Eur Spine J (2006) 15: 821–833
DOI 10.1007/s00586-005-1015-2

ORIGINAL ARTICLE

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Occupations associated with a high risk of self-reported back pain: representative outcomes of a back pain prevalence study in the Federal Republic of Germany

Received: 13 January 2005
Revised: 1 July 2005
Accepted: 31 July 2005
Published online: 24 January 2006

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Abstract Given the increasing medical and economic implications of back pain, occupation-specific prevalence data may provide important pointers for preventive programmes targeted at promoting preventive behaviour and improving conditions. The National German Health Survey is the first study to provide the basis for a representative nationwide analysis of back pain prevalence by occupational category. The net sample comprises a total of 3,488 earners aged 18–69. One in three earners in the Federal Republic of Germany (34%) experienced back pain during the 7 days prior to being interviewed. The 1-year prevalence rate is 60%. Occupational categories associated with a lower-than-average back pain prevalence are highly qualified professionals, senior management, and production occupations associated with a comparatively low degree of manual labour. In contrast, an above-average prevalence was identified for occupations associated with physically strenuous work involving one-sided postures, moving, carrying and holding heavy weights, and work typically performed in poor conditions or bad weather. Our data demonstrates significant inter-occupational differences in terms of self-reported back pain. The results underline the importance of measures to promote preventive behaviour and improve the working conditions of those in low-skill manual labour occupations.

Keywords Back pain · Occupations · Correlates · Risk factors · Prevalence

Introduction

Back pain is unquestionably one of the most serious pain problems of our time. In industrialized western countries, the lifetime prevalence of back pain ranges from 58 to 85%, with a point prevalence of 20–40% [4, 6, 46, 47, 65]. Despite medical advances, extensive occupational safety measures, and more widespread use of automated production systems in parallel with increasing tertiarization, the impact of back pain continues to increase in Germany and elsewhere; in fact, the number of back-pain-related days off work has risen in Germany by a factor of ten over the past 30 years [47]. Back pain accounts for 6% of all direct costs of morbidity, 15% of all days off work sick, and 18% of all early retirements in Germany [36, 59].

Occupation-matched statistics on the prevalence of back pain may help general practitioners to more accurately assess whether an individual case is work-related. Occupation-specific information also helps social workers and occupational physicians to identify activities requiring more extensive prevention and intervention measures and hence to initiate cost-effective behavioural prevention and environmental risk minimization measures.

Population-based occupation-matched figures on back pain prevalence are available from other countries [5, 9, 24, 28, 42], but no representative epidemiological

data has been generated in Germany to date on the prevalence of pain in specific occupational groups. Although there is no lack of clinical back pain trials conducted in defined occupational groups [30, 41], inconsistent data acquisition methods and the use of highly selective patient cohorts vastly compromise the comparability of prevalence data from individual studies, Hildebrandt argues [28].

The National Health Survey enables the first representative nationwide evaluation of the prevalence of self-reported back pain among employed people in post-reunification Germany. The purpose of the present paper is to determine the prevalence of back pain among employed persons in Germany and to establish which occupational groups display comparatively high or comparatively low pain prevalence. The pain prevalence will also be examined in relation to specific job-related risk factors as a basis for identifying pain prevention recommendations.

Material and methods

Study population

The National Health Survey is a representative epidemiological study of the Federal Republic of Germany. The survey was conducted in the period from October 1997 to March 1999 by the Robert Koch Institute in Berlin on behalf of the German Ministry of Health (MOH) and involved a total net sample size of 7,124 people with their main place of residence in the Federal Republic of Germany [60, 66]. The gross and net samples, inclusion criteria and number of non-responders can be seen in Fig. 1, which is based on the CONSORT statement on patient flow charts. Sampling was done by a three-stage random selection process. The first stage was to select communities on the basis of a weighting procedure in proportion to size. The second stage was to identify city districts and electoral districts, again in proportion to size. The third stage involved selecting an equal number of addresses from the population register in the chosen survey sites (city or electoral districts). After this stratified random selection procedure, the gross sample comprised a total of 13,222 subjects aged 18–79. Selected subjects who were now deceased, had relocated, were not known at that address, and non-German born subjects with an insufficient command of German were excluded as non-biasing non-responders. A total of 61.4% (7,124 of 11,601) of the gross sample adjusted for non-biasing non-response took part in the study [48, 54]. Non-responders were not replaced. Factor weighting was used to adjust minor remaining deviations of the net sample from the population structure of the Federal Republic of Germany. Weighting was done in a standard procedure according

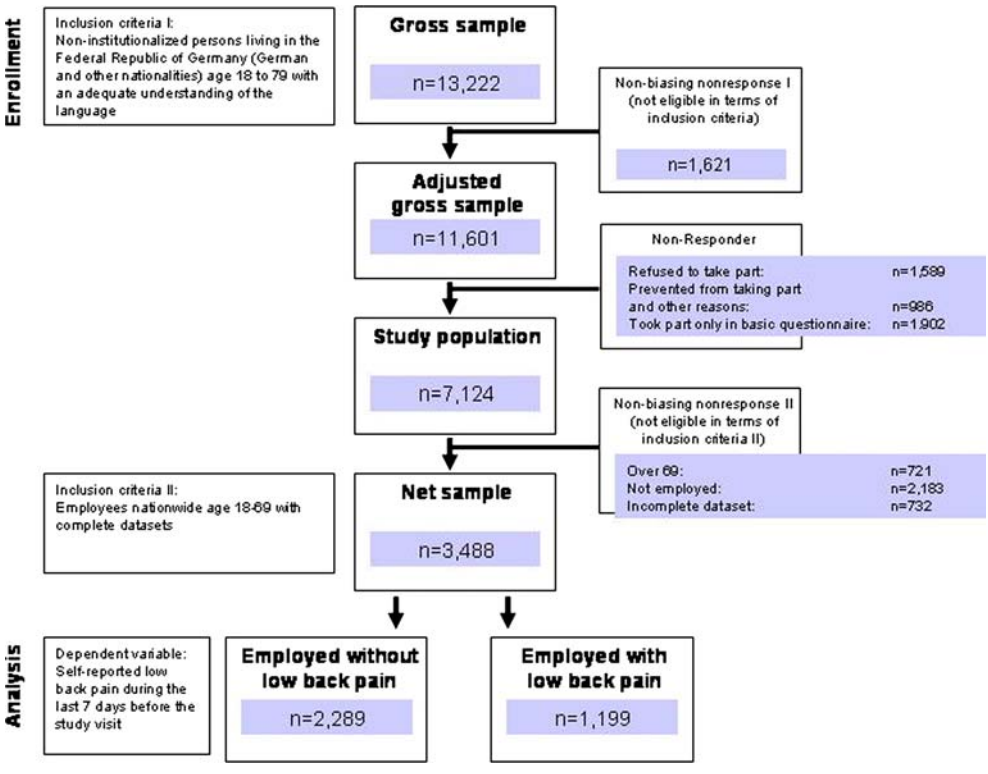

Fig. 1 Flow chart of sampling in the First National Health Survey

to the demographic variables 'West/East×federal state×gender×age'. Each subject was assigned a weighting factor with five places after the decimal point. The sum of weighting factors hence matched the original sample size [60]. The investigating team was subject to regular external quality control audits [3]. On the basis of this representative sample of the population, the conclusions drawn from the present study represent all those aged 18–69 who were full-time employed, part-time employed (minimum working hours 15 h/week), or undergoing job training at the time of the study. Subjects intermittently on sick leave were also included. After excluding those who were not employed or on long-term leave at the time of the survey (subjects on parental leave, for example), weighted cross-sectional data was hence available from a total of 3,488 people.

Documenting pain prevalence

All employed people included in the following analysis were asked whether they had experienced back pain during the past 7 days (including the survey day itself; 1 = yes, 0 = no). The 7-day prevalence of other pain locations such as the neck, shoulders, hips and legs was queried separately and, in order to ensure that different pain syndromes are clearly discriminated, will not be included in the following. Respondents were also asked for information on 1-year back pain prevalence in the question 'Did you experience back pain during the past 12 months?'

Documenting occupations and potential risk factors

Occupations: Occupations were classified in accordance with the latest revised version of the German Census Bureau's 'Classifying Occupations—Kldb92' coding system established for the Federal Republic of Germany [57]. This is the official classification system for German government authorities and is similar to the 'International Standard Classification of Occupations 1988 (ISCO 88 COM)' with modifications to take account of local circumstances [43]. Each full text reply was matched by hand to the respective two-digit occupation code (occupation codes 01-99). *Potential risk factors:* In addition to stating their occupation, subjects were asked on the day of the survey to fill out a questionnaire eliciting information on other potential risk factors. Each employed person was asked to rate the specific stress factors associated with their current job. This analysis covered the five dimensions: (1) carrying/lifting heavy weights, (2) environmental factors, (3) mental stress, (4) shift work, and (5) overtime. Work stress factors were investigated on the basis of the question: 'Does your current job involve

(1) strenuous physical activity involving one-sided posture and/or carrying heavy objects?
(2) noise, dust, gases, fumes and/or bad air?
(3) deadlines, performance pressure, heavy concentration, poor working atmosphere?
(4) overtime or long working hours?
(5) night work or shift work (night shift or alternating shifts)?'

To control for any confounders, sociodemographic particulars and information on recreational activity and individual lifestyle were also elicited. The selection of potential confounds was based on a standard literature review using the keywords 'low back pain', 'risk factor' and 'predictors' (the author will supply the research report [67] upon request). All identified factors were taken into account provided they were involved in the National Health Survey and were found to be significant in bivariate analyses (in-depth, not presented here). Satisfaction with the workplace was investigated on the basis of the question 'How happy are you with your work situation or your main occupation?', with multiple-choice answers in a seven-item Likert scale whose endpoints were 'very unhappy' and 'very happy'. An unweighted additive index made up of the three variables education, income and occupational status was calculated as a status indicator. These three dimensions were attributed the same number of categories. Each of the seven categories in each case was allocated a score of one to seven. The sum of scores gave an index score ranging from 3 to 21 points. On this basis, subjects were classified as lower class (index score: 3–8), middle class (index score: 9–14) or upper class (index score: 15–21). In the case of missing values for a particular score, this score was estimated as the arithmetic mean of the other two [66]. Since the literature views social network as one possible correlate of back pain, family support was investigated through marital status (married, single, widowed, divorced). In order to consider the scope of other sources of social support (from an unmarried partner, close friends, etc.) separately, the additional variable of 'social support' was established to code for the number of people whose help the respondent 'could depend on at any time in an emergency'. The variable 'depressiveness' denoted a subjective, though non-pathological, depressive mood: participants who indicated that they had felt discouraged or sad at least sometimes within the previous 4 weeks, and were so despondent that they could not lift their spirits, received a dummy coding of '1'.

Statistical analysis

Seven-day and 1-year back pain prevalence was first determined on an exploratory basis for all occupational

groups that had yielded at least 25 datasets. Occupational groups representing fewer respondents are not presented in the tables and percentages are rounded up to whole figures, as recommended by Altman [1] and Hildebrandt [28]. Chi-square testing was used to check for significantly different pain prevalences between individual job position categories and training. The correlation between the occupational stress factors studied and self-reported back pain was first explored by bivariate analysis. Social medical and medical sociology research shows that employed persons with an unfavourable risk factor profile (physical activity, lifting heavy weights, repetitive movements, one-sided unphysiological posture, and exposure to the elements) also display a statistically significantly higher rate of exposure to other risk factors. Thus, for example, manual workers frequently have a less healthy lifestyle than non-manual workers. For instance, they are more likely to smoke, have a higher BMI, and tend to be physically inactive during their leisure hours [51]. Such behaviours also constitute known risk factors for back pain (and other conditions, [52]). For that reason, the correlation between work-related factors and back pain was then analysed by logistic regression with potential confounders controlled for (social and lifestyle-related correlates). All tests were performed two-tailed at a level of significance of $P \leq 0.05$ (*) using the statistical program SAS for Windows, Version 8.02 (SAS Institute Inc. Cary, NC 27513, USA).

Results

Our data indicates that one in three members of the working population of the Federal Republic of Germany (34.4%) experiences back pain within a 7-day period. The 1-year prevalence is 60% for the entire working population. Table 1 starts by presenting occupational groups with a lower-than-average prevalence of subjective back pain (7-day prevalence $<34.4\%$). For instance, only one out of six engineers (16%) and one out of five physicians (19%) reported experiencing back pain within 7 days of taking part in the study (Table 1). Closer analysis shows that professionals and managers are highly represented among occupational groups with a low risk of back pain (engineers, physicians, pharmacists, entrepreneurs, managers, marketing experts, ministers, information technology experts, actors, musicians, teachers, and university lecturers). These occupations are professions belonging to the tertiary sector which the German Census Bureau classifies as technical and service occupations (occupational codes 60-93). Some occupations belonging to the secondary sector (manufacturing/construction occupations) also display below-average back pain prevalence. Artisans and production workers are typical members of manufacturing/construction occupations, which bear the occupational codes 10-59 in German labour statistics. It can be seen that the manufacturing/construction occupations featuring in Table 1 rarely involve moving heavy weights (Table 1). Examples include inspectors, crane drivers, florists, laboratory technicians, electricians and technicians.

In contrast, moving, carrying and lifting heavy weights, and/or a stooped posture are more commonly represented in the occupations associated with an above-average back pain prevalence (bricklayers, concrete masons, foremen, printers, plumbers, pipefitters, steamfitters, assembly workers) shown in Table 2 (7-day prevalence $\geq 34.4\%$). Above-average pain prevalences were also reported amongst persons employed in the services sector. In contrast to the occupational groups with third-level qualifications (Table 1), the service employees in Table 2 tend to be engaged in more menial tasks (warehouse workers, furniture movers, postal service mail carriers, cleaners, waiters/waitresses, casual labourers, geriatric nurses). These are also occupations typically involving unphysiological postures and/or moving patients or heavy objects.

In addition to providing occupational statistics, this cross-sectional study also permits a more in-depth exploration of specific work-related stress factors and hierarchical rank. While the sample sizes for individual occupation groups are too low to permit gender-matched stratification of the data, the qualitative aspects of labour focused on in the following facilitate the performance of separate analyses for males and females. Our data indicates that 43% of those in full-time or part-time employment are females. Women displayed significantly ($P < 0.05$) higher levels both in terms of 7-day prevalence (38 vs 32%) and 1-year prevalence (62 vs 58%). Social differences are clearly shown in the analysis of the socioeconomic status which is a composite score made up of income, education and occupation (Fig. 2).

Finally, the implications of known work-related risk factors for back pain were studied. This analysis shows that physically strenuous work in a one-sided physical posture and carrying heavy weights are associated with a significantly higher risk of self-reported back pain (Tables 3, 4). Employed persons not exposed to these strains are much less likely to report back pain. This is reflected in a 12% point difference among males (Table 3) and a 13% point difference among females (Table 4). Environmental factors (noise, air pollution through dust, gases and fumes) and mental stress at work seem to correlate with self-reported back pain in both genders (Tables 3, 4). In contrast, night work, shift work and long working hours do not correlate with a higher risk of back pain. Multiple logistic regression analysis was then used to test whether the work-related strains identified as relevant act per se or

Table 1 Employed persons with below-average back pain prevalence by occupation (own figures calculated from First National Health Survey data)

Occupational classification			Percentage of working population with self-reported back pain		Sample size	
Occupational group	Occupational category	Code[a]	7-day prevalence (%)	1-year prevalence (%)	*n*1[b]	*n*2[c]
Engineers	Surveyors/civil engineers	60	16.2	46.1	102	102
Physicians, pharmacists	Physicians, pharmacists	84	18.7	43.6	41	41
Quality control, occupations	Quality control officers, production supervisors	52	19.1	44.3	39	40
Security	Police officers, fire fighters, security staff	80	19.5	43.3	60	62
Machine, plant operators	Crane driver, construction machinery driver	54	23.0	56.8	37	37
Other service trades	Tourism, real estate	70	23.8	45.2	54	56
Managers, consultants, analysts	Entrepreneurs, managers, marketing experts	75	24.4	53.8	157	158
Horticultural occupations	Landscape engineers, florists, landscape architects	05	24.5	45.0	25	26
Artistic and related occupations	Professional athletes, musicians, actors	83	24.8	67.7	28	28
Assemblers and metalworkers	Electrical appliance assemblers, assemblers	32	25.6	59.2	37	38
Agricultural occupations	Farmers, vintners	01	28.0	53.1	60	61
Parliamentary deputies, administrative occupations	Ministers, administrative experts	76	28.1	50.6	39	39
Accountants, information technology experts	Accountants, information technology experts	77	28.1	55.6	119	122
Chemical occupations	Chemical lab techs, rubber processing	14	28.9	55.3	28	28
Finishers	Glaziers, carpenters, roofers	48	30.4	55.3	54	56
Wholesale and retail sales personnel	Wholesale and retail salespersons, druggists	67	30.8	54.6	151	153
Teachers	School and university teachers	87	32.0	57.3	139	140
Electrical/electronics occupations	Electricians, electronic engineers, TV repairers	31	32.1	59.3	84	85
Bank, building society, insurance clerks	Banking, insurance clerks	69	32.6	54.8	114	114
Office workers, clerks	Office managers, clerks	78	34.3	64.3	371	379

[a]Occupational group code used by German Census Bureau pursuant to occupation classification 'kldb92'
[b]Number of employed in this occupational group with datasets on 7-day prevalence
[c]Number of employed in this occupational group with datasets on 12-month prevalence

whether their impact can be seen to change if the relevant confounders are held constant.

The situation for male employees is as follows: It was shown for the male population that the risk factors shown to be significant in bivariate analysis remained in force (Table 3, Model 1). Even with lifestyle differences and age structures controlled for, the odds ratio for male respondents with exposure to heavy loads is 1.45, or 45% higher than that of other employed persons with an odds ratio of 1.00 by definition (Table 3, Model 2). Unfavourable environmental factors increase the risk of developing back pain by another 26%, and mental stress increases the risk by an additional 37% (Table 3, Model 2).

In contrast, the only morbidity-relevant factor among the female population is heavy manual labour (Table 4, Model 2: odds ratio: 1.50). More extensive analysis of the same dataset shows that overweight, depression and family situation seem to play a role as confounders in the aetiology of back pain among females while these variables are of no relevance in men.

Discussion

Limitations of the study and validity of the data

The National Health Survey elicited information on 7-day prevalence and 1-year prevalence. No further information was elicited on lifestyle prevalence or differentiation in acute vs chronic pain. The investigation of back pain was based upon the self-reports of the

Table 2 Employed persons with an above-average back pain prevalence by occupation (own figures calculated from First National Health Survey data)

Occupational classification			Percentage of working population with self-reported back pain		Sample size	
Occupational group	Occupation category	Code[a]	7-day prevalence (%)	1-year prevalence (%)	*n*1[b]	*n*2[c]
Industrial foremen, tradesmen	Industrial and technical foremen, tradesmen	65	52.8	69.0	30	30
Civil engineering workers	Bricklayers, concrete masons	44/46	47.9	68.9	76	76
Publishing, translation, librarian occupations	Interpreters, librarians	82	47.4	74.9	25	25
Personal services occupations	Hairstylists, beauticians	90	47.3	69.7	26	26
Printing and related processing occupations	Printing assistants, bookbinders	17	45.6	61.9	27	27
Service station occupations, sales reps	Service station workers, sales reps	68	45.1	65.8	49	49
Metalwork and plumbing occupations	Pipefitters, steamfitters, assembly workers	26	43.5	72.9	56	56
Other healthcare occupations	Nurses and orderlies	85	43.0	65.0	202	205
Textile, leather manufacturing occupations	Saddlers, shoemakers, tanners, tailors	35-37	42.3	54.5	31	31
Casual labourers	Casual labour; no specific occupation stated	53	40.6	62.5	51	53
Mechanics and maintenance occupations	Industrial mechanics, repairers/fitters	27	40.1	65.7	91	91
Sales occupations	Sales clerks, driver-sales workers	66	39.8	65.1	153	153
Hotel and catering occupations, domestic science and food industry occupations	Caterers, waiters/waitresses	91-92	38.5	56.7	81	83
Metal manufacturing occupations	Milling workers, welders	20-25	38.4	52.8	48	48
Security occupations	Watchman, porter, janitors	79	38.2	62.5	41	42
Social service occupations	Geriatric carers, social workers	86	37.2	59.6	136	138
Cooks	Cooks	41	37.0	72.3	48	48
Timber and plastics manufacturing occupations	Carpenters, timber workers	50	36.8	65.0	41	41
Cleaning and disposal occupations	Building cleaners, dry cleaners	93	36.4	55.8	39	39
Technicians	Electrical/construction technicians	62	36.3	64.4	107	109
Painters, lacquerers and related occupations	Painters, lacquerers	51	36.0	63.2	28	28
Communications occupations	Postal clerks, mail deliverers	73	36.0	74.6	27	28
Warehouse managers, warehouse and freight workers	Warehouse/freight workers, furniture movers	74	35.9	58.6	53	53
Transport occupations	Railroad personnel, lorry drivers	71	35.1	68.0	108	110
Vehicle, aviation construction and maintenance occupations	Bodywork and vehicle constructers	28	34.6	67.4	40	41

[a]Occupational group code used by German Census Bureau pursuant to occupation classification 'kldb92'
[b]Number of employed in this occupational group with datasets on 7-day prevalence
[c]Number of employed in this occupational group with datasets on 12-month prevalence

respondents. Vingard et al. validated self-reported back pain by objective diagnostic procedures in a population-based case-referent study and concluded that 'self-reports of pain may be sufficient enough for classifying subject in epidemiologic studies' [62]. However, it is worth noting that back pain can be caused by a variety of factors (including non-pathological ones). There is an unequivocal differential diagnosis only in a small proportion of back pain cases [29]. The fact that this study is based on self-reported questionnaire data is problematic for another reason: there is always a risk of recall bias for many of the particulars investigated [34]. Johnston et al. [31] and Byrns [13] pointed out that people with back pain may be more likely than pain-free respondents to report specific potential factors or exaggerate their importance (such as stress at work or low job satisfaction [44]) if more attention is being paid to specific possible causes, and may tend to retrospectively attribute symptoms to causes that have been singled out beforehand. It is impossible to quantify the extent of such potential sources of bias ex post for the study presented here.

Another point worthy of further consideration is the participation rate of 61.4%. Similar national interview surveys conducted in the past achieved participation rates of 57–85%, in the majority of cases between 70 and 80% [9, 15, 17, 18, 21, 38, 55]. However, most of the surveys referred to here consisted of no more than a single interview. Subjects participating in the National Health Survey, furthermore, underwent a medical

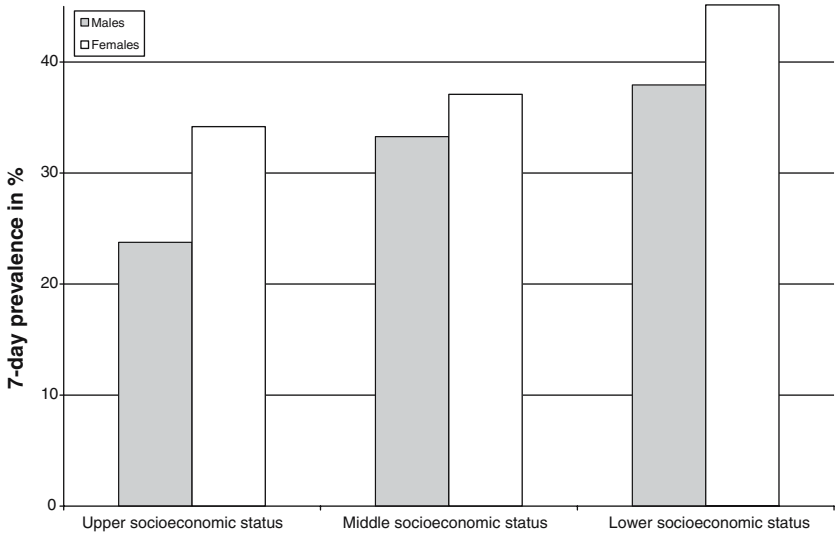

Fig. 2 Back pain prevalence for the Federal Republic of Germany by socioeconomic status and gender (own figures calculated from First National Health Survey data, $n = 3{,}488$)

examination and were required to spend several hours at the study headquarters, which helps to explain what seems at first glance to be a rather low participation rate. Half of the non-participants were prepared to provide basic health information and socioeconomic data for a non-respondent analysis. According to the data provided, non-participants and participants did not differ with regard to age, gender ratio, smoking or health, but non-participants were more likely to have lower educational qualifications [60]. Exclusion of the over-69 population ($n = 721$) and those not engaged in paid work ($n = 2183$) is qualitatively neutral. It was necessary to exclude 732 incomplete datasets and foreigners with an insufficient command of German for statistical reasons. This is a quality problem if there is reason to suppose that, for instance, people with back pain or individual sectors of the population studied separately by us filled out the questionnaires significantly more frequently or significantly less frequently than other segments. The gross sample population knew that the survey was about health issues, so it is possible that people with health problems would have been more willing to complete the questionnaires. However, because of the numerous other conditions included in the

Table 3 Prevalence of self-reported back pain for male German working population by workplace stress factors in % and resultant pain risk (odds ratio); own figures calculated from First National Health Survey data, $n = 1{,}997$

Work-related risk factors for men		Of whom: back pain during the past 7 days	Model 1[a] (pain risk with social and lifestyle factors not held constant)		Model 2[b] (pain risk with social and lifestyle factors held constant)	
			Odds ratio[c]	95% CI	Odds ratio[c]	95% CI
Lifting/carrying heavy loads	Yes	38.8%*	1.52	(1.21; 1.90)*	1.45	(1.14; 1.84)*
	No	26.7%	1.00		1.00	
Environmental factors	Yes	38.3%*	1.27	(1.02; 1.59)*	1.26	(1.01; 1.58)*
	No	27.4%	1.00		1.00	
Mental stress	Yes	35.1%*	1.35	(1.09; 1.66)*	1.37	(1.11; 1.70)*
	No	26.2%	1.00		1.00	
Shift work	Yes	34.9%[n.s.]	–	–	–	–
	No	31.0%	–	–	–	–
Overtime	Yes	32.7%[n.s.]	–	–	–	–
	No	30.5%	–	–	–	–

*$P \leq 0.05$; n.s. non-significant

[a]Adjusted for job satisfaction and sedentary occupation

[b]Adjusted for job satisfaction, sedentary occupation, age, gender, social status, marital status, social support, depression, sports and BMI

[c]The odds ratio (OR) indicates the pain risk compared with a reference group given a value of 1.00. Thus, male workers with an OR of 1.52 who are regularly exposed to lifting heavy weights at work have a 52% higher risk of back pain vs a reference group with no such exposure

Table 4 Prevalence of self-reported back pain for female German working population by workplace stress factors in % and resultant pain risk (odds ratio); own figures calculated from First National Health Survey data, $n = 1{,}491$

Work-related risk factors for women		Of whom: back pain during the past 7 days	Model 1[a] (pain risk with social and lifestyle factors not held constant)		Model 2[b] (pain risk with social and lifestyle factors held constant)	
			Odds ratio[c]	95% CI	Odds ratio[c]	95% CI
Lifting/carrying heavy loads	Yes	46.5%*	1.65	(1.30; 2.10)*	1.50	(1.16; 1.94)*
	No	33.5%	1.00	–	1.00	–
Environmental factors	Yes	45.6%*	1.26	(0.96; 1.64)[n.s.]	1.23	(0.93; 1.62)[n.s.]
	No	35.9%	1.00	–	1.00	–
Mental stress	Yes	40.4%*	1.04	(0.84; 1.31)[n.s.]	1.07	(0.85; 1.35)[n.s.]
	No	35.3%	1.00	–	1.00	–
Shift work	Yes	40.5%[n.s.]	–	–	–	–
	No	37.6%	–	–	–	–
Overtime	Yes	38.8%[n.s.]	–	–	–	–
	No	37.6%	–	–	–	–

*$P \leq 0.05$; n.s. non-significant
[a]Adjusted for job satisfaction and sedentary occupation
[b]Adjusted for job satisfaction, sedentary occupation, age, gender, social status, marital status, social support, depression, sports and BMI

survey (ranging from allergies to venous thrombosis), the study participants would not have been aware of the specific issue on which this study was focused. Likewise, it is equally hard to judge whether people with back pain might have been more likely to submit incomplete forms because of their health problems. These two effects would be inclined to cancel each other out to an extent, and the non-respondent analysis gives us no grounds to assume a greater bias than in other cross-sectional studies [60]. On the other hand, many of the foreigners with an insufficient command of German who were not included in this survey have jobs exposing them to major stress factors. This also tends to limit the robustness of this dataset.

Comparison with existing data also indicates that the results are generally applicable: the percentage of employed subjects in our dataset was 49% (3.488/7,124). Official statistics report an employment percentage of 44%. We believe this discrepancy is due to the inclusion of 15- to 17-year-old high school students and subjects over 65 by the German Census Bureau, while our inclusion criteria limited the age range from 18–65. German Census Bureau estimates indicate that females in full-time or part-time employment made up a fairly constant 43–44% of the total workforce from 1996 to 2001. Our study population was 43% female [56, 58]. In addition, 7-day and 12-month prevalences for employed persons were, as to be expected, slightly below those of the general German population [33, 49]. What is more, our prevalences correspond to those in other national surveys [14, 64].

All this merely points towards the representativeness of our data at the time the survey took place. A causal interpretation of the relationships identified between occupations, exposure to risk factors and back pain is fundamentally impossible in epidemiological cross-sectional studies like this one [8, 10]. In particular, the so-called healthy worker effect needs to be taken into account, according to which people give up or change their occupation because of physical strain and/or the morbidity resulting from it [16, 26, 39]. This migration from high-risk occupations to other jobs or to disability status produces a selection effect due to the fact that (older) people with a morbidity accumulate in the non-working cohort (which was not studied here), and due to the fact that long-standing symptoms (such as chronic back pain) can no longer be linked to the cause on a retroactive basis [9]. Thus, Dahl showed that the socio-economic class-specific difference in health status grew when formerly employed persons were factored in [19]. Given that the study described in this paper only included currently employed persons, stating their current employment, the correlation identified between exposure and back pain may actually be an underestimate [9, 26, 28, 35].

The National Health Survey is intended to provide epidemiological data for a number of medical disciplines (diabetologists, nutrition experts and cardiologists). The compulsion to maximize detection efficiency means that valid scores and measuring procedures were available for only a selection of potential risk factors (such as socioeconomic status and BMI). Other factors and confounders (such as occupational stress) were investigated only on the basis of the non-validated self-reports given in the 'Material and methods' section. Hence, it was not possible to differentiate the information on physical and mental occupational stress in terms of important aspects such as whole body vibration, working on high structures and working on uneven or slippery surfaces.

Occupational groups and back pain

The few studies identifying back pain prevalences for different occupational groups relate to the working populations of Denmark, the Netherlands, Norway, the UK and the USA. Survey data from Denmark and national accident statistics from the 1980 s shows that physical overuse is the most common cause of work-related back pain [5]. Similar to our results, the Danish data indicates that back pain is most commonly associated with manual production and physically strenuous service occupations. Plumbers, pipefitters, steamfitters and nurses are high-risk occupations in Denmark, as they are in Germany.

Hildebrandt reached similar conclusions for the Netherlands [28]. The occupations associated with the highest risk of back pain were construction and manufacturing workers among the male population and cleaners and wholesale workers among the female population. Scientists and professionals displayed the lowest prevalences.

A representative Norwegian sample also disclosed manufacturing and construction workers as having the highest risk of developing musculoskeletal symptoms [9]. Prevalences of musculoskeletal disease were twice as high among carpenters (in the male population) and among manufacturing workers and nurses (in the female population) than for (male and female) engineers and civil servants.

The occupational groups with the highest incidence rates in the UK are construction workers and clerks among males and domestic household workers and professionals among females [42]. Finally, Guo's representative data on the prevalence of back pain for the working population of the USA [24] indicates that the main high-risk occupations are carpenters and car mechanics among males and nurses, and nursing orderlies, and related occupations among females. By and large, the data from other countries closely approximates the figures presented here for Germany. Almost all the high-risk occupations documented in the literature exhibited an above-average prevalence of back pain in our study too.

Whole body vibration is being accorded increasing importance as an occupational risk factor, notably for back pain [38, 45]. For instance, European Parliament Directive 2002/44/EC is scheduled to be imposed throughout the EU by mid-2005, with the intention of protecting members of the workforce from harmful mechanical vibrations. Lorry drivers are an example of an occupational group opposed to whole body vibration [40]. Although our cohort was not asked about specific exposure, $n = 96$ lorry or bus drivers can nevertheless be identified in the 'Transport occupations' category (Table 2). The above-average prevalence scores may be cautiously interpreted as indicating the relevance of whole body vibration.

Our analysis also draws attention to a number of occupations that have not been studied closely to date. High prevalences among personal service/body care occupations (hairstylists, beauticians), sedentary occupations (publishing), and the catering industry (waiters/waitresses, cooks) indicate a need for research and preventive programs in these areas (Table 1). Conversely, closer analysis of prevalence data shows unexpectedly low prevalences among farmers, machine operators and loaders (Table 2).

Socioeconomic status, risk factors and back pain

No matter how socioeconomic status is operationalized, the results of empirical studies on the negative correlation between level of education, job rank and income indicators on the one hand and back pain prevalence on the other are highly consistent. This applies to data from countries as different as the USA, UK, Denmark, Canada, France, Netherlands, Switzerland and Sweden [15]. The effect is attributed to unhealthier working conditions, an unhealthier lifestyle and poorer medical care among lower socioeconomic groups [23, 27, 53, 64]. Information on specific work-related risk factors is particularly valuable for its preventive potential. For example, unphysiological posture and repetitive carrying, lifting and holding heavy loads are the most conclusively documented work-related risk factors for back pain [7, 12, 24, 42, 50, 62], although experts disagree as to the specific biomechanical mechanisms of action involved [64]. More in-depth analyses of our data (not presented here) show approximately identical pain scores for 0–7 h of manual labour, and a sharp increase to much higher pain scores for subjects with daily exposure to more than 7 h of heavy manual labour. Due to the fact that sustained manual labour, shorter periods spent sitting per day, and back pain are interrelated in the National Health Survey ($P < 0.05$), a more in-depth analysis of this shift effect is not possible on the basis of our data.

The health impact of work-related environmental factors such as physical, chemical and biological pollutants has also been demonstrated in numerous studies. The best-documented environmental morbidities are damage to the organs of hearing, respiratory tract and internal organs [2, 22, 44]. The impact of these pollutants on the prevalence of back pain has rarely been studied in the empirical literature. Torp et al. identified physical environmental factors (such as noise, light, ergonomics and contact with chemical products) as predictors of back pain [61]. Danish statistics additionally demonstrate the effect of frequent changes of temperature and a cold working environment in a number of occupations (such as maritime workers, cold room workers and foresters)

[5]. In contrast, Harkness et al. concluded that high temperatures were more likely to trigger back pain while a cold and humid environment was not associated with a significantly increased risk [25]. In our studies, the impact of physical stress factors did not decline significantly when the potential mental consequences of such working conditions (such as stress or subjective dissatisfaction, see Tables 3, 4, Model 1) were controlled for.

Furthermore, the fundamentally bidirectional relationship between occupational stress and back pain needs to be taken into account, in that back pain can be interpreted both as a reaction to stress and as a stressor [20, 37, 53, 63, 64]. In such a case, cause and effect may form a vicious circle [11].

Josephson et al. also interpret shift work as a potential stressor that may have an adverse effect on sleep (quantitatively and qualitatively), increase muscle tension and thus promote back pain [32]. However, the empirical data reported in Josephson's paper does little to back up this assertion; nor does our data support this claim (Tables 3, 4, Model 1). The same applies to another indirect indicator of occupational stress: overtime. Our studies agree with those of Krause et al. [35] and Bildt et al. [7] in not identifying overtime and shift work as risk factors for back disorders. Comparison of the odds ratios from Models 1 and 2 (Tables 3, 4) shows that the relevance of specific work-related factors remains virtually unchanged when known confounders are controlled for.

The aim of the study was to demonstrate occupation-related differences in the prevalence of back pain and to identify potentially high-risk occupations. The main endpoint was subjective individual perception of pain as reported by the respondent. Perception of pain is the outcome of a multidimensional process. Hence, work-related stress factors are only one cause among many in explaining the socioeconomic gradient for back pain (as presented in Fig. 2). Our biopsychosocial aetiology model is presented in Fig. 3. In addition to the occupational stress factors focused on here, (1) members of lower socioeconomic groups more commonly have a higher risk lifestyle as a result of specific socialization processes (e.g. in terms of sporting activity—or lack thereof—and the associated obesity). (2) Lower socioeconomic groups also have deficits in terms of preventive behaviour (e.g. in terms of participation in back care programmes). (3) The cited factors result in increased vulnerability, thereby increasing physical and mental comorbidity which acts as an additional stressor. (4) These processes, not only individually but interactively, result in a higher risk potential for lower socioeconomic groups. These objective stressors undergo a cognitive evaluation process before becoming manifest in a subjective perception of pain. (5) Hence, somatization tendencies (which are likewise correlated with socioeconomic status), ineffective coping styles and depressive tendencies tend to reinforce nociception.

This complex mesh of factors also explains why pain may be perceived in the absence of a morphological correlate such as physically objective spinal degeneration. Pain syndromes are in most cases denied official recognition as an occupational disease in the absence of specific lesions of the spinal vertebrae. Thus, damages

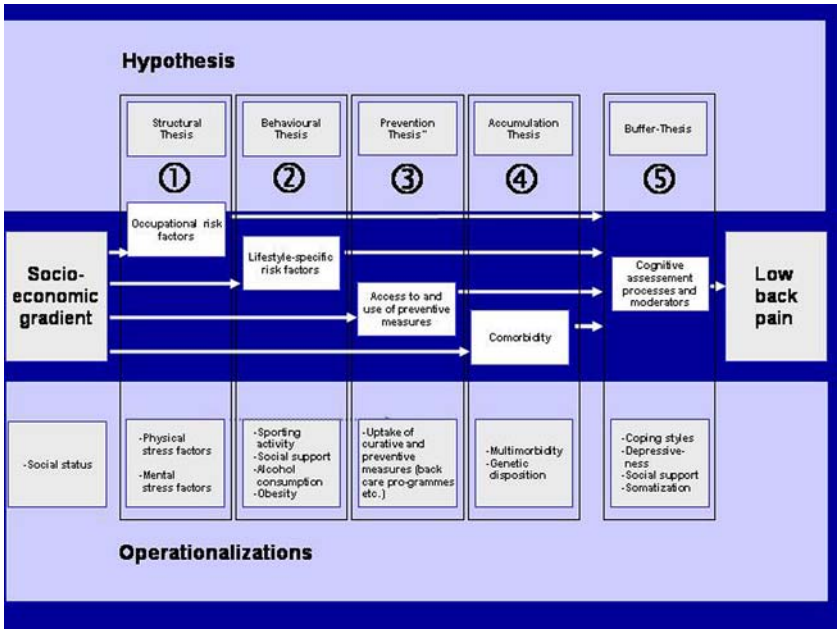

Fig. 3 Biopsychosocial model of the aetiology of the socioeconomic gradient in back pain

are awarded in less than 2% of reported 'suspected cases of work-related intervertebral disk damage involving the lumbar spine' (Annex 1 to the Occupational Diseases Regulation, No. 2108) [59]. This percentage is far below the average figure for all occupational diseases, pointing up the complexity of the phenomenon of back pain and the impact of psychosomatic aetiological factors (Fig. 3).

Conclusions

This epidemiological study is the first to provide representative data on the prevalence of self-reported back pain among individual occupational groups in post-reunification Germany. Our data demonstrates significant inter-occupational differences in the experience of back pain. Although self-reports do not permit conclusions to be drawn with regard to the underlying somatic effects and causes of individual nociception, our data does nevertheless point to particular occupational groups in which there is a very great need to study workload stress factors and devise adequate preventive and interventional action.

Acknowledgements Special thanks are due to Dr. Heribert Stolzenberg, Robert-Koch-Institut Berlin, for providing the data sets. We also wish to thank Saskia Tönges for her assistance in drafting and formatting the text. This publication was supported by a grant from the research fund of the Department of Orthopaedic Surgery, University of Heidelberg, Germany. We declare that the study was conducted in compliance with the pertinent German laws. Ethics committee approval was obtained.

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