those items is also good with kappa values of 0.59 and 0.66 respectively. When comparing worker and analyst opinions, lifting of more than 10 kg load shows a fair to good agreement (k=0.66) at dichotomous level. Reproducibility of this question is poor but good for lifting of more than 25 kg load (k=0.67). An acceptable agreement was observed between observer and worker for two subjective items: the perceived constraint associated to the manual handling of loads (k= 0.49) and the ability to hold the charge close to the body (k=0.46).
Self reported postural constraints present a poor agreement when compared to observation; yet, agreement is better for the trunk flexion than for flexion/rotation combination or frequent rotation. These results are also observed in the reproducibility test. When compared to observer judgement, frequent trunk bending (more than 12 time per hour) shows a fair to good agreement (k=0.55). In the test-retest, this estimation shows an acceptable kappa (0.49). Moreover, the holding of trunk bended posture presents a satisfactory reproducibility at dichotomous level (k=0.52).
Reported whole body vibration compared to observation exhibits a satisfactory (k=0.47) to excellent (k=0.93) agreement when scale is reduced. The reproducibility test presents similar results (Kappa varying from 0.59 to 0.82 respectively).
Static postures assessment shows no good agreement with observation; however agreement between worker and observer opinions is satisfactory for the prolonged sitting position (k=0.52) and the ability to vary posture (k= 0.47). For these questions, reproducibility level is considered as acceptable (k=0.49 and 0.45 respectively). However, agreement levels are poor for standing work without moving in both validity and reproducibility tests.

4. Discussion and conclusions

Both validation and reproducibility results seem to fit to the literature except the sitting posture estimation that generally shows good to excellent agreement when compared to observation. This may be explained by the fact that a 2 hours cut-off had been selected to dichotomize the observed subjects while no duration limit was formulated in the questionnaire.
Moreover the agreement values found in the present study are generally lower than in other validation and reproducibility studies. As explanation, it must be noted that at baseline, the worker filling up the self-questionnaire was invited to think to "a typical work day" while on the observation day he had to think to "the day of today if it is a typical workday". If these two formulations were meant to carry out at the same time validation and reproducibility tests, they could have been wrongly interpreted by some workers.
In conclusion, the questionnaire can be considered valid and reproducible for well defined constraints assessed at dichotomous level, using a single cut-off value.

5. References

(1) MAIRIAUX, PH., MASSCHELEIN, R., MOENS, G. Work related back-pain: design characteristic of the Belgian collaborative study, 4th PREMUS Congress, Proceeding book p.209, Amsterdam 2001.
(2) SOMVILLE P.R. and MAIRIAUX PH, Evaluation des risques biomécaniques pour la colonne lombaire sur base de questionnaires, Médecine du travail et ergonomie, 40(1) : 5-17, 2003.

6. Acknowledgements

The present study is financially supported the Belgian government, SPP-PS research project PS/12/26, the SMIL foundation and the FNRS research grant S 2/5-DD-E42.

PREMUS 2004
Fifth international Scientific Conference on Prevention of Workrelated Musculosceletal Disorders

Abstract Submission Guidelines

1.	Papers should conform to the theme of the Congress
2.	Abstracts should be written in English. The 2-page Abstract including this page should be submitted by December 1st, 2003 and should be sent as a MS-Word document by email to premus-abstract@bbscongress.ch.
3.	Submitted Abstracts will be peer-reviewed by the Scientific Committee.
4.	Selected authors will be notified on the 1st of March, 2004

Enter your personal information

** Required*

Corresponding Author

* Title	Mr			
* Last Name	SOMVILLE			
* First Name	Pierre-René			
* Organization	Occupational Health and Health Education unit, Department of Public Health, University of Liège			
* Mailing Address	Sart Tilman B23, B-4000 Liège			
* Country	Belgium			
* Postal Code	4000			
* Phone	Country Code	0032	Number	43 66 24 91
Fax	Country Code	0032	Number	43 66 28 89
* User ID[1]	Pr.somville@ulg.ac.be (password 2rucu3)			

Authors

* Main author: Name	Pierre-R. SOMVILLE
* Presenting author: Name (if different from main author)	
Coauthor 1: Name	An Van NIEUWENHUYSE
Coauthor 2: Name	Daniele PIRENNE
Coauthor 3: Name	Guido MOENS
Coauthor 4: Name	Philippe MAIRIAUX
Coauthor 5: Name	

Required information concerning your proposal

* Title of your abstract	Validation of a self-administrated questionnaire for exposure assessment to work related low back pain risk factors	
* Name of attached file (incl. extension)	Premus2004Validation	
* Topics (see next page)	low back, exposure, biomechanics.	
* Keywords (max. 3)	questionnaire; low back pain; mechanical constraints	
* Session Type	Oral Presentation: **yes**	Poster Presentation: **yes**

[1] If you experience problems with registration, the abstract can be sent without User-ID. (but please don't!)

Abstract Number (leave blank)

Predictive value of on-site observations on the occurrence of low back pain in a cohort of young, pain free, workers

Pierre-R. SOMVILLE, An Van NIEUWENHUYSE*, Danièle PIRENNE
Guido MOENS*‡, Philippe MAIRIAUX
Department of Public Health, University of Liège, Belgium
** Department of Occupational Health, Catholic University of Leuven, Belgium*
‡ IDEWE - Occupational Health Services, Leuven, Belgium

Topic classification: low back, exposure, biomechanics.

Keywords: mechanical risk factors; low back pain; cohort study

1. Introduction

On-site ergonomic observations have been selected as the core method to assess physical workload exposure in the Belgian Low Back Cohort Study. This study over etiologic and prognostic determinants of work related low back pain involved 972 young (<31 yr) and pain free workers from either health care (n=542), distribution (n=305) or home care (n=39) sectors. Due to time and cost limitations, on-site observations only concerned a sample of the study subjects. This paper aims at analysing the predictive value of such an evaluation of exposure to physical workload on the occurrence of low back pain (LBP) at 12 month follow-up.

2. Methods

A single analyst observed each worker of the sample during 4 periods of 30 minutes randomly distributed along the shift and entered observational variables on a handheld PC every 15 seconds (1).
From the 884 cohort workers available at the beginning of the observations, 154 workers drawn from the various job categories were observed and then distributed into 23 homogeneous exposure groups (HOG). These were retrospectively defined based on expert judgement and on interview with human resources managers. These HOG's only concerned individual functions without taking into account the polyvalence system existing in the distribution sector.
From the whole set of exposure variables derived from the input observational data, the 9 variables that best discriminate between groups were selected for the outcome analysis. These variables are expressed in percentage of total coded events.
In order to perform the analysis, 31 exposure groups (EG) had to be derived from the 23 HOG's in order to take into account the polyvalence system and the percentage of time the worker spend in each function.
The 972 study subjects were then distributed into these 31 EG's and were allocated, for each of the 9 exposure variables, the average percentage value of the EG they belong to. The health outcome was evaluated on the basis of a self-administrated questionnaire and defined as an episode of LBP lasting more than 7 days within the follow up year. The outcome model included 790 workers.
Univariate relative risks were calculated for the 9 exposure variables in relation to the workers distribution by comparing workers belonging to the 4th quartile of distribution to those belonging to the 1st quartile.

3. *Results*

Table 1: Relative Risks (RR) and 95 % confidence interval (CI 95%) for the 9 exposure variables

Variable	classification	RR	IC 95%
Driving in a sitting position	>P75 vs <P25	1,35	[0,92;1,96]
Sitting position (except driving)	>P75 vs <P25	0,57	[0,33;1,01]
Trunk flexion > 20°	**>P75 vs <P25**	**2,36**	**[1,35;4,15]**
Trunk flexion > 20° with a load	**>P75 vs <P25**	**1,97**	**[1,13;3,44]**
Trunk rotation	**>P75 vs <P25**	**1,84**	**[1,04;3,24]**
Trunk flexion > 20° and rotation with a load	>P75 vs <P25	1,68	[0,98;2,89]
Lifting/carrying ≥ 1kg	>P75 vs <P25	1,49	[0,86;2,58]
Lifting/carrying ≥ 10kg	>P75 vs <P25	1,57	[0,89;2,77]
Pushing/pulling ≥ 1kgF	>P75 vs <P25	1,22	[0,75;2,03]

Table 1 show that an increased risk of developing a LBP episode is associated with the exposure to postures with the trunk bended more than 20° forward. This risk remains significant when this postural constraint is associated to the handling of a load. Moreover, a significant risk for trunk rotation is also observed. Finally it is worth noticing that the table suggests a protective effect of sitting position, the RR value being almost significant.

4. *Discussion and conclusions*

According to a recent literature review (2), strong evidence is demonstrated for a positive effect of manual handlings of loads, bending and twisting postures and exposure to whole body vibration; however, inconsistent results are found for the effect of prolonged sitting position.
The present study confirms these conclusions as regard bending and twisting postures but not for the other risk factors. Whole body vibration exposure had no effect on LBP outcome but this may be due to the fact that only a few cohort workers were exposed. The non significant results of manual handling were not expected. This could be ascribed to a possible underestimation of the actual load handling frequency in some tasks characterised by a very short cycle time, because of the 15 seconds sampling interval used in the observation protocol.
In order to interpret the observed protective effect associated to sitting position, it must be underlined that the exposure assessment methodology did not allow to measure a continuous duration in the sitting position but only a cumulative exposure to this variable.

5. *References*

(1) SOMVILLE, P. R. and MAIRIAUX Ph. Using on-site observations for low back related work load assessment. Methodological issues. In Strasser, H., Kluth, K., Rausch, H., et Bubb, H. (Ergonomia verlag), 219-222. May-2003. Munich, GfA ISOES Congress. Quality of work and Products in entreprises of the future.

(2) HOOGENDOORN WE, VAN POPPEL MN, BONGERS PM, KOES BW, and BOUTER LM. Physical load during work and leisure time as risk factors for back pain. Scand.J.Work Environ.Health, 25:387-403, 1999.

6. *Acknowledgements*

The present study is financially supported the Belgian government, SPP-PS research project PS/12/26, the SMIL foundation and the FNRS research grant S 2/5-DD-E42.

PREMUS 2004
Fifth international Scientific Conference on Prevention of Workrelated Musculosceletal Disorders

Abstract Submission Guidelines

1.	Papers should conform to the theme of the Congress
2.	Abstracts should be written in English. The 2-page Abstract including this page should be submitted by December 1st, 2003 and should be sent as a MS-Word document by email to premus-abstract@bbscongress.ch.
3.	Submitted Abstracts will be peer-reviewed by the Scientific Committee.
4.	Selected authors will be notified on the 1st of March, 2004

Enter your personal information

** Required*

Corresponding Author

* Title	Mr			
* Last Name	SOMVILLE			
* First Name	Pierre-René			
* Organization	Occupational Health and Health Education unit, Department of Public Health, University of Liège			
* Mailing Address	Sart Tilman B23, B-4000 Liège			
* Country	Belgium			
* Postal Code	4000			
* Phone	Country Code	0032	Number	43 66 24 91
Fax	Country Code	0032	Number	43 66 28 89
* User ID[1]	Pr.somville@ulg.ac.be (password 2rucu3)			

Authors

* Main author: Name	Pierre-R. SOMVILLE,
* Presenting author: Name (if different from main author)	
Coauthor 1: Name	An Van NIEUWENHUYSE
Coauthor 2: Name	Daniele PIRENNE
Coauthor 3: Name	Guido MOENS
Coauthor 4: Name	Philippe MAIRIAUX
Coauthor 5: Name	

Required information concerning your proposal

* Title of your abstract	Predictive value of on-site observations on the occurrence of low back pain in a cohort of young, pain free, workers	
* Name of attached file (incl. extension)	Premus2004observationRR	
* Topics (see next page)	low back, exposure, biomechanics	
* Keywords (max. 3)	mechanical risk factors; low back pain; cohort study	
* Session Type	Oral Presentation: **YES**	Poster Presentation: **NO**

[1] If you experience problems with registration, the abstract can be sent without User-ID. (but please don't!)

D/2004/1191/15

Published by the
Belgian Science Policy

For more informations:

Madame E. Bourgeois
Belgian Science Policy
rue de la science 8 Wetenschapstraat
Bruxelles 1000 Brussel
Tel.: +32-2-238.34.94
Fax.: +32-2-230.59.12
E-mail: boug@belspo.be
Internet: http://www.belspo.be