

ORIGINAL ARTICLE

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Musculoskeletal complaints in the Netherlands in relation to age, gender and physically demanding work

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Abstract Objectives: This cross-sectional study was performed in order to elucidate the relationship of musculoskeletal complaints with age, gender and physically demanding work in the Netherlands.

Methods: Questionnaire data of male ($n = 36\,756$) and female ($n = 7\,730$) employees, gathered as part of periodical occupational health surveys among active workers in the Netherlands, were stratified for age, gender, and type of work demands. For each stratified group prevalence rates (PR) were calculated for complaints of the back, neck, upper and lower extremities. Moreover, prevalence rate differences (PRD) were estimated as an absolute effect measure of exposure to various types of physical work demands, with active employees in mentally demanding work acting as a reference population.

Results: Musculoskeletal complaints among workers in physically demanding occupations were found to increase with age for both sexes. For several complaints, substantially higher rates were reported for women than for men, with a relatively high number of complaints observed among the older female workers (around 40% for complaints of back, upper and lower extremities). Significant PRDs were present in particular for employees in heavy physically demanding occupations and in jobs with mixed mental and physical work demands.

Conclusions: With the ageing of the workforce in mind, these findings stress the need for implementation of preventive measures. Special attention towards the susceptible group of female employees, the elderly age groups in particular, seems justified. In order to clarify the combined effects of age and physical work demands on musculoskeletal complaints, additional studies are required.

Key words Ageing · Physical work demands · Questionnaire · Periodical occupational health survey · Healthy-worker effect

Introduction

The economic and social costs of musculoskeletal disorders are enormous. In the Netherlands, musculoskeletal diseases are the fifth most expensive disease category regarding hospital care, and the most expensive regarding work absenteeism and disablement [39]. As in many countries, the working population in the Netherlands is ageing. In the coming years, this phenomenon may account for an increase in absenteeism and disablement costs resulting from musculoskeletal disorders.

Over the years, several cross-sectional studies on musculoskeletal complaints have reported a sharp increase in prevalence rates with advancing age for both male and female workers [2, 14]. It can be hypothesized that several age-related factors are partially responsible for this age-effect. First, biological changes related to the ageing process, e.g. degenerative changes of the intervertebral discs [5], are suggested to contribute to the pathogenesis of musculoskeletal disorders. Second, the increasing number of years in service during which ageing workers are exposed to harmful work demands have been associated with an increased risk of disorders [34, 36]. Third, a chronic overload for the elderly worker caused by a disruption of the balance between physical workload and physical work capacity with advancing age has also been suggested as a potential cause for the development of musculoskeletal disorders [10, 15].

In general, exposure to physical work demands has frequently been identified by scientific studies [21] as a risk factor for the development of musculoskeletal disorders. At present, many branches of industry in the Netherlands, characterized by strenuous, physically demanding work, are faced with a relatively large number of elderly workers [38]. For example, among male construction workers 25% are aged 45 years or more, and in

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agriculture this percentage is even higher (37%). For female workers relatively high percentages have been reported among professional cleaners (38%) and within agriculture (40%). In all age groups, participation of women in the workforce in the Netherlands has shown an accelerating increase over a number of years [4].

The present situation, as well as future developments in the age distribution of the work force, demands more insight into the effects of ageing and physically demanding work on health complaints of male and female workers, as many aspects are still not understood [41]. This kind of information is needed in particular for further development of preventive measures. The aim of the present study was to elucidate the relationship of musculoskeletal complaints with age, gender and physically demanding work in the Netherlands.

Materials and methods

Questionnaire

In the Netherlands, occupational health services (OHS) gather data about work and health by a standardized questionnaire as part of periodical occupational health surveys (POHS) among active workers. Employees of affiliated companies are invited by their OHS to participate in a POHS on a voluntary basis (participation rate 75%–80%) [40]. The POHS questionnaire comprises 117 questions about health complaints and 55 about work demands and working conditions. The response structure of these items is dichotomous: a complaint is either present or absent. For this paper, the data from four questions concerning musculoskeletal complaints were selected: (1) Do you regularly have pain or stiffness in the back? (2) Do you regularly have pain or stiffness in the neck? (3) Do you regularly have pain or stiffness in the upper extremities? (i.e. shoulder, elbow, wrist, hand or fingers, upper arm or forearm) (4) Do you regularly have pain or stiffness in the lower extremities? (i.e. hip, knee, ankle, foot or toes, upper or lower leg).

Subjects

In our study, data from POHS questionnaires to a sample of 44 486 active employees (aged 16–64 years) were used. The questionnaires were gathered between 1982 and 1993 by one regional OHS in the

eastern part of the Netherlands. The sample was characterized by workers in a wide range of occupations, including several hundreds of different job titles. The total study sample was stratified for gender (male, female), age (16–24, 25–34, 35–44, 45–54, 55–64 years) and type of work (four categories of work demands), classified on the basis of the worker's job title.

Within the four categories of work demands, the category of *mentally demanding work* was characterized by sedentary occupations mainly involving mentally demanding tasks. Examples of occupations within this category are: manager, supervisor, book-keeper, architect, scientist and secretary. Within the category of *mixed mentally/physically demanding work* occupations with a combination of mentally demanding as well as physically demanding tasks are present. The physically demanding tasks (light and heavy) are characterized by standing, walking, lifting, frequently with high physical strain on the back. Occupations such as nurse and truck driver form part of this category. The category of *light physically demanding work* includes tasks such as standing, walking and lifting of light objects which can be found in jobs such as store personnel, caretaker, cleaner, waiter, etc. Finally, the category of *heavy physically demanding work* is characterized by lifting of heavy objects, handling of heavy tools, stooping, frequently in combination with standing or walking. Examples of occupations within this category are jobs in construction work, the agricultural sector and industry. A more detailed description of this classification has been reported elsewhere [9]. In Table 1 the distribution of the study sample is presented.

Data analysis

For each stratified group, prevalence rates (PR) of the four items on musculoskeletal complaints were computed separately, expressed as the percentage of employees with complaints within a group. In order to increase the reliability of the estimated PRs, groups with 50 or less subjects were excluded from analysis. This was the case for two groups for which the results are therefore not presented in the figures and tables (see Table 1). Prevalence rate differences (PRD) and their 95% test-based confidence intervals (95% CI) were computed between the category of mentally demanding work, acting as a reference population of sedentary work, and each of the three other categories characterized by exposure to several types of physical work demands (mixed mentally/physically demanding work, light physically demanding work, and heavy physically demanding work). The effect measure PRD was chosen as it is considered to be a useful measure for estimating the absolute magnitude of the occupational health problem presented by the exposure [30]. Moreover, an absolute effect measure seems to be more appropriate according to the descriptive nature of this study.

Table 1 Number of employees studied, stratified for gender, age and type of work demands

	Age group (years)					All ages
	16–24	25–34	35–44	45–54	55–64	
<i>Male</i>						
Mentally demanding work	589	3512	4010	2447	1009	11567
Mentally/physically demanding work	61	733	902	792	311	2799
Light physically demanding work	35 ^a	126	149	156	89	555
Heavy physically demanding work	2840	6702	6978	3961	1354	21 835
Total male employees	3525	11 073	12 039	7356	2763	36 756
<i>Female</i>						
Mentally demanding work	1269	1462	767	329	85	3912
Mentally/physically demanding work	358	534	350	214	55	1511
Light physically demanding work	140	209	305	336	118	1108
Heavy physically demanding work	569	277	240	93	20 ^a	1199
Total female employees	2336	2482	1662	972	278	7730

^a Groups with 50 or fewer subjects are excluded from further analysis

PRDs are calculated by subtracting the PR of the reference group from the PR of the exposed group.

Results

Figures 1 to 4 present PRs of musculoskeletal complaints stratified for age, type of work demands, and gender. Tables 2 and 3 show PRDs and their 95% CIs for these complaints for male and female employees respectively, with the category of mentally demanding work acting as a reference population.

Back complaints

In all four categories the PRs of back complaints for both men and women increased with age until the age group of 45–54 years, followed by a sharp decline in the oldest age group (Fig. 1). For men, highest PRs were reported by workers in heavy physically demanding work (up to 36% in the age group 45–54 years). For women, highest PRs in the two youngest age groups were found for the category of heavy physically demanding work. In the age group 35–44 years, the cate-

gory of mixed mentally/physically demanding work and the category of heavy physically demanding work reported the highest rates (31%). In the oldest two age groups among women, highest PRs were observed in mixed mentally/physically demanding occupations (41% and 36%).

For male employees, significant PRDs were found for all age groups in heavy physically demanding work (highest PRD for the age group 35–44 years was 14.4%) and for the age groups between 25 and 54 years in mixed mentally/physically demanding work. For the oldest age group in light physically demanding work a negative PRD reached the level of significance (Table 2). In the category of heavy physically demanding work among women, only in the three youngest age groups significant PRDs were present (Table 3). Furthermore, significant differences were found in the three age groups between 25 and 54 years in mixed mentally/physically demanding work and the youngest age group in light physically demanding work.

Neck complaints

Among male workers, PRs of neck complaints were relatively low in all categories and increased with age. Within each age group no large differences in PRs were reported between the four categories (Fig. 2). Female employees in all types of work suffered substantially more from neck complaints when compared with males (Fig. 2). Complaints increased with age, followed by a decline in the oldest age group in the categories mixed mentally/physically demanding work and light physically demanding work. Besides the category of heavy physically demanding work, high PRs were reported in the oldest two age groups among female workers in mixed mentally/physically demanding occupations (33% and 31%).

Among men, significant PRDs were found in the age groups between 25–44 years in the category mixed mentally/physically demanding work and the three age groups between 25–54 years among workers in heavy physically demanding jobs (Table 2). For the youngest age group of female workers in mixed mentally/physically demanding occupations a significant negative PRD was found of -6.8% and a positive PRD of 8.0% in the group aged 45–54 years (Table 3). Only for the youngest workers in heavy physically demanding occupations was a significant PRD found.

Complaints of the upper extremities

PRs of complaints of the upper extremities generally increased with age for both sexes (Fig. 3). The increase in complaints among men flattened with age, and even decreased in the oldest age group of heavy physically demanding work, whereas the increase in PRs among women showed a sharp rise starting in the group aged

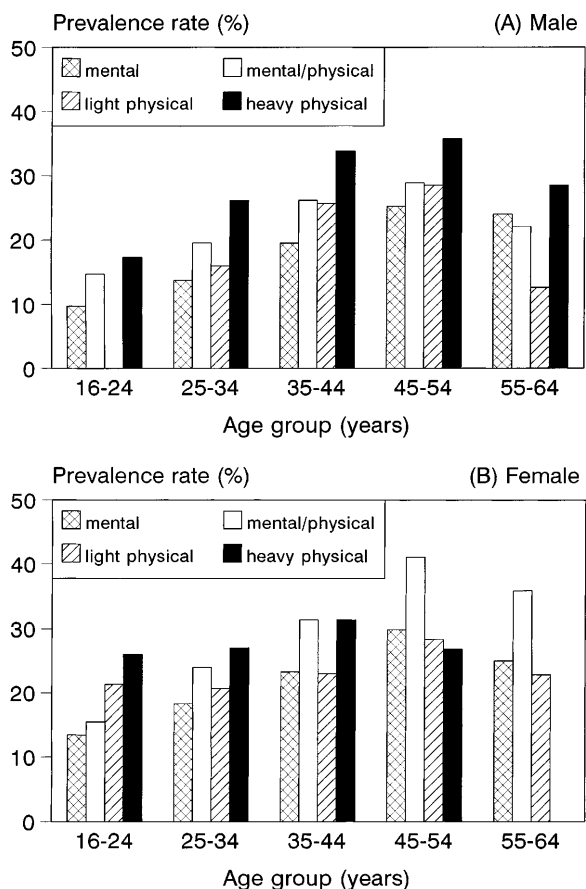


Fig. 1 Prevalence rates (PRs) of back complaints, stratified for age and type of work demands for male (A) and female (B) employees

Table 2 Prevalence rate differences and their 95% confidence intervals (in parentheses) for various musculoskeletal complaints among male employees, stratified for age and type of physical work demands with the category of mentally demanding work as a reference population

Site of complaint and type of work	Age group (years)				
	16–24	25–34	35–44	45–54	55–64
<i>Back</i>					
Mentally/physically demanding work	5.0 (–3.0, 13.0)	5.8* (3.0, 8.7)	6.7* (3.7, 9.6)	3.6* (0.1, 7.2)	–1.9 (–7.5, 3.6)
Light physically demanding work	–	2.3 (–3.9, 8.4)	6.2 (–0.4, 12.7)	3.3 (–3.9, 10.4)	–11.4* (–20.7, 2.2)
Heavy physically demanding work	7.6* (4.3, 10.8)	12.4* (10.7, 14.1)	14.4* (12.6, 16.2)	10.5* (8.2, 12.9)	4.5* (0.8, 8.1)
<i>Neck</i>					
Mentally/physically demanding work	–1.3 (–6.8, 4.2)	2.5* (0.3, 4.7)	2.2* (0.1, 4.4)	1.4 (–1.5, 4.2)	–1.5 (–6.1, 3.2)
Light physically demanding work	–	–0.6 (–5.3, 4.2)	2.0 (–2.9, 6.8)	–1.4 (–7.1, 4.2)	–3.4 (–11.4, 4.6)
Heavy physically demanding work	0.9 (–1.1, 3.0)	1.2* (0.1, 2.4)	3.7* (2.5, 5.0)	2.8* (0.9, 4.6)	1.2 (–1.9, 4.2)
<i>Upper extremities</i>					
Mentally/physically demanding work	–1.9 (–6.7, 2.9)	5.2* (3.1, 7.4)	7.5* (4.9, 10.0)	2.3 (–1.0, 5.6)	2.0 (–3.3, 7.3)
Light physically demanding work	–	–0.6 (–5.2, 4.0)	2.2 (–3.3, 7.7)	–1.2 (–7.7, 5.3)	2.7 (–6.3, 11.7)
Heavy physically demanding work	8.5* (5.7, 11.2)	10.4* (8.9, 11.8)	12.9* (11.3, 14.5)	11.4* (9.1, 13.6)	7.5* (3.9, 11.0)
<i>Lower extremities</i>					
Mentally/physically demanding work	–3.0 (–11.4, 5.3)	2.6* (0.1, 5.0)	3.0* (0.5, 5.5)	0.4 (–2.8, 3.7)	–1.2 (–6.6, 4.2)
Light physically demanding work	–	1.3 (–4.0, 6.6)	0.4 (–5.2, 5.9)	12.1* (5.5, 18.8)	5.2 (–4.1, 14.5)
Heavy physically demanding work	4.8* (1.6, 8.0)	11.7* (10.2, 13.3)	13.7* (12.0, 15.3)	10.3* (8.1, 12.5)	7.1* (3.5, 10.8)

* $P < 0.05$

35–44 years. Within all age groups of male workers, highest PRs were found for workers in heavy physically demanding jobs. This was also the case in the four age groups upto 54 years among the women. Rather high numbers of complaints were present among women aged 45–54 years (e.g. in mixed mental/physical work, 36%; and heavy physical work, 41%) and among women aged 55–64 years (e.g. in mental work, 35%; mental/physical work, 42%; and light physical work, 41%). For all categories and in all age groups the PRs of women were systematically and substantially higher than among men.

Significant PRDs were present for all age groups of men employed in heavy physically demanding occupations (Table 2). This was also the case for men between 25 and 44 years in the category mixed mentally/physically demanding work. Among female workers in heavy physical jobs, large significant PRDs were observed for the four age groups between 16 and 54 years (Table 3).

Complaints of the lower extremities

Similarly, for complaints of the lower extremities, a tendency of increasing PRs in the youngest age groups

was followed by a flattening, and even a small decrease in the category of light physically demanding work, in the older age groups among male employees (Fig. 4). In the youngest three age groups the highest number of complaints were reported among workers in heavy physically demanding jobs. In the age group 45–54 the highest PR was found in light physically demanding occupations. Among female workers a sharp rise in complaints was present from the age group of 35–44 years onward, resulting in very high PRs in the oldest age group. About 40% of the women aged 55–64 years employed in mixed mentally/physically and light physically demanding work reported complaints of the lower extremities regularly (Fig. 4).

The PRDs in the category of heavy physical work among male employees were all significant (Table 2). Other significant PRDs were found in the two age groups between 25 and 44 years in mixed mentally/physically demanding work and in light physically demanding work in the age group 45–54 years. Among women, significant PRDs were found for the two age groups between 35–54 years in mixed mentally/physically demanding work, the youngest age group in light physically demanding work, and the two youngest age groups in heavy physically demanding work (Table 3).

Table 3 Prevalence rate differences and their 95% confidence intervals (in parentheses) for various musculoskeletal complaints among female employees, stratified for age and type of physical work demands with the category of mentally demanding work as a reference population

Site of complaint and type of work	Age group (years)				
	16–24	25–34	35–44	45–54	55–64
<i>Back</i>					
Mentally/physically demanding work	2.0 (-2.1, 6.1)	5.7* (1.7, 9.7)	8.1* (2.5, 13.7)	11.2* (2.9, 19.5)	10.9 (-4.8, 26.5)
Light physically demanding work	7.9* (1.8, 14.1)	2.4 (-3.3, 8.0)	-0.3 (-5.9, 5.4)	-1.5 (-8.5, 5.5)	-2.2 (-14.2, 9.8)
Heavy physically demanding work	12.6* (8.9, 16.4)	8.7* (3.6, 13.9)	8.1* (1.7, 14.4)	-3.0 (-13.5, 7.5)	-
<i>Neck</i>					
Mentally/physically demanding work	-6.8* (-10.6, -3.1)	-3.2 (-6.8, 0.5)	2.1 (-3.1, 7.2)	8.0* (0.1, 15.9)	0.3 (-15.4, 16.0)
Light physically demanding work	-1.7 (-7.6, 4.3)	-0.7 (-6.1, 4.7)	-3.8 (-9.0, 1.5)	0.9 (-5.8, 7.6)	-11.5 (-23.5, 0.6)
Heavy physically demanding work	4.9* (1.4, 8.4)	3.4 (-1.5, 8.3)	0.6 (-5.3, 6.4)	7.4 (-2.8, 17.6)	-
<i>Upper extremities</i>					
Mentally/physically demanding work	0.2 (-3.1, 3.5)	-1.5 (-4.9, 1.9)	4.9 (-0.2, 10.0)	7.3 (-0.7, 15.4)	6.5 (-10.0, 23.0)
Light physically demanding work	3.7 (-1.3, 8.7)	0.5 (-4.6, 5.5)	3.1 (-2.2, 8.4)	4.1 (-2.9, 11.1)	5.7 (-7.9, 19.4)
Heavy physically demanding work	15.7* (12.3, 19.1)	13.1* (8.3, 17.8)	14.1* (8.1, 20.1)	12.6* (2.0, 23.3)	-
<i>Lower extremities</i>					
Mentally/physically demanding work	-1.0 (-4.0, 2.0)	0.6 (-2.4, 3.6)	4.9* (0.3, 9.6)	9.2* (1.5, 16.8)	14.4 (-1.8, 30.6)
Light physically demanding work	5.1* (0.5, 9.8)	3.7 (-0.8, 8.1)	3.3 (-1.5, 8.1)	4.1 (-2.5, 10.8)	9.7 (-3.6, 23.0)
Heavy physically demanding work	10.4* (7.3, 13.4)	10.9* (6.7, 15.0)	5.0 (-0.3, 10.3)	3.8 (-6.0, 13.7)	-

* $P < 0.05$

Discussion

In this study the relationship of musculoskeletal complaints with age, gender and physically demanding work in the Netherlands was described. PRs of musculoskeletal complaints were found to increase with age among workers of both sexes. For several complaints, substantially higher rates were reported for women than for men, with a relatively high number of complaints present among elderly female workers.

Age differences

In line with our expectations, elderly employees in physically demanding work were found to be at higher risk for musculoskeletal complaints when compared with their younger colleagues. These findings are consistent with those found in other studies among employees in the Netherlands [2, 14, 37] and abroad [22, 33].

For several complaints, a flattening or even decrease in PRs was observed in the older age groups. Several possible explanations for this trend can be given. First, this could be the result of a health-related selection of

workers out of occupations. Workers who are not able to cope with the physical work demands due to the presence of musculoskeletal complaints will drop out (with, for example, sickness absence or disability) or move to a “lighter” job. This results in a selection of relatively healthy “survivors”, in the older age groups in heavy physically demanding occupations in particular, which may have masked the real occupational health effects in these groups [27].

Second, it is hypothesized that in order to cope with heavy physical work demands ageing workers change their working method and technique [10, 19]. Cloutier [7] demonstrated that older rubbish collectors adopt specific work practices related to work rhythm and team work. Individual work technique variables have been reported to be risk factors for developing musculoskeletal disorders [18]. Thus, a change to a more efficient or safer work technique may be one of the possible explanations for flattening and decreasing PRs among the older workers in our study. In addition, a decline in physical workload for the older worker may also be achieved by a redistribution of physically heavy tasks from older to younger workers [19]. This redistribution can be the outcome of an “implied agreement” between younger and older workers, or the result of a personnel policy pursued by the management.

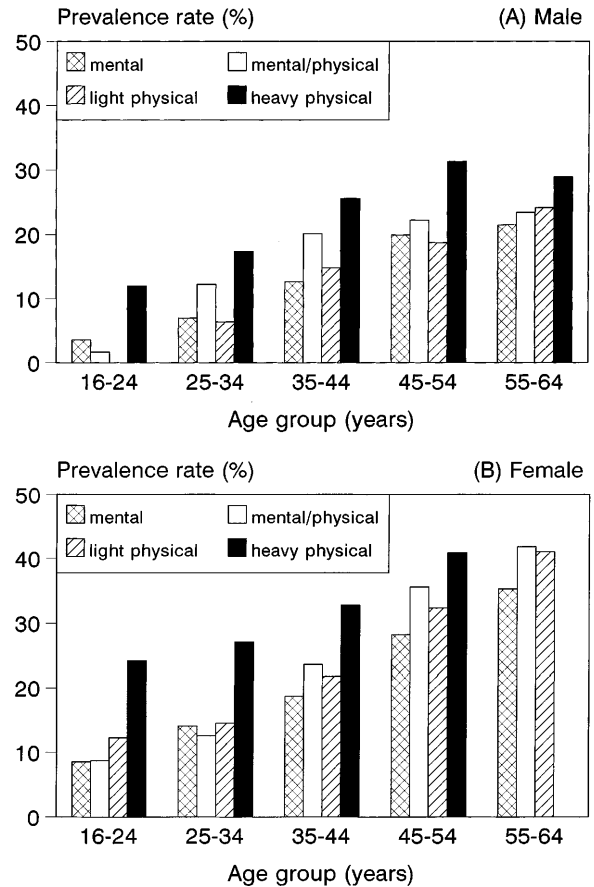
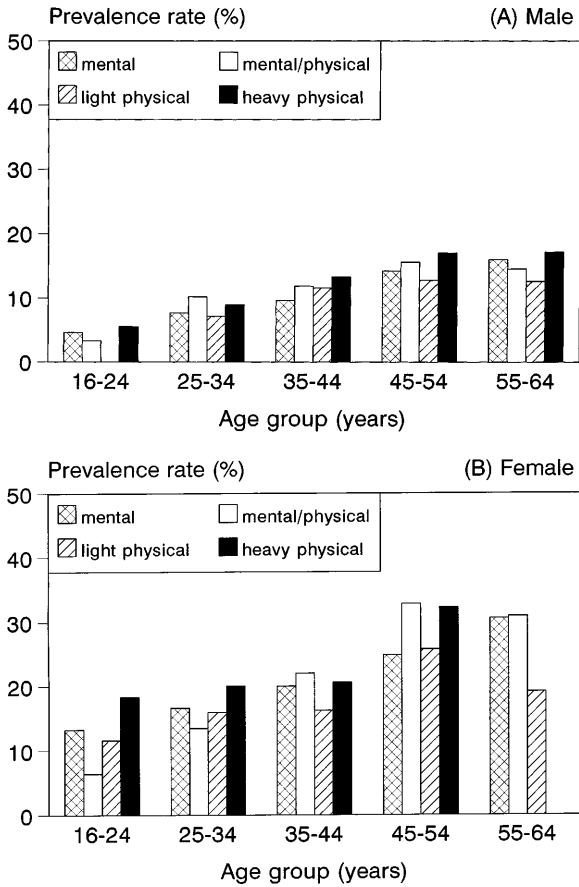


Fig. 2 Prevalence rates (PRs) of neck complaints, stratified for age and type of work demands for male (A) and female (B) employees

Fig. 3 Prevalence rates (PRs) of complaints of the upper extremities, stratified for age and type of work demands for male (A) and female (B) employees

Finally, spinal degeneration has been found to result in stabilization of the spine with increasing age. This process is characterized by increased stiffness and a reduction in mobility of the spine and is hypothesized to be one of the explanations for a diminishing prevalence of back complaints with age as seen among the workforce as well as the general population [20]. Conclusive evidence for this theory, however, is still lacking.

Gender differences

For most complaints, the observed PRs of women were substantially higher than those of men, which is consistent with observations in earlier studies [17, 35]. Whereas men reported a flattening or even decrease in PRs for complaints of the upper and lower extremities in the older age groups, the PRs of women showed a sharp rise beginning in the age group of 35–44 years. Several factors may explain these gender differences.

Biological differences between sexes may have accounted for gender-related difference in PRs of musculoskeletal complaints. In general, physical work capacity has been found to be lower for women than for men [1, 12]. This implies that the relative physiological

workload for women will be higher compared with men exposed to similar work demands [32], thereby increasing the risk of an acute or chronic musculoskeletal overload. Furthermore, for older women hormonal changes during the menopause have been found to result in a significant bone loss [31] and are suggested to be related to the dramatic peri-menopausal decline in muscle strength [28]. Both menopause-related biological changes might partly be responsible for the high PRs of musculoskeletal complaints found in our study among the elderly women. Empirical evidence for this hypothesis, however, is still poor.

Among employees, traditional gender differences can still be observed in terms of main responsibility for household duties, child care, etc. [24]. For many female employees, this double burden of paid work, often part-time, and the (physically) demanding activities at home increases the total workload over the day and reduces the opportunities of physical recovery after a working day. These factors are assumed to contribute to the increased susceptibility of women to musculoskeletal disorders [23].

Workplace design and differences in work demands between both sexes have also been associated with an increased risk of disorders for female workers. Most workplaces are inappropriate for women as they have

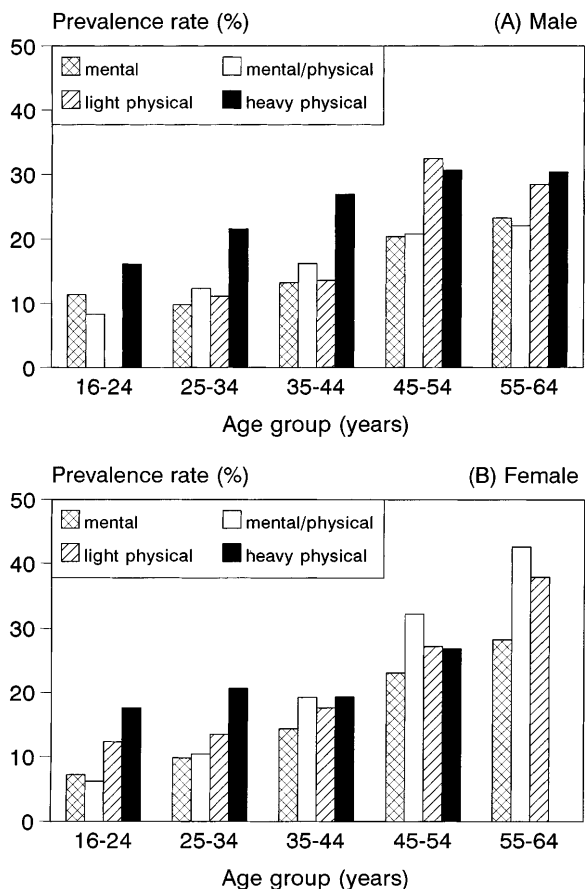


Fig. 4 Prevalence rates (PRs) of complaints of the lower extremities, stratified for age and type of work demands for male (A) and female (B) employees

been designed on the basis of anthropometric data for men [8, 26]. This is particularly the case for workplaces, machinery and tools in traditionally male occupations such as agricultural work [11]. Also, differences can be found between males and females in type of work demands and occupations resulting in different levels of absolute physical workload [32]. Women are often employed in monotonous and repetitive jobs [23] such as, within the manufacturing industry [8], which might explain the high PRs for complaints of the upper extremities observed among women in heavy physically demanding work. Within our survey sample, several occupations were found to be gender-related. In the category of mixed mentally/physically demanding work, 50% of the men were employed as transport equipment operators (e.g. bus driver, truck driver) versus 0 among women. On the other hand, in this category, 61% of the women were employed in medical occupations versus 10% among men.

A more psychosocial explanation suggested in the literature is that female workers are not at increased risk for health disorders but are more likely to report these complaints than men are [17]. According to this line of reasoning, gender-related differences are the result of information bias.

Physical work demands

The cross-sectional nature of this study limits the possibility of determining a causal relation between work factors and musculoskeletal disorders [13]. However, cross-sectional studies based on large, well-defined and representative populations, as in our study, can give reliable estimates of PRs and can suggest risk indicators that can be tested in other (longitudinal) studies [25].

Despite the fact that rather crude exposure measures were used in this study and various forms of selection have presumably underestimated the real occupational risks, the results indicated an association between heavy physically demanding work and musculoskeletal complaints in almost all age groups for men and for a lesser number of age groups among women. Heavy physically demanding work in this study was characterized by performance of heavy demanding tasks such as lifting of heavy objects, handling of heavy tools and stooping, frequently in combination with standing or walking. Most of these work-related factors have been identified as risk factors in earlier studies [29]. Noticeable were the small differences in PRs for neck complaints between mentally demanding work and heavy physically demanding work. A possible explanation for this finding might be the presence of a high psychological workload within our reference category of mentally demanding work. This characteristic work factor has frequently been associated with an increased risk for the onset of neck and shoulder symptoms in particular [16]. A second explanation could be the widespread use of video display terminals in mentally demanding occupations. Operation of these terminals is characterized by a constant static load on the muscles of the neck and shoulder area increasing the risk of disorders [6].

The PRDs were found to vary across the age strata. For the male workers highest PRDs were reported in the age group 25–44 years. The low estimated risks for the youngest age groups are presumably the result of the small number of years of exposure, entrance selection of healthy persons, and a high turnover rate among younger workers in physically demanding occupations. On the other hand, the low estimated risks for the oldest age group are most likely to be the outcome of the earlier mentioned effects of health-related selection among the exposed groups in particular. It may be assumed that these age-specific selection mechanisms significantly bias the results of studies on the combined effects of age and physical work demands on musculoskeletal complaints. Therefore, data from cross-sectional study designs, which are particularly vulnerable to selection effects among workers, seem to be less suitable for these kind of studies.

Subjects and questionnaire data

Although subjects in this study represented workers of one region of the Netherlands, trends reported in our

study with respect to age and gender differences were found to show correspondence with similar large scale surveys in the Netherlands [2, 14] and abroad [22, 35].

The outcome measure of self-reported complaints by means of a questionnaire, as used in this study, can be considered to be rather crude and subjective. Its measurement depends on the perception and the description of the person experiencing it. Whether an employee complains about a particular health problem will depend partly on the interaction between (existing) health problems on the one hand and working conditions on the other [3]. The high PRs of musculoskeletal complaints reported for workers in heavy physically demanding jobs may be explained partly by these interaction effects, but are not assumed to explain all.

Conclusions

This study confirms the conclusion of previous studies that the risk of musculoskeletal complaints among workers in physically demanding occupations increases with advancing age. With the ageing of the workforce in mind, these findings stress the need for implementation of preventive measures. Special attention to the susceptible group of female employees, the elderly age groups in particular, seems justified. In order to clarify the combined effects of age and physical work demands on musculoskeletal complaints, additional studies are required.

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References

- Åstrand P-O, Rodahl K (1986) Textbook of work physiology. McGraw-Hill, New York
- Broersen JPJ, De Zwart BCH, Van Dijk FJH, Meijman TF, Van Veldhoven M (1996) Health complaints and working conditions experienced in relation to work and age. *Occup Environ Med* 53: 51-57
- Broersen JPJ, Van Dijk FJH, Weel ANH, Verbeek JHAM (1995) The atlas of health and working conditions by occupation. 1. Occupational ranking lists and occupational profiles from periodical occupational health survey data. *Int Arch Occup Environ Health* 67: 325-335
- Bruyn-Hundt M (1994) Distribution of paid and unpaid work of people of 50 plus in the Netherlands. In: Snel J, Cremer R (eds) *Work and aging: a European prospective*. Taylor and Francis, London
- Buckwalter JA (1995) Aging and degeneration of the human intervertebral disc. *Spine* 20: 1307-1314
- Carter JB, Banister EW (1994) Musculoskeletal problems in VDT work: a review. *Ergonomics* 37: 1623-1648
- Cloutier E (1994) The effect of age on safety and work practices among domestic trash collectors in Québec. *Safety Sci* 17: 291-308
- Cox S, Cox T (1984) Women at work: summary and overview. *Ergonomics* 27: 597-605
- De Zwart BCH, Broersen JPJ, Van der Beek AJ, Frings-Dresen MHW, Van Dijk FJH (submitted) Occupational classification into work demands: an evaluation study. *Int J Occup Med Environ Health*
- De Zwart BCH, Frings-Dresen MHW, Van Dijk FJH (1995) Physical workload and the ageing worker: a review of the literature. *Int Arch Occup Environ Health* 68: 1-12
- Engberg L (1993) Women and agricultural work. In: Headapohl DM (ed) *Women workers. Occupational medicine: state of the art reviews* 8: 869-882
- Headapohl DM (1993) Sex, gender, biology, and work. In: Headapohl DM (ed) *Women workers. Occupational medicine: state of the art reviews* 8: 685-707
- Hernberg S (1984) Work related diseases: some problems in study design. *Scand J Work Environ Health* 10: 367-372
- Hildebrandt VH (1995) Back pain in the working population: prevalence rates in Dutch trades and professions. *Ergonomics* 38: 1283-1298
- Ilmarinen J, Tuomi K, Eskelinen L, Nygård C-H, Huuhtanen P, Klockars M (1991) Summary and recommendations of a project involving cross-sectional and follow-up studies on the aging worker in Finnish municipal occupations (1981-1985). *Scand J Work Environ Health* 17[Suppl 1]: 135-141
- Johansson JÅ (1995) Psychosocial work factors, physical workload and associated musculoskeletal symptoms among home care workers. *Scand J Psychol* 36: 113-129
- Kelsh MA, Sahl JD (1996) Sex differences in work-related injury rates among electric utility workers. *Am J Epidemiol* 143: 1050-1058
- Kilbom Å, Persson J (1987) Work technique and its consequences for musculoskeletal disorders. *Ergonomics* 30: 273-279
- Kilbom Å, Winkel J, Karlqvist L (1995) Is physical load at work reduced with increasing age? A pilot study. Abstracts of the second international scientific conference on prevention of work-related musculoskeletal disorders, September 1995. Institut de Recherche en Santé et en Sécurité du Travail du Québec, Montreal, pp 60-62
- Kirkaldy-Willis WH (1988) The three phases of the spectrum of degenerative disease. In: Kirkaldy-Willis WH (ed) *Managing low back pain*. Churchill Livingstone, Edinburgh, pp 117-131
- Kuorinka I, Forcier L (eds) (1995) *Work-related musculoskeletal disorders (WMSDs): a reference book for prevention*. Taylor & Francis, London
- Liira JP, Shannon HS, Chambers LW, Haines TA (1996) Long-term back problems and physical work exposures in the 1990 Ontario health survey. *Am J Public Health* 86: 382-387
- Lundberg U (1996) Work, stress and musculoskeletal disorders. In: *Occupational health and safety aspects of stress at modern workplaces*. Schriftenreihe der Bundesanstalt für Arbeitsmedizin. Bundesanstalt für Arbeitsmedizin, Berlin, conference report 11, pp 66-78
- Lundberg U, Mårdberg B, Frankenhaeuser M (1994) The total workload of male and female white-collar workers as related to age, occupational level, and number of children. *Scand J Psychol* 35: 315-327
- McDonald C (1995) Study design. In: McDonald JC (ed) *Epidemiology of work-related diseases*. BMJ Publishing, London, pp 325-351
- Morse LH, Hinds LJ (1993) Women and ergonomics. In: Headapohl DM (ed) *Women workers. Occup Med State of the Art Rev* 8: 721-731
- Östlin P (1989) The "health-related selection effect" on occupational morbidity rates. *Scand J Soc Med* 17: 265-270
- Phillips SK, Rook KM, Siddle NC, Bruce SA, Woledge RC (1993) Muscle weakness in women occurs at an earlier age than in men, but strength is preserved by hormone replacement therapy. *Clin Sci* 84: 95-98
- Riihimäki H (1995) Back and limb disorders. In: McDonald JC (ed) *Epidemiology of work related diseases*. BMJ Publishing, London, pp 207-238
- Rothman KJ (1986) *Modern epidemiology*. Little, Brown, Boston

31. Silver JJ, Einhorn TA (1995) Osteoporosis and aging. *Clin Orthop* 316: 10–20
32. Suurnäkki T, Nygård C-H, Ilmarinen J (1991) Stress and strain of elderly employees in municipal occupations. *Scand J Work Environ Health* 17[Suppl 1]: 30–39
33. Tola S, Riihimäki H, Videman T, Viikari-Juntura E, Hänninen K (1988) Neck and shoulder symptoms among men in machine operating, dynamic physical work and sedentary work. *Scand J Work Environ Health* 14: 299–305
34. Törner M, Bilde G, Eriksson H, Kadefors R, Karlsson R, Petersen I (1988) Musculo-skeletal symptoms as related to working conditions among Swedish professional fishermen. *Appl Ergonom* 19: 191–201
35. Tuomi K, Ilmarinen J, Eskelinen L, Järvinen E, Toikanen J, Klockars M (1991) Prevalence and incidence rates of diseases and work ability in different work categories of municipal occupations. *Scand J Work Environ Health* 17[Suppl 1]: 67–74
36. Undeutsch K, Gärtner KH, Luopajarvi T, Küpper R, Karvonen MJ, Löwenthal I, Rutenfranz J (1982) Back complaints and findings in transport workers performing physically heavy work. *Scand J Work Environ Health* 8[Suppl 1]: 92–96
37. Van der Beek AJ, Frings-Dresen MHW, Van Dijk FJH, Kemper HCG, Meijman TF (1993) Loading and unloading by lorry drivers and musculoskeletal complaints. *Int J Ind Ergon* 12: 13–23
38. Van Scheppingen AR, Frings-Dresen MHW, Van Mechelen W (1996) Fysiek belastend werk in Nederland [Physically demanding work in the Netherlands]. *Tijdschr Soc Gezondheidsz* 74: 177–183
39. Van Tulder MW, Koes BW, Bouter LM (1995) A cost-of-illness study of back pain in the Netherlands. *Pain* 62: 233–240
40. Weel ANH, Broersen JPJ (1992) Signalen van problemen in werk en gezondheid: periodiek bedrijfsgezondheidskundig onderzoek bij groepen werkenden [Signals of problems in work and health: periodical occupational health survey among groups of employees]. Dissertation, University of Amsterdam, Amsterdam
41. WHO (World Health Organization) (1993) Aging and working capacity (Technical report series 835). WHO, Geneva