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The Atlas of Health and Working Conditions by Occupation

1. Occupational ranking lists and occupational profiles from periodical occupational health survey data

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Abstract In this article, we describe methods which have been applied in the compilation of the *Atlas of Health and Working Conditions by Occupation.* First, we discuss the need for information systems to identify problems concerning working conditions and health. Such information systems have an exploratory purpose, being deployed to identify work risks in companies, groups of occupations and sectors of industry, and can also be a starting point for the generation of hypotheses on the causes of adverse health effects. In the Netherlands, occupational health services gather questionnaire data about work and health as part of periodical occupational health surveys. In the atlas, aggregated questionnaire data for 129 occupations with male employees and 19 occupations with female employees are presented. In this article, we explain the methodology used to compare occupations with regard to each item in the questionnaire. We then discuss applications of these occupational ranking lists. The cross-sectional nature of the data collection, various forms of selection and the limited size of some occupational populations have to be taken into account when interpreting the results. Occupational ranking lists can be applied in the allocation of resources and in the design of scientific research. The overviews for each occupation, presented in the second half of the atlas, provide an occupational profile of existing problems with respect to work and health. These profiles are used as basic information to develop a practical policy on working conditions and health.

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Introduction

Governments and the business community have an increasing need for systematically collected, adequate information about working conditions in relation to health and safety. A more conscious use of human resources and the high costs of turnover, sickness absence, and disability are among the reasons for this need.

The European Foundation for the Improvement of Living and Working Conditions has compiled an inventory of the existing information systems for the registration of working conditions in relation to safety and health in the member states of the European Union [24]. Three types of information system are distinguished:

a) Systems describing the actual working conditions of a population of employees, e.g., all employees in a country, a region or a sector of industry. Examples are surveys and census systems.

b) Systems based on data about registered occupational diseases and accidents, or absence through illness or disablement. These systems provide information on the effects of some of the working conditions.

c) Other systems which indirectly provide information about working conditions, e.g. documentation systems of chemical substances or working methods.

Surveys aimed directly at a population of employees are most informative. This is one of the conclusions of the EU study. Although there is a risk of subjectivity in the answers collected with questionnaires, the surveys based on those questionnaires provide the most detailed information about work sites, physical and mental workload, and the perceived consequences of them. Moreover, one can adjust for confounding personal factors because in most surveys this information is also collected. The practical importance of these systems is threefold: Firstly, the status of and developments in working conditions are described. Secondly, sectors of industry, occupations and work sites at risk for health damage can be identified. Thirdly, one can acquire "standards" which can serve as a reference for specific studies.

Some such questionnaire-based surveys have been conducted in recent years. Gollac [12] has described a series of French surveys containing questions about working conditions. Paoli and Litske [23] recently presented a European survey with questions regarding both health items and working conditions which was applied to samples of employees in all 12 member states of the European Union.

In the Netherlands, occupational health services (OHSs) have been collecting data as part of periodical occupational health surveys (POHSs), which were originally only periodical medical examinations. A standard questionnaire for POHSs has been available since 1981 and is currently being used by most regional OHSs [22].

Aggregation of the data on the level of departments or enterprises is possible if the questionnaire data are collected in a uniform manner. Data from several companies can then be merged, e.g., for the description of the health and working conditions in a sector of industry or in one occupation, to support the occupational health policy.

In 1991, the book *Atlas of Health and Working Conditions by Occupation* was published, providing overviews of work and health in 148 occupations [3]. In this article, the methods used to construct the overviews and the possibilities of relating differences between occupations to the classification "occupation" will be discussed. The method will be demonstrated by presenting an occupational ranking list of 129 occupations with male employees on the item "back ache complaints". The occupational ranking lists are less suited when recommendations have to be formulated for a specific occupation. For this application, the data in the atlas are also grouped by occupation in the form of occupational profiles. The occupational profile of male carpenters is presented as an example.

Materials and methods

Questionnaire data of 36 000 employees have been used. These data were gathered in POHSs carried out by the regional OHS "Oost-Gelderland" in the period 1981–1990. The questionnaire comprises 55 items about work and working conditions and 117 items about health, and is part of a periodical voluntary examination (response more than 75%) that also includes biometric assessments and

Table 1 Distribution of occupations and of employees in occupational categories within the study population, according to the classification of the Dutch Central Bureau of Statistics

	Occupations		Employees	
	Male	Female	Male	Female
	No. (%)	No. (%)	No. (%)	No. (%)
0000–1999 Scientific and other professionals, artists	15 (12%)	3 (16%)	1672 (7%)	587 (19%)
2000–2999 Policymakers and higher management positions	9 (7%)	– –	1645 (7%)	– –
3000–3999 Clerical staff	16 (12%)	10 (53%)	2438 (10%)	1679 (54%)
4000–4999 Commercial occupations	7 (5%)	– –	761 (3%)	– –
5000–5999 Service occupations	1 (1%)	4 (21%)	133 (1%)	625 (20%)
6000–6999 Agrarian occupa-ions, fishermen	5 (4%)	– –	658 (3%)	– –
7000–9999 Handicraft, industrial and transport workers and related occupations	76 (59%)	2 (11%)	16200 (69%)	193 (6%)
All occupations/ employees	129	19	23507	3084

a physical examination. A short description of a number of the items is provided by Figs. 2–4. The POHS was applied company-wise, all employees of a company being invited to participate. Occupations were coded according to the classification of occupations of the Dutch Central Bureau of Statistics (CBS) in a four-digit code [7]. Male and female employees were analysed separately because of biological and cultural differences in capacities and because of differences in working hours and in the work load at home because of household and child care duties. Notable differences between occupations in the percentage of male and female employees are an additional reason for the separate analysis. Only occupations with 50 or more employees were selected for this study. The percentages of complaints in each occupation were standardized for age to prevent age-related bias. Direct standardization for age allows comparison of occupations with each other. However, this method of standardization produces unstable complaint percentages if the age distribution of an occupation differs greatly from the age distribution of the total population, as in the case of occupations with mainly young employees. For this reason, 30 occupations were excluded from the analysis. The final file comprised 129 occupations with a total of 23 507 male employees, and 19 occupations totaling 3084 female employees. Table 1 shows a classification of the CBS occupation codes in categories of occupations.

Occupational profiles

In the occupational profiles, the items are divided into three categories, i.e., questions on health, on working conditions with an optimum percentage not equal to zero and on working conditions with an optimum equal to zero.

Optimum zero working conditions

Zielhuis [28] formulated a difference between environmental factors intrinsic to, or even essential for the human physical and mental system, and factors which are not familiar to and certainly are not needed by the system. He called these factors "system-own" and "system-strange" respectively. Harm can be caused by both an overload of system-own factors and their absence. For system-strange factors, the risk of health impairment increases with the dose. In this conceptual scheme, almost all industrial chemical substances, noise and vibration are system-strange factors. Ideally, they should be reduced to zero levels.

If a system-strange risk factor is nearly or totally absent, it is still possible that some employees will answer positively, indicating the presence of a risk. Misinterpretations of the question, and errors in filling in the questionnaire and during data processing might be the cause of a low percentage of positive answers. In contrast, we assume that a high percentage of positive answers reflects the effect of risk factors that cause feelings of overload or annoyance. Partly based on observed frequencies, a level of 15% positive answers has been chosen as a threshold value. Below this value we expect no widespread problems. To separate signals of "some load" from signals of "serious load", 30% complaints has been decided upon as a second threshold value. Both threshold values are useful for the reduction of signals.

On the other hand, a factor may be more than incidentally present although almost nobody answers positively. In situations where employees are highly selected and motivated, complaints might be prevented by a high physical capacity or by the commitment of the workers. The low score then presumably corresponds to a balance between work load and coping capacity, which conforms to the intended use of the questionnaire.

Clearly, this questionnaire is not suited for the detection of risk factors which are not experienced as a nuisance due to lack of sensory information or knowledge: especially "invisible" risks, such as asbestos and radiation, and risks with a long latency have to be detected by other instruments.

Optimum non-zero working conditions

Several working conditions have an optimum not equal to zero. Human beings need some amount of physical and mental effort. To evaluate such working conditions, we need an optimum value as reference. Both higher and lower scores could refer to undesired or hazardous work. For this category we selected the questions on strenuous physical and mental work, concentration during work, precision, time pressure and impediments caused by unexpected situations. The choice of these items was made partly on theoretical grounds and partly from experience. For example, OHSs are familiar with high scores for the items precision and concentration in most occupations, which seem to reflect a normal and even desirable situation. Only when almost all employees judge their jobs as mentally very demanding will overload be a problem. When just a few employees define their work as such, underspending of capacities might be the issue as challenges are absent.

To estimate the optimum value we used the mean value of the reference population defined as all employees in all selected occupations. For each item in each occupation the direct age-standardized percentage of complaints was computed. Finally, in each occupation the standardized item scores were compared with the scores of the reference population. Deviations were tested two-sided for significance.

Health questions

Many diseases are not work related. So-called work-related diseases [26] are explicitly defined as multicausally determined. Even so-called classical occupational diseases – defined as diseases with a high work-related aetiological component – are not completely determined by working conditions. Life-style, genetic factors and sources of infection at home are examples of non-occupational determinants of diseases. In the atlas, the prevalence of a disease in the absence of occupational risk factors is regarded as the non-occupational background level. This background prevalence varies with population characteristics and the disease in question. Therefore, to detect occupational and work-related diseases in a study population, we need a reference population.

The population without paid work is not suited for use as such a reference population as powerful selection processes control in- and outflow from paid work, resulting in healthy workers and relatively unhealthy outsiders. Consequently, the most suited reference population is a working population which is optimally exposed to work and working conditions. Difficulties arise when further selections within the working population have to be made to fulfil the criterion "optimally exposed". With respect to certain health items, relevant working conditions are not always well known. In other cases, insufficient exposure data and absence of threshold limit values complicate a valid classification. Moreover, the influence of decision latitude has to be taken into account [9, 17].

We concluded that the composition of such an ideal reference group, which has to be selected for each of the 117 health items separately, is not (yet) possible. Thus, we decided to compare the prevalence in each occupation with the prevalence in the large occupational reference population described above. In the analyses, men and women were processed separately. The prevalences of an occupation were directly age standardized as described before. This choice has the additional advantage of the application of only one reference population for all health questions and some of the work questions. The large size of the reference population also implies very stable prevalences in the various age strata. A clear disadvantage is a misclassification bias caused by relevant exposure in the reference population in cases where substantial proportions of the reference population are exposed, resulting in an underestimation of the contribution of working conditions to the prevalence of a disease [4].

Tests

All male or all female employees in the selected occupations were chosen as reference populations, using their age distribution for direct standardization [21]. Differences between each occupation and the reference population were tested with an assumption of a χ^2 distribution with one degree of freedom, and the significance was computed using formula 26.2.17 on page 932 of Abramowitz and Stegun [1]. Thus, the mean level of complaints in the reference population was used as a reference value.

In the occupational profiles, the differences for health items were only tested when the studied occupation had a higher prevalence value than the reference population. In contrast, two-sided tests were performed for work items with an optimum unequal to zero. For system-strange work items no reference values were used; hence no tests were performed.

Results

Occupational ranking lists

The first part of the atlas contains occupational ranking lists of the age-standardized percentages of complaints for all selected occupations for all health and work items separately.

We were especially interested in items showing systematic differences, possibly related to factors involved

Fig. 1 The distribution of 129 occupations with male employees on the item "pain or stiffness in the back"

Item : pain or stiffness in the back (male employees)

mean : 25 SD_x : 7.98

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% complaints  occupational codes

60

55

      9514
50
      9550

      9511
45


      1803 9490
40
      8340
      6232 7290 9541 9912
      7810 8719 9595
35    7289 7349 8199
      7250 7545 9102
      8462 8722
      2120 7029 7239 9016 9229 9913
      7021 8413 8570 9109 9312 9914
30    7790 8432 9544
      7330 9254 9599 9715 9792
      4620 6090 8369 9719
      6240 7733 8490
      7499 8322 8364 8457
25    1936 2130 3593 4722 7342 7739 9222 9440 9714 9855
       143 3106 8110 9854 9980
       283 1330 6233 6290 8333 8419 8463 8555 9392
       325 7019 8120 9019
       329 3912 3914 3998 8532 8539 8790 9859
20    2192 2194 3913 4610 9990
       331 2140 3939 7014 7016
       281 3399 3936 4812 5822 7017 8739 9393
       359 2110 3101 4520 4900
       289  390 1593 2199 3392 3920
15    3312 3999 4519
       259 3313 3938 7024
      2195
      9693
       240 9699
10    2191


 5


 0
      ________________________________________________
                         5                    10
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TOP TEN

No.	Occupation	Code
1	Road worker	9514
2	Plasterer	9550
3	Bricklayer	9511
4	Handicraftsman/woman	9490
5	Sports instructor	1803
6	Automatic mach. oper.	8340
7	Carpenter	9541
8	Metal products worker	7290
9	Bricklayers assistant	9912
10	Gardeners assistant	6232

in the work or the working conditions. When no systematic differences exist between occupations with respect to the causes of a given work or health problem, the complaint percentages for the occupations will still vary. If occupations are compared to the reference population in the absence of systematic differences, it is to be expected that 5% of the occupations will show significant differences ($P < 0.05$) in respect of any one item. Those occupations with a significantly differing complaint percentage are a random set of occupations with extreme complaint percentages based on chance. If a much greater percentage of the occupations differ significantly from the reference population on a given item, we regard this as a statistical indication of systematic differences between occupations on that item. In this way, the distribution per item enables us to differentiate between items with and items without systematic differences between occupations. We performed this analysis on the occupations with male employees because the number of occupations with female employees was relatively small. For each item, we started by computing the percentage of occupations having a significantly differing percentage of complaints. A figure of more than 10% was regarded as a statistical indication of systematic differences with respect to that item. Systematic differences between occupations were observed for 85 of the 117 health items and for all 55 work items.

As an example of an occupational ranking list, Fig. 1 shows the distribution of the complaint percentages on the item "pain or stiffness in the back". The top of each page contains a short description of the item, the mean percentage and the standard deviation. The addition of other statistical information about the distribution proved to be confusing for users not familiar with statistics. On the vertical axis the percentage of complaints increases from the bottom of the page from 0% up to 100% (for this article, the scale is adapted with a maximum of 60%). The CBS occupation codes of the 129 occupations with male employees or of the 19 occupations with female employees have been put behind the percentages equal to the directly standardized percentage of complaints for those occupations on the item concerned. From this presentation one can derive the relative position of an occupation in the total distribution of occupations. For the exact meaning of all occupation codes, the reader is referred to Broersen et al. [3]. In a separate frame, the ten occupations with the highest complaint percentages are described (or five occupations in the occupational ranking lists of female employees). The "top ten" of Fig. 1 is dominated by blue-collar occupations, especially from the construction industry. In the occupation with the highest score, the road worker ($n = 151$), more than 50% of the employees complained of regularly having pain or stiffness in the back.

The distributions of the complaint percentages on the health items without a statistical indication of systematic differences between occupations are very narrow and peaked, and the differences between occupations are small and the relative position of each occupation is not relevant. Almost all of the selected health items show a more widespread distribution with a certain central tendency: a more or less normal distribution, sometimes slightly skewed by some outliers with high percentages of complaints. Many work items, on the other hand, show a longdrawn-out distribution.

Occupational profiles

In the second part of the atlas, occupational profiles are given of 129 occupations with male and of 19 occupations with female workers. Each profile consists of three figures or histograms on separate pages: one concerning work and two concerning health questions. The prevalence among the reference population is shown if relevant. Significant differences between the occupation studied and the reference population are labelled. As an example, Figs. 2–4 show the results for the male carpenters ($n = 1821$).

For system-strange working conditions, we presented only the prevalences for the occupation concerned. Vertical lines represent the thresholds of 15% and 30% work complaints. In Fig. 2 one can see six signals of serious load ($>30\%$, i.e. annoyance by noise, dust, cold, temperature changes and by draught and uncertainty about future employment) and 18 signals of some load ($>15\%$) out of a total of 45 items with an optimum equal to zero.

In comparison with the reference population, carpenters judge their work to be physically strenuous and they experience discomfort due to prolonged standing, working in one posture and bending down. Annoyance from draught, cold and temperature changes presumably stems from outdoor work. As is wellknown from more detailed observational studies, physically strenuous tasks and outdoor work may explain the high frequency of backache and complaints of upper and lower limbs, especially of the elbow and knee. The increased prevalence of medical treatment for muscle and joint complaints and for long-lasting neck or back complaints is indicative of the seriousness and the health care costs of these complaints.

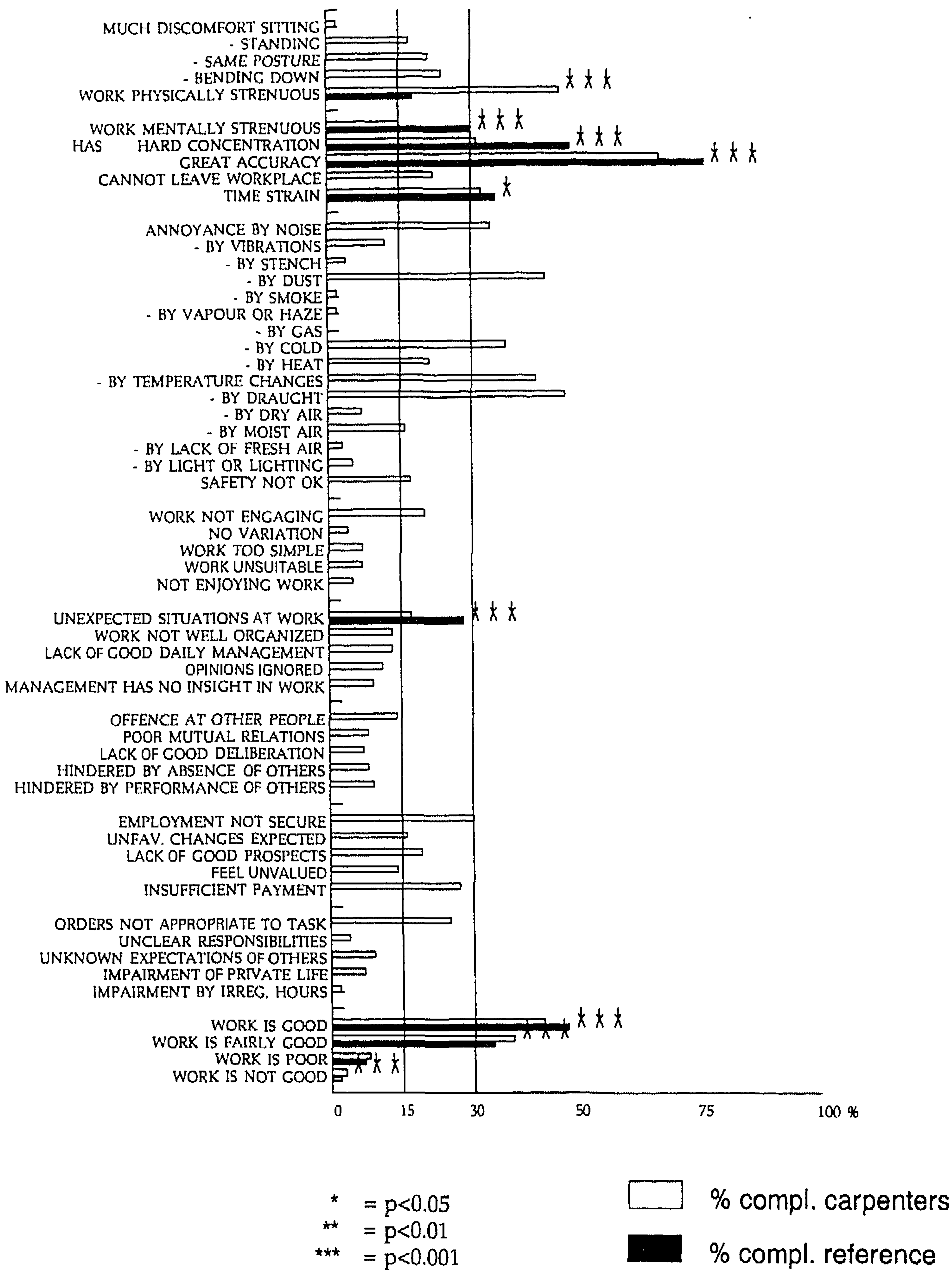
Carpenters often mention annoyance by noise and show a high percentage of hearing impairment, both of which are presumably caused by high noise levels at work. Annoyance by dust, for example wood dust, might be correlated with self-reported allergy of the lungs, in accordance with epidemiological studies.

Many carpenters are uncertain in their employment perspectives. Their work does not appear to be mentally strenuous but only a few carpenters refer to it as too simple. Generally they enjoy their work and have no substantial problems with the labour organization or their colleagues. Finally, carpenters frequently link health impairment to their working conditions. Their overall evaluation of their jobs is significantly more negative compared with the reference population. Some significant but small health differences like nervous complaints, dizziness at posture change and pain in the chest are difficult to interpret.

Discussion

The method of aggregating questionnaire data according to occupation and the presentation of the data in occupational ranking lists and occupational profiles represents an improvement in the assessment of the health risks of occupations, e.g. in the monitoring of work and health. However, several qualifying comments should be made here. The influence of the

Fig. 2 Occupational profile of male carpenters ($n = 1821$); questions on working conditions (shortened description of the items)



occupational composition of the data and of the region will be discussed in the second article [6].

Possible errors in the classification of the items

Two kinds of error can be made in using a statistical criterion for judging the presence of systematic differences between occupations. First, one can unjustly conclude that an item shows systematic differences between occupations. This occurs in cases when more than 10% of the occupations have a significantly differing percentage of complaints due to chance alone. The probability of this kind of error is calculated to be less than 1.5% per item in the case of 129 occupations. If the occupations do not differ systematically from each other on all of the items, then this probability would result in an expected number of two incorrectly judged items, an acceptable chance. Second, one can, incorrectly, conclude that no differences exist between occupations. As work-related factors vary more between occupations and as these factors more strongly dominate the response to the items, the risk of incorrectly missing differences is low [4].

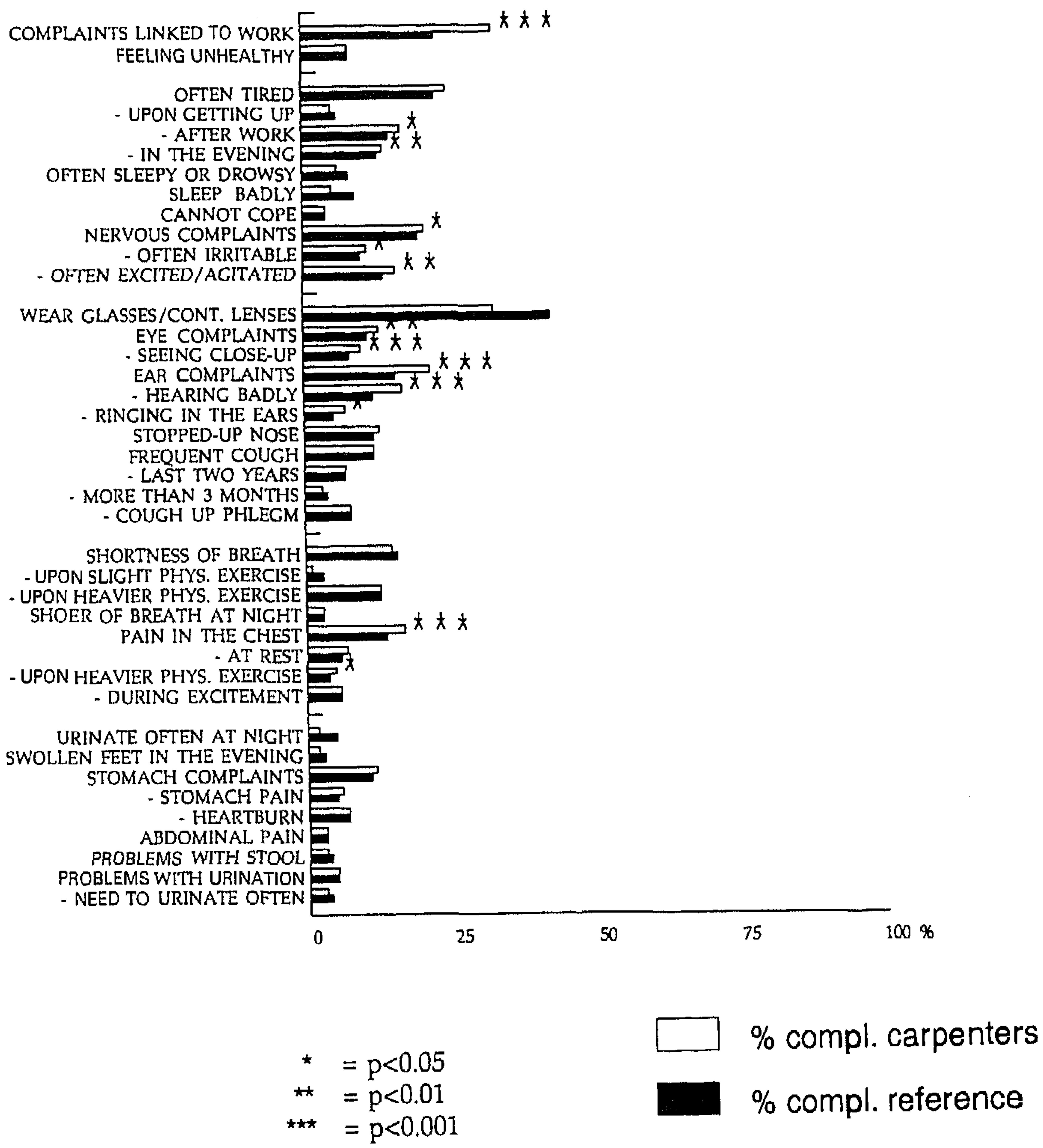


Fig. 3 Occupational profile of male carpenters ($n = 1821$); health questions part 1 (shortened description of the items)

Forms of selection

The relative position of an occupation is determined by the comparison of its complaint prevalence with the distribution of complaint prevalences of the other occupations. The presented occupations can differ systematically from one another in the percentages of complaints due to work-related factors common to all or many of the employees in one occupation, and through effects of different forms of selection.

The influence of occupation can be biased by *selective non-response*. Some of the non-respondents may have stayed away because they felt healthy. Others, by contrast, may have done so because they were treated medically or because they feared an adverse medical assessment of their work capacity. Therefore, as a result of non-response, both underestimation *and* overestimation of the percentage of complaints is possible. A rather high percentage of respondents (for example, 76% in 1989 and 78% in 1990 [2]), and the opposite effects of selective non-response, give rise to the expectation of a rather limited effect. Two studies into non-response to a POHS did not produce indications of selective non-response [13, 19].

Other relevant forms of selection are entrance and departure selection of employees in a given occupation. *Entrance selection* by the employer, for example, through a pre-employment medical examination [20], and self-selection of applicants will occur. Consequently, people with health problems will, in general, less often be appointed in demanding occupations. *Departure selection* occurs if employees with health complaints run a greater risk of prematurely leaving their job, e.g., through resignation, disablement, a redundancy scheme, or an early retirement scheme [27]. Changes in occupational cohorts caused by health problems are also well-known; for example, a construction worker with a back complaint may be reappointed as a janitor.

In cross-sectional studies which are limited to employees who are still working, especially departure selection is an important problem. Selection bias can lead to problems with validity [8] in studies into the development of health problems in the long run. In

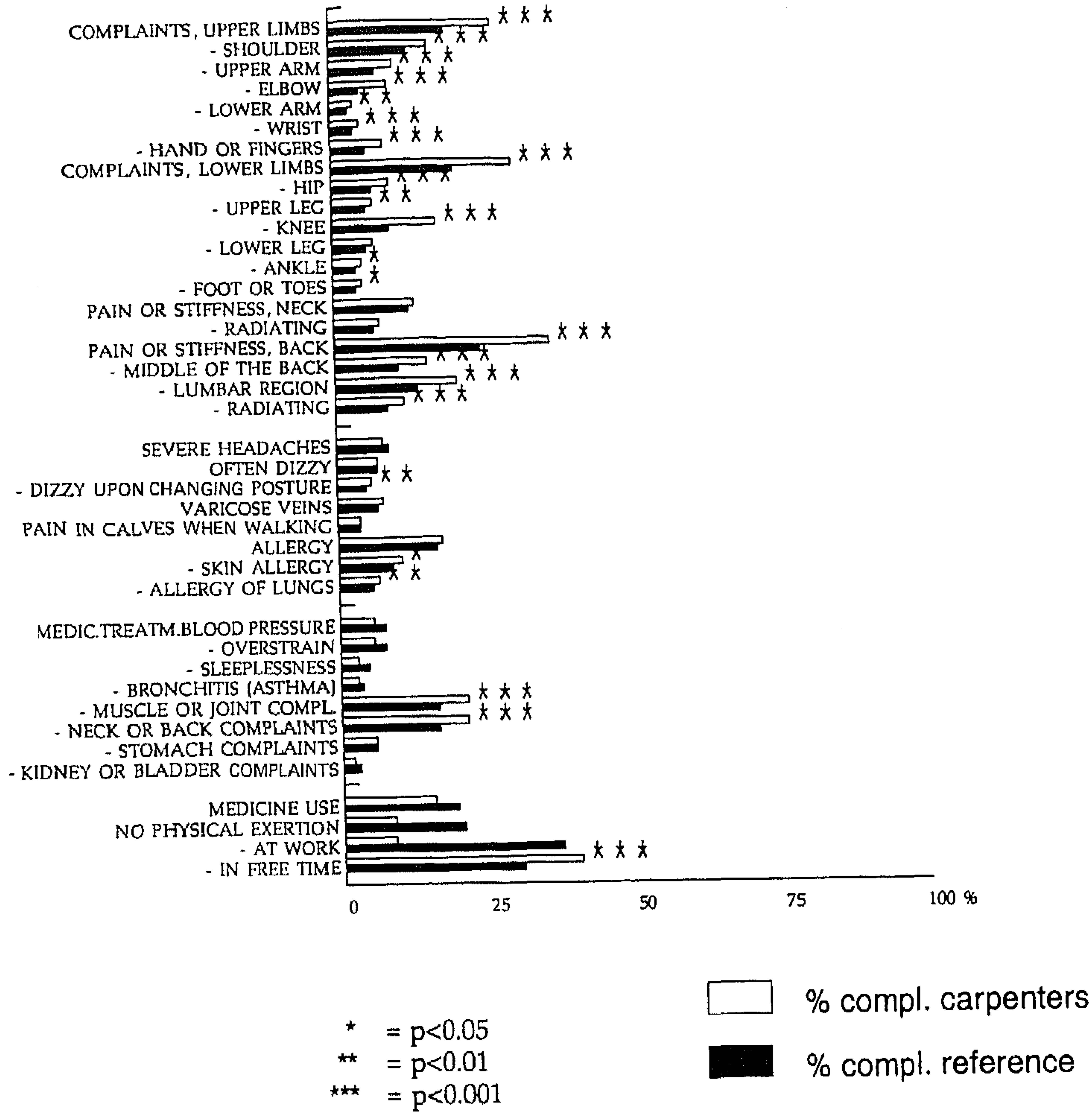


Fig. 4 Occupational profile of male carpenters ($n = 1821$); health questions part 2 (shortened description of the items)

cross-sectional analyses one frequently observes an increase in the prevalence of health complaints and disorders up to 50 or 55 years, after which a stabilization or even a decrease in complaints and disorders is found [5]. This phenomenon can be explained through an increased probability of departure of employees with complaints and diseases. This results in a relatively healthy selection of "survivors" in the older age categories [27], particularly in occupations in which the employees are highly exposed to demanding factors. For this reason, the differences between "heavy" and "light" occupations will probably be reduced by the effects of selection, resulting in an underestimation of the effects of demanding work-related factors.

Socio-economic inequalities may act as confounders in the overviews of health items, as non-occupational socio-economic class-related factors may influence the relative position of groups of occupations pursued by one socio-economic class. For instance, the influence of obesity, more often present in people with less education, on backache might be relevant. Of course, this factor cannot explain differences between occupations within a socio-economic class.

The interpretation of complaint percentages in different kinds of occupation

Where systematic differences exist between occupations, we assume the presence of causal factors in the work situation (or the population). These factors vary sufficiently to elongate the distribution of complaint percentages. Variation in causal factors can be produced by variations between occupations in the intensity of exposure or in the proportion of exposed employees.

The response to the items about work will naturally be greatly dominated by (demanding factors in) the working situation. The distributions of the complaint percentages on the work items is elongated. In the answers to the health items, factors outside of work can play an important role, e.g. complaints as a result of chronic non-occupational diseases. Especially in occupations with relatively small numbers of employees, these non-occupational causal factors may have a noticeable influence.

Demanding factors in an occupation can exacerbate a pre-existing health problem. Employees with an ankle injury and without the possibility of sitting during work will more readily complain about ankle pain compared with colleagues in sedentary jobs. We always have to keep in mind that a health complaint will partly depend on the interaction between existing health problems and working conditions. The items about work and working conditions are mainly questions about annoyance, and for the time being we assume that these items refer to a comparable experience in different kinds of occupations. To measure the demanding factor itself, objective measurement instruments are to be preferred, like a personal noise dose meter or a personal air sampler. However, for many relevant work aspects no easy-to-handle and objective measurement instruments are available, e.g., in the case of noise annoyance or time pressure or the experienced quality of the management.

Occupational profiles

In the interpretation of occupational profiles several pitfalls have to be avoided. Occupational profiles stemming from a large number of employees sometimes show significant outcomes which are small and not very relevant. On the other hand, when the number of employees is small, relevant findings can be overlooked as they are not significant in the sample.

The occupational title provides information limited to the moment of the study. No information about job history is available in the data file. Given the frequent turnover in jobs, especially among young workers, one should be cautious about using profiles to test for the presence of long-term work-related health impairment. Studies including job histories or, ideally, prospective longitudinal studies are to be preferred.

Validity of the occupational profiles is restricted to the comparison of a specific occupation with an absolute criterion or with a reference population. The temptation to combine presumed "causal factors" and "effects" within one profile is strong. However, the combined finding within one occupation of, for example, a high level of complaints about physically strenuous work and of medical treatment for muscle or joint complaints, is in itself no scientific proof of a causal effect. Even correlations between such variables on an individual level are not satisfactory. To support or reject a hypothesis of a causal relationship we need supplementary knowledge or insight from well-designed and valid dose-effect studies.

Generalization of the results is one of the aims of the Atlas. Here, too, caution is important. Workers in the same occupation can differ in exposure to work demands depending on the company and the exact nature of the job. For instance, the truck driver (code 9855) may drive locally or internationally and may have to load and unload the cargo himself or not [16]. Wide diversity within an occupational group renders generalization of the atlas results to all members of the group problematic, as the effect may be that some high- and low-risk groups are not identified.

Comparison with other studies is not easy. Gamble et al. [10] demonstrated the use of "occupational titles" in epidemiological studies in the rubber industry. "Occupational titles" refer to certain functions in the production process, like mixing or milling, where groups of workers are thought to be homogeneously exposed to chemical substances. The next step was the concept of job exposure matrices (JEMs), providing a list of specific exposures for each occupation or function [14, 15]. A problem is the limited validity in time and place and consequently the restrictions on application [11, 25]. Misclassification of exposure can distort epidemiological research [18].

JEMs are mainly meant for epidemiological research while occupational profiles are designed primarily for policy development. The similarity is nevertheless striking as both are characterized by the purpose of providing more detailed information about specific occupations or functions as well as by a validity limited in time and place. It appears logical to combine both approaches for policy consultations and for research purposes. In the future we hope to develop occupational profiles consisting of questionnaire data supplemented not only by objective toxicological and physical activity data but also by sickness absence and disability figures.

It is the task of the scientific community to support OHSs, employers and employees by providing information which is scientifically as sound as possible. However, decision-makers do not wait for the final scientific proof. We plead that the foregoing remarks and warnings should not lead to rigidity. Though occupational profiles are still imperfect, they may provide many benefits when interpreted with caution and when considered in conjunction with other data sources. The magnitude of ratios and differences can be estimated and used for cost/benefit estimations. Other sources of such broad-scale information about work perception, health complaints and medical treatment are not easy to find. Unexpected findings are derived from large files, and in the case of the carpenters, for example, constitute a reason for further research into knee complaints.

Conclusion

A statistical criterion is used to select those items of the questionnaire of the POHS which yield systematic differences in the percentages of complaints between occupations. For these items, the relative position of an occupation can be an indication of the extent of "exposure" to demanding work-related factors in that occupation. This position is partly determined by the complaint percentages of the other occupations. The 129 occupations with male employees tend to be dominated by blue-collar occupations. However, a considerable number of white-collar occupations are also present, resulting in a heterogeneous population. Therefore, the relative position forms an indication of the absence or presence of causal factors in the work situation, and one might expect an occupation with a relatively high percentage of complaints also to show a high score in another population with various kinds of occupation.

The information derived from the *occupational ranking lists* can be used for the generation of hypotheses in the design of (scientific) research. Occupations with a high or a low percentage of complaints can be selected for more detailed studies. Hypotheses about causes of complaints, diseases and disorders cannot be tested simply using the atlas, due, among other things, to its cross-sectional nature. Often, longitudinal research is required for hypothesis testing. In many studies, the work-related factors need to be measured objectively.

The most obvious application of the occupational ranking lists is for the formulation of a national and sector-orientated work and health policy. Whenever possible, atlas information should be combined with information from other sources, e.g. work site surveys, epidemiological studies and absenteeism figures, to identify problems and determine priorities. The occupational ranking lists are less appropriate in applications in which the occupation plays a central role. For these applications, the occupational profiles can provide important indicators of work and health problems. Interpretation of occupational profiles has to be cautious as there may be many pitfalls, as discussed. Nevertheless, the profiles can supply valuable additional information. They should be used in the modelling and evaluation of a work and health policy on a branch and firm level. Occupational health care experts need to be trained in the professional application of these instruments.

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