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ORIGINAL ARTICLE

Symptomatology of recurrent low back pain in nursing and administrative professions

Peter Schenk · Thomas Läubli · Juerg Hodler · Andreas Klipstein

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Abstract The aim of the present study was to explore if (a) recurrent low back pain (LBP) has different symptomatologies in cases from occupations with predominantly sitting postures compared to cases from occupations involving dynamic postures and frequent lifting and (b) if in the two occupational groups, different factors were associated with the presence of recurrent LBP. Hundred and eleven female subjects aged between 45 and 62 years with a long-standing occupation either in administrative or nursing professions, with and without recurrent LBP were examined. An extensive evaluation of six areas of interest (pain and disability, clinical examination, functional tests, MR examination, physical and psychosocial workplace factors) was performed. The variables from the six areas of interest were analyzed for their potential to discriminate between the four groups of subjects (administrative worker and nurses with and without recurrent LBP) by canonical discriminant analysis. As expected, the self-evaluation of physical and psychosocial workplace factors showed significant differences between the two occupational groups, which holds true for cases as well as for controls ($P < 0.01$). The functional tests revealed a tendency for rather good capacity in nurses with LBP and a decreased capacity in administrative personnel with LBP ($P = 0.049$). Neither self completed pain and disability questionnaires nor clinical examination or MR imaging revealed any significant difference between LBP cases from sedentary and non-sedentary occupations. When comparing LBP cases and controls within the two occupational groups, the functional tests revealed significant differences ($P = 0.0001$) yet only in administrative personnel. The clinical examination on the other hand only discriminated between LBP cases and controls in the nurses group ($P < 0.0001$). Neither MRI imaging nor self reported physical and psychosocial workplace factors discriminated between LBP cases and controls from both occupational groups. Although we used a battery of tests that have broad application in clinical and epidemiological studies of LBP, a clear difference in the pattern of symptoms between LBP cases from nursing and hospital administration personnel could not be ascertained. We conclude that there is no evidence for different mechanisms leading to non-specific, recurrent LBP in the two occupations, and thus no generalizable recommendations for the prevention and therapy of non-specific LBP in the two professions can be given.

Keywords Low back pain · Nurses · Sedentary work · Physical workplace factors

P. Schenk (✉) · T. Läubli · A. Klipstein
Center for Organisational and Occupational Health Sciences (ZOA), ETH Zurich, Leonhardstrasse 25a, 8092 Zurich, Switzerland
e-mail: pschenk@ethz.ch

J. Hodler
Orthopaedic University Hospital Balgrist, Forchstrasse 340, 8008 Zurich, Switzerland

A. Klipstein
Department of Rheumatology and Institute of Physical Medicine, University Hospital Zurich, Zurich, Switzerland

Introduction

Low back pain (LBP) is a widespread pain condition in the working population. It may be defined as an unpleasant sensation such as pain, strain, tension, or stiffness localized below the costal margin and above the inferior gluteal folds [1]. In about 85% of patients with LBP, no precise

patho-anatomical diagnosis can be given [2]. From epidemiological studies in the working population, several physical and psychosocial risk factors for the occurrence of episodes of LBP were established [3] and recommendations for differential diagnosis in LBP were published [4]. This breadth and diversity of concepts and instruments support the multifactorial character of LBP.

In recent years a number of studies about LBP in nurses were carried out, revealing that this occupational group is especially at risk [5–8]. This can be accounted for by the special nature of the nursing profession, which is a strenuous job involving frequent lifting, pushing and pulling in close contact to patients being in need of help. Furthermore, awkward working postures determined by the patients needs, as well as sudden, unexpected peak loads were observed in nursing aides [9]. In addition, the nursing profession must be considered as a high stress job due to the frequent occurrence of unseen events, the need to work under time pressure and impossibility to have breaks when required [10]. This is also reflected in the presence of moderate to severe burnout syndrome reported in the majority of nurses [11].

Work in the administrative division on the other hand is associated with predominantly sedentary postures, and there is a certain flexibility regarding organizational and postural adaptations in case of the presence of complaints such as LBP. Recent studies revealed that sedentary work itself was not associated with LBP [12] or sitting posture even appeared as a protective factor [13]. Nevertheless, prolonged sitting and inactivity could forward immobility and a weakened musculoskeletal system, which in turn could be associated with LBP [14].

Therefore, it is to expect that in nurses and administrative workers different factors contribute to the development of LBP, and that LBP in the two occupational groups lead to different symptoms and deficiencies. This would help to obtain a better understanding of the pathology, which would be of relevance with regard to primary and secondary prevention.

We applied a broad battery of assessment methods commonly used in clinical and epidemiological studies of LBP in order to assess the dimensions reported or expected to contribute to the occurrence of LBP to a large extent. They may topically be assigned to six areas of interest:

- Pain and disability questionnaires were applied as pain is the leading symptom in LBP and previous studies in nurses have shown that LBP is often associated with the presence of complaints in the neck, arms or legs [10]. Therefore, the assessment of complaints in other body regions and the degree of disability emerging from the presence of LBP are important factors in the assessment of LBP.
- Routine clinical examination of subjects with recurrent LBP is often subjective and has limited reliability. Nevertheless, the patient's medical history and physical assessment are important elements in order to exclude red flags and to help interpreting further findings [4, 15].
- Functional and performance based tests were included since many approaches of secondary prevention in LBP base on physical training and improving functional capacity. The underlying concepts are manifold: on the one hand, a causal association between reduced capacity of the muscles involved in global trunk stabilization and LBP was proposed [14]. On the other hand it was hypothesized that the presence of LBP over a long period of time may lead to physical inactivity and deconditioning [16]. However, functional tests merit consideration and the reliability of adequate tests has been shown to be sufficient for comparisons on a group level [17].
- Magnetic resonance imaging (MRI) has a clear place in the investigation of sciatic conditions, but its usefulness in non-specific LBP is often questioned since degenerative findings are also frequent in asymptomatic subjects [18–20]. Within the framework of this multidimensional analysis, it was of interest whether long-standing occupational exposures in administrative professions or in the nursing service lead to characteristic forms of disc degenerations. Prolonged sitting might lead to dehydration and malnutrition, whereas frequent material handling might lead to deformation and mechanical damage of the intervertebral discs.
- Physical workplace factors such as lifting and carrying weights as well as working in bent or rotated postures, are known risk factors for LBP [21–23]. For this study we used an illustrated and standardized questionnaire to assess the working postures, as well as the weights of materials handled, in order to better characterize the differences between the two occupational groups.
- Psychosocial factors gained massive attention in the research of LBP and it turned out that they are important determinants in primary and secondary prevention of non-specific LBP [24], although, at least with regard to the development of LBP, it is not conclusively clear which precise dimension of psychosocial workplace factors are the most important ones [25].

The aim of the present study was to explore, whether long-standing occupational exposures lead to different pattern of symptoms and deficiencies in LBP cases from administrative professions (exposed to prolonged, sedentary working postures) compared to LBP cases from the nursing service (doing dynamic work involving frequent walking, lifting and carrying).

Furthermore, we wanted to study whether different factors were associated with the presence of non-specific, recurrent LBP, when studying the multitude of factors expected to be relevant for the development of LBP: clinical and functional variables, MR findings, physical and psychosocial workplace factors.

This would provide information about the diagnostic value of the instruments used in the analysis of recurrent LBP and highlight the influence of characteristic, long-standing (physical) workplace factors, and give evidence for specific interventions in the prevention and therapy of non-specific LBP in subjects with different occupational loadings.

Simultaneous exploration of broad fields of potential correlates of LBP is justified because the multidimensional nature of LBP has been confirmed by many studies. But still, existing models only insufficiently predict who will develop LBP. Canonical discriminant analysis offers a tool to deal with high numbers of variables in limited datasets. Using canonical discriminant analysis, the best possible separation between groups of interest can be assessed and visualized in an educative and comprehensive way without the risk of erroneous results due to multiple testing. We believe that this method has big advantages in epidemiological studies dealing with complex risk factors and not clearly defined disorders, as it is the case with LBP.

The present study summarizes our research activities conducted within the European cost-shared project Neuromuscular Assessment in the Elderly Worker NEW (contract Nr. QLRT-2000-00139). More detailed and focused analyses of the data presented here were published in a number of papers authored by members of the NEW Consortium (eg. [26–29]).

Methods

Study design and subjects

A case control study was conducted and the subjects were selected with respect to different long-standing occupational exposures, i.e. predominantly static, sedentary work as for administrative personnel and physically demanding work, including frequent walking and lifting, as for nurses. The subjects were selected from the employees of a large hospital and inclusion criteria were a workload of a minimum of 20 h per week, having similar working tasks for at least 5 years and aged from 45 to 62 years. Subjects with neurological deficits, spinal cord compression, severe structural deformity, osteoporosis, instability, acute fractures or infections, severe cardiovascular, respiratory, autoimmune or metabolic disease, cancer or previous spinal surgery were excluded from this study.

The subjects were subdivided into LBP cases and controls based on the Nordic questionnaire [30]. Subjects who indicated 0 or 1–7 days with complaints from the lower back during the previous 12 months were considered as controls, subjects who indicated suffering from LBP on 8–30 days, more than 30 days or every day were considered as LBP cases. In total, 111 subjects met these criteria: 24 nurses with recurrent LBP and 34 healthy controls; 17 administrative workers with recurrent LBP and 36 healthy controls. The subjects signed a informed consent and all tests were approved by the responsible ethics committee.

Six areas of interest expected to be relevant with respect to LBP were studied:

Pain and self-reported disability

We assessed the frequency of complaints in eight body regions other than the lower back using the Nordic questionnaire [30]. Furthermore, we formed a score from the number of body regions with complaints reported on at least 1–7 days during the previous 12 months.

To assess the subjects' responsiveness to experimentally applied pressure stimuli, we measured pressure pain thresholds (PPT) on 12 distinct anatomical sites on the lower back and on a reference site (middle of the forehead) using a digital Dolorimeter. The PPT from the 12 low back points highly correlated with each other and a high internal consistency was shown with a Cronbach coefficient alpha > 0.95 and the 12 low back measures were averaged for further analysis [27].

To evaluate the degree of disability in everyday activities due to LBP the Roland Morris disability questionnaire (RDQ) was used [31]. The RDQ consists of 24 performance-based questions. The additional specification "because of my back" is added to each of these questions to make sure that a potential limitation was due to LBP. The 24 items were equally weighted and summed up to a score ranging from 0—meaning no disability, to 24—meaning worst disability. The RDQ proved to be a reliable and valid tool which is capable to differentiate between subjects with different intensities of LBP [32].

The subjects' workability was measured by using the work ability index WAI. The concept of work ability can be defined as the ability of a worker to perform his or her job, taking into account the specific work demands, individual health condition and mental resources [33].

The WAI is a self-administered questionnaire, which comprises of seven items and depicts the workers own concept of her workability. On a group level, the mean WAI score was found to be a stable measure over a 4-week interval and it predicted the incidence of work disability in a group of 50-year olds [34].

Clinical examination and medical history

A thorough clinical examination was performed in order to (a) identify subjects meeting the exclusion criteria and (b) to study potential distinctive features in the four groups. The medical assessors were naïve to the results of the questionnaires applied and to the profession of the subjects.

Factors assessed during clinical assessment were medication during the last months (6-level scale), visual problems during the last 6 months (VAS 0–10) and shortening of the muscles rectus femoris, psoas and hamstrings was assessed on a four-level scale. Furthermore, an extensive set of restrictions/abnormalities was assessed and the dichotomous variables were assigned to the following indicator variables:

- Medical history: nine items describing previous disorders, surgery or accidents related to the nervous, respiratory, cardiovascular, endocrine and musculoskeletal system.
- Presence of musculoskeletal disorders from six body areas other than the lower back.
- Clinical inspection: ten items describing abnormalities in the thoracic spine, the lumbar spine, the hips, as well as abnormal gait.
- Active movements: 15 items describing restrictions in the thoracic spine, the lumbar spine, the hips and the iliosacral joint.
- Neurological status: 23 items describing indications for a potential neurological problem.

Functional tests

Mobility, strength and endurance: We based the choice for the most reliable instruments on the systematic review by Essendrop et al. [17]. We assessed maximum voluntary contraction force (MVC) and endurance in trunk flexion and extension, fingertip to floor distance, side bending and performed the upper schober test. Furthermore, we measured MVC in shoulder elevation. Additionally, the subjects' cardiovascular endurance was measured in a submaximal bicycle endurance test [35]. The testing procedure is extensively described in an earlier publication [28].

Lifting capacity: Two different instruments were used to assess the subjects' lifting capacity: the functional capacity evaluation (FCE) according to Isernhagen [36] and the progressive isoinertial lifting evaluation (PILE) according to Mayer et al. [37]. Both lifting tests consist of repeatedly lifting a box of increasing weight in a lower (floor to waist) or in an upper (waist to shoulder) condition. In the FCE, which is a kinesiophysical test, the administering therapist is set into control and the tasks are stopped when biomechanical, respiratory or cardiovascular signs of maximal effort are observed or when the safe lifting limit is reached.

The PILE, on the other hand, is stopped when time limits for four repeated lifting movements are exceeded or when the cardiovascular limit is reached. The test can also be stopped by the subject when she is fatigued or feels pain. Thus the PILE measures the subjects' ability to cope with a physical load, whereas the FCE measures the limits for safe lifting and relevance with respect to physical functioning was shown to be different [28].

MR examination of the lumbar spine

MR examinations of the lumbar spine were acquired on either a 1.0 T (Siemens Expert) or a 1.5 T (Siemens Symphony) magnet (Siemens Medical Solutions, Erlangen, Germany). Based on the routine protocol used at one of the involved institutions, sagittal T1- and T2-weighted, as well as axial T2-weighted images, were obtained. Axial images of the L3/4, L4/5 and L5/S1 levels were obtained. If the technician detected abnormalities at the Th12/L1, L1/2 or L2/3 levels on the sagittal T2-weighted images, axial images were obtained at the abnormal levels.

The MR images were evaluated by a staff radiologist with a 17-year experience with MR imaging of the spine. He was blinded to the subjects' history of LBP as well as profession. Disc degeneration was classified according to [38]. The motion segments were also classified with regard to abnormal disc form, nerve root compromise, distal high intensity zones, facet joint osteoarthritis [39] and endplate abnormalities [40].

The present publication explored the potential of MR findings from the lumbar spine to contribute to a significant discrimination between the four groups studied: a comprehensive analysis of the degenerations found in the individual motion segments is published elsewhere [26].

Physical workplace factors

To assess the subjects' exposure to physical workplace factors, a partly illustrated questionnaire was developed. It contained a set of 18 questions covering the following dimensions: frequency of working postures (sitting, standing, walking, kneeling), frequency of physically strenuous work (work requires increased respiration), frequency and load manual material handling tasks (pushing, lifting, carrying), frequency of awkward working postures, frequency of different head postures. Perception of working postures and workloads was measured with five or six step Likert scales.

Psychosocial variables

To assess the psychosocial state of the subjects, a short form of the Copenhagen Psychosocial Questionnaire (COPSOQ) was used [41]. It comprises 44 questions and covers the following eight dimensions: (1) demands (quantitative demands, emotional demands, demands for hiding emotions), (2) influence and possibilities for development (influence at work, possibilities for development at work, degree of freedom at work, meaning of work and commitment to workplace), (3) social support (predictability, quality of leadership, social support, feedback at work and sense of community), (4) insecurity at work, (5) job satisfaction, (6) general health, (7) mental health and (8) vitality.

Due to limited coherence of the variables belonging to one dimension, the sub items were not summarized but used independently

Furthermore, the stress/energy questionnaire was used [42]. Scores were computed for two scales:

1 Energy: a dimension that goes from positively evaluated high activation states to negatively evaluated low activation states. Six adjectives belong to this scale: focused, energetic, active, ineffective, dull and passive.
2 Stress: a dimension that goes from negatively evaluated high activation states to positively evaluated low activation states. Six adjectives belong to this scale: tense, stressed, pressed, rested, relaxed and calm.

Statistics

Statistical analysis was carried out by use of SAS® System™, version 9.1 for Windows (SAS Institute, Cary, NC, USA). The variables and scores from the six areas of interest described above were treated independently and missing values were replaced with the variable mean.

With the variables from each area of interest, a canonical discriminant analysis was computed. The canonical discriminant analysis finds linear combinations of the original (measured) variables that provide maximal separation between the groups of interest, namely nurses and administrative worker with and without recurrent LBP. Given a classification criterion identifying the four groups of interest, first a linear combination of the original variables that has the highest possible multiple correlation with the groups of interest is derived. This variable defined by linear combination of the experimental variables is called the first canonical variable (can 1).

The second canonical correlation is obtained by finding the linear combination uncorrelated with the first canonical variable (thus perpendicular to the first canonical variable) that has the highest possible multiple correlation with the groups. Again, the second canonical variable (can 2) is defined by a second linear combination of the experimental variables.

From four groups studied, a maximum of three canonical variables can be extracted. Since the subjects examined in this study were selected according to two classification criteria (LBP and profession), we expected that the four groups can be discriminated by two canonical variables; one related to LBP and one related to the profession.

The first and the second canonical variables are displayed as scatter plots: these scatter plots represent the highest possible discrimination between the groups of interest which can be yielded using linear combinations of all experimental variables assessed in this study.

A power analysis revealed that the number of subjects included in this study was sufficient to detect an effect size of one with the chosen significance level $\alpha \leq 0.05$ (two tailed) with a power greater than 90%.

Results

Description of the subjects studied is provided in Table 1: the subjects from the four groups studied did not differ in age and height, but healthy controls from both professions were significantly lighter than the LBP cases. All subjects had long-standing occupational exposures as they all worked in the present or similar professions for long periods ranging from 18.8 to 25.8 years.

The results of the canonical discriminant analysis (i.e. the maximal possible discrimination that can be yielded by combining the original variables) in the six areas of interest are presented as scatter plots in Fig. 1. Values of the individual subjects are plotted in gray; group means are plotted in black.

In five of the six areas of interest studied, a significant discrimination between the groups was possible, but as shown in Fig. 1, there remained a substantial overlap between the four groups. The second canonical dimension did not reach the level of significance in any of the areas studied.

The discriminatory potential regarding the four groups studied is summarized in Table 2.

The self completed pain and disability questionnaires discriminated between the LBP cases and controls ($P < 0.01$) and no difference between the two occupational groups could be observed. The variable that showed the strongest association with the discriminatory first canonical variable was an index formed from the number of body regions with complaints during the last 12 months.

The clinical evaluation only discriminated between cases and controls in the nurses group ($P < 0.0001$) and an index built from clinically observed restrictions of active movements was strongest associated with the discriminatory first dimension.

Table 1 Description of the subjects studied

	Recurrent LBP		Healthy control	
	Nurses (N = 24)	Secretaries (N = 17)	Nurses (N = 34)	Secretaries (N = 36)
Age (years)	51.7 (4.4)	52.5 (4.8)	51.4 (4.5)	52.8 (5.3)
Weight (kg)	70.5 (11.0)	70.2 (15.1)	63.4 (9.4)	63.8 (14.5)
Height (cm)	165.9 (7.2)	166.9 (5.7)	163.9 (6.3)	164.3 (5.0)
Years in present or similar profession	25.8 (8.1)	18.8 (11.5)	21.4 (8.9)	19.9 (12.8)
Frequency of LBP				
1–7 days/year	0	0	18	30
8–30 days/year	12	9	16	6
>30 days/year	9	7	0	0
Every day	3	1	0	0
Regional musculoskeletal complaints (>30 days/year)				
None	8	4	30	32
In 1 body region	9	6	3	4
In 2 body regions	5	5	0	0
In 3 body regions	2	2	1	0

The frequency of low back pain (LBP), as well as complaints from eight other body regions were assessed using the Nordic Questionnaire [30]

The functional tests discriminated between cases and controls from the administrative personnel ($P = 0.0001$) and subjective feelings of exertion in trunk fatiguing tasks were strongest associated with the discriminatory first dimension. There was a trend for rather good functional capacity in nurses with recurrent LBP and a decreased capacity in administrative personnel with LBP ($P = 0.048$).

The MR imaging revealed no discriminatory power between cases and controls, nor between the two professions.

As expected, the self-evaluation of physical workplace factors showed significant differences between the occupational groups in both, cases and controls ($P < 0.001$). No impact of LBP status on the self-evaluation of the workplace factors could be observed. The factor that correlated highest with the discriminatory first canonical variable was the frequency of pushing and pulling.

The psychosocial workplace factors also showed significant differences between the occupational groups in cases ($P < 0.001$) as well as in controls ($P = 0.01$). The variable "meaning of work" correlated highest with the discriminatory first canonical variable. There was a non significant but consistent trend for more weekly working hours, lower vitality, poorer general health and worse quality of leadership in both cases groups.

Discussion

The main interest of this study was to analyze characteristics found in recurrent LBP cases compared to controls, and to examine the different symptomatologies that were expected in nurses compared to administrative workers.

In order to cope with the high number of variables derived from many tests, we topically classified the dataset into six areas of interest and conducted a discriminant analysis in each of the six areas of interest.

The four groups could not be clearly separated from each other in any of the six areas of interest. The groups strongly overlapped and the second canonical dimension did not significantly contribute to the discrimination.

Highly significant differences were present for physical and psychosocial workplace factors, which held true not only for the LBP cases, but also for the controls. By contrast, the commonly used clinical, functional and imaging methods failed to depict clear differences between LBP cases from the two occupational groups, namely nurses and administrative workers, although we used standardized and validated instruments and clear case definitions.

Pain and disability

In the area of self-reported pain and disability, the frequency of complaints from other body regions was significantly more in cases from both professions. This means that recurrent LBP was not an isolated problem, but it was strongly associated with the presence of complaints in other body regions. This could be explained by a common disorder leading to pain in several body regions, not only in the lower back. On the other hand, a detailed analysis of the PPT revealed that the groups did not differ in the subjects' sensitivity to experimentally applied pressure pain stimuli [27]. We conclude that wide spread pain merits more clinical attention as an independent entity and not as a concomitant of LBP.

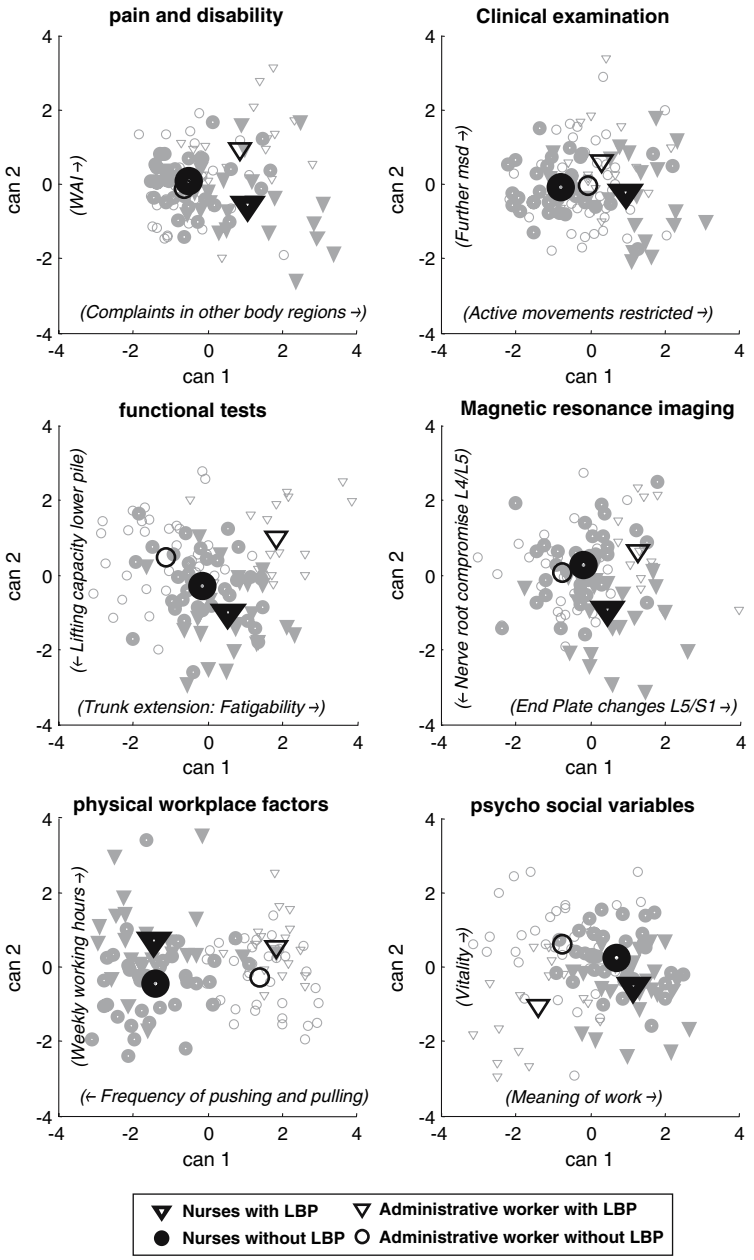

Fig. 1 Scatter plots of the first and second canonical variables in the six areas of interest. Group means are plotted in *black bold*, the values of the individual subjects are plotted in *gray*. The canonical variables are linear combinations of original variables, which yield the greatest discrimination between the four groups of subjects studied. In order to facilitate interpretation of the graphs shown, the original variables that showed the highest correlation with the canonical variables (and thus can be considered as indicator variables) are added to the plots (brackets). Except for MR findings, all fields of interest revealed a significant discrimination, yet only in the first dimension (*can 1*). Physical workplace factors obviously discriminated between the two occupational groups studied, but even there a certain overlap between the two professions is visible

Clinical examination

Clinical guidance for the management of LBP agrees on the importance of diagnostic triage [43]. Such an examination aims at identifying the minority of LBP cases with specific conditions, such as nerve root pain or severe conditions, so called red flags. Furthermore, clinical examinations are widely used in order to assess the hypothetical underlying condition of the complaints and the severity of the disablement. Based on the subjects we selected for the current study, the presence of specific conditions was not to be expected. It turned out that the clinical examination performed by two medical experts who were naïve with respect to complaints and profession, was not able to discriminate the four groups. Nevertheless, it is of interest that again, the variable about other musculoskeletal disorders (here an anamnesis finding) was associated with the two canonical variables.

Functional tests

Overall, functional tests did not clearly discriminate between the four groups. There was a major overlap between the groups, but at least cases and controls from the administrative officials group could be distinguished, yet not by objective measures of capacity but by subjective

Table 2 *P*-values of the pairwise discrimination of the four groups in the six areas of interest

	Nurses Case-control	Admin Case-control	Cases Nurse-admin	Controls Nurse-admin
Self-reported pain and disability	0.001	0.004	0.11	0.62
Clinical examination	<0.0001	0.64	0.23	0.26
Functional tests	0.55	0.0001	0.048	0.26
MRI	0.46	0.06	0.41	0.75
Physical workplace factors	0.71	0.86	<0.0001	<0.0001
Psychosocial factors	0.48	0.07	0.0002	0.01

Values are provided for the comparisons case/control in the nurses (first column), case/control in administrative worker (second column), nurses with LBP/administrative worker with LBP (third column) and finally healthy nurses/healthy administrative worker (right outermost column)

ratings of perceived exertions. This indicates that in our group of subjects from a working population, no signs of deconditioning were present. Furthermore, this supports the finding that in functional restoration, the subjective sensation and self-evaluation of one's capacity has to be considered, as well as the objectively measurable performance [44].

Magnetic resonance imaging

Possible associations between physical or occupational factors with the prevalence of disc abnormalities, and the relationship between disc degeneration and the presence of LBP has been debated controversially [45, 46]. In the present study, an extensive evaluation of different forms of degeneration in the lumbar spine could not contribute to a discrimination, neither between cases and controls nor between sedentary and non-sedentary work. MR diagnostic does not contribute to a better understanding of the development of LBP, therefore, it cannot recommended as routine assessment tool in non-specific LBP.

Physical workplace factors

It is no surprise that the subjective evaluation of working postures revealed a good separation between office workers and nurses. A few nurses intermixed with the administrative workers, which is probably due to the inclusion of specialized head nurses who do a large amount of computer work. We consider it remarkable that within the occupational groups, the workload and the working postures were evaluated identically by the cases and controls. Thus, at least in this study, the evaluation of working postures was not biased by the presence of pain.

Psychosocial variables

There is a general agreement that social, psychological and behavioral factors play a role in the development of non-specific LBP and even more, in the development of chronic back pain. Nevertheless, there are conflicting results concerning how strong they influence LBP. Recent reviews revealed strong evidence for low job satisfaction and low social support as an important risk factor for LBP [25, 47]. Within the framework of this cross-sectional study, the psychosocial factors underlined the diverse nature of the two workplaces studied but no association of these two known risk factors with LBP was found.

Previous studies in recurrent LBP identified a number of potential risk factors from many fields of interest, but the findings were controversial and failed to explain the occurrence of LBP to a satisfactory extent. To the authors' knowledge, no study so far has assessed such a multitude of factors in a common sample of subjects in order to analyze the diagnostic value of the instruments being used by many researchers. This very comprehensive analysis of many dimensions that may be associated with the occurrence LBP did not reveal correlates that could be generalized within the study population. A limitation of the applied statistical procedure might be that interactions between the factors studied could not be addressed. However, a recent study revealed that only a combination of risk factors succeed to predict the occurrence of LBP [48].

This indicates that LBP is either the result of very specific combinations of factors, or, if there should really be factors that could be generalized, they were not included in this comprehensive analysis and would probably be located in other fields, which we are not aware of.

The very clear connection between LBP and musculoskeletal disorders from other body regions could indicate that further research in recurrent LBP should rather concentrate on general musculoskeletal pain than on problems located in the lower back. But again, it has to be stated that the current study is not about heavy work and established risk factors, such as whole body vibration, are not questioned.

Methodical consideration

The strengths of the current study are that it included an extensive set of validated diagnostic instruments that covered, to a large extent, all known dimensions of recurrent LBP and that we used clear case definitions with respect to complaints and occupation. All subjects received a clinical assessment in order to check for inclusion and exclusion criteria. Furthermore, the vast majority of the subjects had the same employer, thus the bias introduced by different management philosophies in the workplaces studied could

be confined and they were occupied in the same profession for long time and, therefore, the duration of exposure was sufficient to study occupational influences.

In order to observe relevant influences by the occupation, we only included subject who had the same exposure for at least 5 years. This might lead to healthy worker effects which we can not exclude. Nevertheless, in a former study in a comparable population from the same institution, we were able to exclude a major impact of a selection by health [5].

Such a comprehensive study leads to high costs and therefore only a limited number of subjects could be included. Nevertheless, the power analysis conducted revealed, that the study sample was large enough to detect differences between the groups, as long as they have effect sizes bigger than one, which we considered as clinically relevant.

Since an extensive number of variables were collected, an adequate statistical evaluation was crucial. Canonical discriminant analysis is a promising tool for analyzing environmental factors and disorders which show unclear and variable symptomatologies, as it is the case in non-specific LBP. In the past, this statistical procedure found scarce application, eg. in the research of chronic pain [49] and falling in elderly women [50].

Using canonical discriminant analysis, the multitude of factors derived from many diagnostic tests and instruments could be analyzed, avoiding the problem of multiple testing.

The subjects included in this study were currently working and subjects suffering from LBP on 8–30 days during the last year were classified as recurrent LBP cases. Therefore they were relatively healthy compared to the subjects suffering from chronic disabling LBP often studied. This may limit general conclusions, but this may also influence the discriminating properties of some factors. Nevertheless, with respect to the understanding of mechanisms and implication to secondary prevention, the selected study population had a higher potential to detect relevant factors in an early stage.

Conclusions

In the present study the commonly used clinical, functional and imaging methods failed to depict clear differences between LBP cases from the two occupational groups, namely nurses and administrative workers. Mainly with respect to clinical examinations, the result cold not be expected and the question arises about the validity of such procedures. Highly significant differences were present for physical and psychosocial workplace factors, which holds true not only for the LBP cases, but also for the controls. This indicates that the occupation might well modulate the occurrence of LBP, but has minor impacts on the specific characteristics of the complaints and, therefore, specific recommendations on interventions in secondary prevention of LBP cannot be given.

There were different factors discriminating between LBP cases and controls in the two occupational groups: in nurses LBP was associated with a restriction of active movements, whereas in administrative workers LBP was associated with an increased perception of fatigue. In both occupational groups, the occurrence of LBP was strongly associated with the presence of complaints in other body regions. This lets us conclude that in this group of subjects selected from a working population, non-specific LBP was not an independent entity but an indicator for general responsiveness to musculoskeletal complaints.

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