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ORIGINAL ARTICLE

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Risk of health complaints and disabilities among Dutch firefighters

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Abstract ***Objectives***: The purpose of the present study was threefold: (1) to compare the work demands on firefighters (FFs) and office workers (OWs), (2) to compare the prevalence of health complaints and disabilities in the work situation in these two groups, and (3) to explore the effect of work demands on the risk of health complaints. ***Methods***: Self-reported information was gathered from 1,624 FFs (55% response) and 630 OWs (80% response), at the same fire departments in different regions of the Netherlands, on work demands ('sitting', and biomechanically and energetically demanding activities and 24-h shifts), health complaints and disabilities. First, we compared the work demands and prevalence rates of health complaints and related disabilities in the two groups, then we explored the risk of health complaints in workers with high and low exposure to work demands. ***Results***: Compared with office workers, FFs reported: (1) less exposure to 'sitting' and more to biomechanically and energetically demanding activities, (2) more knee (OWs 14% vs FFs 20%) and ankle (3% vs 10%) complaints and disabilities resulting from back complaints (30% vs 47%), and (3) less hypertension (7% vs 5%), stomach (13% vs 7%), heart (6% vs 2%), neck (26% vs 16%), shoulder (16% vs 14%) and arm (14% vs 6%) complaints. A higher risk of subjective fatigue was found in workers highly exposed to 'energetically demanding activities', and of neck, shoulder and arm complaints in workers highly exposed to 'sitting'. ***Conclusions***: Firefighters reported higher physical demands (with the exception of 'sitting') than office workers did. The prevalence rate of certain complaints or disabilities among FFs was higher (knee and ankle complaints and disabilities related to back complaints) or lower (hypertension, stomach, heart, neck, shoulder and arm complaints) than among OWs. The results suggest that exposure to highly biomechanically demanding activities might cause an increased risk of knee and ankle complaints and that exposure to highly energetically demanding activities might increase the risk of subjective fatigue.

Keywords Occupational risk · Health complaints · Disabilities · Firefighter

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Introduction

Fire fighting has been reported as a stressful job with varying occupational exposures, such as shift work and emotional and/or physical demands (Orris et al. 1995). Musculoskeletal complaints (Reichelt and Conrad 1995), cardiovascular disorders (Melius 1995) and fatigue and sleep complaints (Paley and Tepas 2002) have been reported among firefighters. These complaints may restrict firefighters during actual performance of firefighting tasks and activities (Matticks et al. 1992).

Several risk factors may explain the development of complaints among Dutch firefighters. Firstly, shift work may explain the development of fatigue, cardiovascular, sleeping and gastrointestinal complaints (Bøggild and Knutssen 1999; Fischer et al. 2001; Harrington 2001; Morikowa et al. 1999; Peter et al. 1999). Dutch firefighters work in shifts, usually 24 h 'on' followed by 48 h 'off'. One of the main physiological problems reported by shift workers is that working, eating and sleeping cycles are changed. This disruption of the circadian rhythm has been reported as one of the factors in the development of cardiovascular disorders in the long run (Bøggild and Knutssen 1999). There is general agreement in the literature that shift work has a negative

effect on sleep (Gilberg 1998; Harma 1995; Harrington 2001). Although there is variation between people, sleep loss is a major effect of shift work (Åckerstedt 1990). The resulting decreased quality of sleep may also explain the development of fatigue among firefighters working irregular shifts in unpredictable working conditions. Unhealthy and irregular eating habits during shifts may explain the development of gastrointestinal disorders (Harrington 2001). Secondly, the high biomechanical and energetic demands of fire fighting may explain the development of musculoskeletal complaints (Bos et al. 2004). Although the literature on fire-fighting factors that contribute to development of musculoskeletal complaints is sparse, several prospective studies have been conducted to examine the development of musculoskeletal complaints in other occupations in the past. Studies have demonstrated that, e.g., lifting, carrying, twisting and bending are associated with an increased risk of back and neck complaints (Ariëns et al. 2000; Hales and Bernard 1996; Hoogendoorn et al. 1999; Hoozemans et al. 2002a, b; Kraus et al. 1997; Kuijper et al. 1999; Linton 1990; Poulsen et al. 1995; Waters et al. 1993). Pushing and pulling have been identified as risk factors in back, shoulder and neck complaints (Fuortes et al. 1994; Hoozemans et al. 1998; Hoozemans et al. 2002a, b; Macfarlane et al. 1997). Finally, short and frequent peak-energy loads during actual fire fighting may cause individual physical overload. The intermittent high-energy work increases the heart rate and may cause fatigue and over-exhaustion (Bos et al. 2004). Several studies report that workloads at peak energy and of long-duration are risk factors in the development of fatigue complaints (Bos et al. 2004; Saha 1979; Wu and Wang 2001, 2002).

In the case of firefighters, health complaints may negatively affect performance on the job and consequently increase the risk of human error and serious accidents. Until now, however, there has been no information on the increased risk to firefighters of developing the health complaints described above and the consequent disabilities. To what extent these complaints can be attributed to the specific job demands of fire fighting also remains unclear. In order to explore the risk to firefighters we investigated the work demands on, and health complaints of, Dutch firefighters and office workers at the same fire departments. Firstly, then, the study raises the following two questions:

- Is there a difference in the work demands on Dutch firefighters and office workers?
- What is the prevalence of health complaints and related disabilities among Dutch firefighters and office workers?

Besides making a comparison between the work demands on, and complaints (and related disabilities) of, firefighters and a group of office workers, we need to explore the risk of health complaints due to specific exposure factors such as 'sitting' and biomechanically and energetically demanding activities. Manifestations of one specific health complaint might, of course, be related to different exposure factors, e.g. shoulder complaints might be related to the activities of 'pushing and pulling' and of 'sitting'. The risk of high exposure to a specific work demand can also be explored with respect to a specific health complaint. Following on from the above questions, the third question posed by the present study is:

- What is the risk of health complaints among workers with high exposure to work demands vis-à-vis workers with low exposure?

To sum up, the purpose of the present study was threefold: (1) to compare the work demands on firefighters and office workers, (2) to compare the prevalence of health complaints and disabilities in the work situation in these two groups; and (3) to explore the effect of work demands on the risk of health complaints.

Methods

Study design

A cross-sectional questionnaire survey was executed, with regard to work demands and health complaints and disabilities among workers of the Dutch fire service. A total of 2,254 questionnaires was sent to firefighters ($n = 1{,}624$; involved in fire-fighting tasks and working 24-h shifts) and office workers ($n = 630$; without fire-fighting tasks) at the same institutes in different regions in The Netherlands. The questionnaire was designed to obtain information on physical work demands and working 24-h shifts (work demands; independent variables) and cardiovascular, stomach and sleeping complaints, subjective fatigue, need for recovery, musculoskeletal complaints and related disabilities (dependent variables), and the socio-demographic variables of the subjects (control variables). Two weeks after sending the first questionnaire we sent a reminder to all participants. Firstly, it was explored whether the group of firefighters differed from the office workers with regard to the work demands. Secondly, it was investigated whether the prevalence of health complaints and disabilities differed in the two groups. Thirdly, the risk of health complaints was explored in workers with high exposure to work demands compared with workers exposed to low demands.

Assessment of exposure variables (independent variables)

Exposure to physical work demands was assessed from one scale of the Nordic questionnaire (Kuorinka et al. 1987). The scale consists of 14 questions. We rated, on a 4-point scale, the answers to the question ''How often (1 = never, 2 = seldom, 3 = sometimes and 4 = often)

are physical activities (walking, standing, sitting, lifting/carrying, pushing/pulling, kneeling/squatting, stooping, working in a twisted posture, running, jumping, climbing, crawling, swimming) performed?'' The following question was appended to the scale: ''How often does compulsory physical exercise occur on duty?'' (physical exercise as part of the job, including, for example, physical workouts, soccer or gymnastics during working time), which was scored with the same 4-point scale.

Assessment of the prevalence of health complaints and disabilities (dependent variables)

In the case of both firefighters and office workers, health complaints (related to the physical demands and 24-h shifts) and related disabilities were assessed with the following questionnaires. Firstly, we assessed 6-month prevalence of cardiovascular and stomach complaints, using parts of the periodic occupational health survey (POHS) questionnaire (Weel and Broersen 1992). Three questions concerning complaints of the stomach, hypertension and heart (pain and oppressive feeling on the chest) were incorporated. Answers were rated on a 2-point scale (yes or no). A question concerning disabilities for job performance (yes or no) was appended to the scale. Secondly, we assessed 6-month prevalence of musculoskeletal complaints (neck, back, shoulder, arm, knee, and ankle) and resulting disabilities, for job performance, using a self-formulated questionnaire. In the scale the following dichotomous (yes or no) questions were raised: ''have you had any complaints in the last 6 months?'' and (if complaints during the last 6 months were reported) ''did those complaints disable you in your job performance?''. Thirdly, subjective fatigue (e.g. ''I feel tired'') during the past 2 weeks was assessed with the subscale of the *multidimensional checklist individual strength (CIS)* (Beurskens et al. 2000; Vercoulen et al. 1994). The scale consists of five statements, which the person has to indicate on a 7-point Likert scale (1 = yes, that is true, and 7 = no, that is not true). The CIS is well validated within the clinical setting (Vercoulen et al. 1994) and the work situation (Beurskens et al. 2000; Bültmann 2002). High scores indicate a higher degree of subjective fatigue. Fourthly, (1 month) need for recovery was measured with the 'need for recovery after work scale' of the *Dutch VBBA* questionnaire (Van Veldhoven and Meijman 1994), which comprises 11 dichotomous items. Typical items on the need-for-recovery-after-work scale are: ''at the end of a working day I am really worn out'' and ''I find it hard to relax at the end of a working day''. This scale is transformed into a scale ranging from 0 to 100. Higher scores indicate a higher degree of need for recovery after work. The question concerning disability for job performance (yes or no) was appended to the scales. Fifthly, sleep complaints (during the past 1 month) were assessed with the *sleep quality* scale of the *Dutch VBBA* questionnaire (Van Veldhoven and Meijman 1994). A question concerning disabilities for job performance (yes or no) was appended to the scale. We calculated the total score by counting the number of answers scored ''yes''. Higher scores on the sleep complaint scale indicated more sleep complaints.

Socio-demographic variables of the subjects (control variables)

Several variables might be potential confounding factors when the work demands and health complaints of the two groups are compared. The socio-demographic variables of age and body mass index (BMI; height/weight^2) were gathered for both firefighters and office workers because those variables have been reported to be related to musculoskeletal and other health complaints (De Zwart et al. 1997; Hales and Bernard 1996; Ladwig et al. 2000). Also, gender was assessed because female workers might have a tendency to report more health complaints than male workers (Hales and Bernard 1996; Ladwig et al. 2000; Stewart-Brown and Layte 1997). 'Years in the fire service' was assessed, since it is assumed that there is an increasing chance for the development of health-related complaints due to cumulative exposure through the years in the fire service. Finally, the number of office workers, who, in the past, had worked as firefighters and had left fire fighting work because of health complaints, was assessed. The inclusion of those office workers may imply an overestimation of work demands and/or prevalence rates of complaints or disabilities for the total group of office workers, caused by previous work exposure, and, thereby, give a false picture of results.

Data analyses

Dependent, independent and control (dichotomous) variables were tested for violations of normal distribution with the Kolmogorov–Smirnov test.

Difference in the distribution of male and female subjects between both groups (firefighters and office workers) was tested with a χ^2 test. For all other socio-demographic and exposure variables the mean values were compared between the two groups with a simple *t*-test (in case of a normal distribution) or a Mann–Whitney *U* test (in cases with skewed distribution).

Based on the scale of the Nordic questionnaire concerning physical work demands, an average score was calculated for the activities of standing, lifting/carrying, pushing/pulling, kneeling/squatting, stooping, working in a twisted posture and jumping, which was called the 'biomechanically demanding activities' scale. Also, an average score was calculated for the physical activities of running, walking, swimming and 'physical exercise as part of the job', which was called the 'energetically demanding activities' scale. In order to calculate the total scores of these scales, firstly, we aggregated the

individual scores of the corresponding physical activities and then divided through the total amount of activities. In this way, for each individual, a mean score was calculated for both scales. The mean individual score was calculated only in case there were no missing values concerning a particular physical activity. Secondly, for each scale a 'group average' was calculated for both groups. Finally, in the same way a 'group average score' was calculated for both groups for the activity 'sitting', separately.

The office workers who had worked as firefighters in the past and had left fire fighting because of health complaints were excluded and not used in the further analyses. The differences in the distribution of health complaints and disabilities between the two groups were tested with a χ^2 test. For disabilities, this was done only for the cases of complaints. Scores were converted to a scale from 0 to 100 (expressed as a 'percentage score') for the questionnaire concerning need for recovery, general fatigue and sleep complaints of the firefighters and the office workers. Mean scores on the need for recovery and sleep complaints scales of the Dutch VBBA questionnaire were compared with scores of the general Dutch working population (SKB 1997). The total score and sub-scale concerning 'subjective fatigue' of the CIS were compared with the scores of healthy blue-collar workers in industrial work (Beurskens et al. 2000). The two groups were compared by use of a Mann–Whitney U test. Subsequently, the scores of the firefighters and office workers were compared with available reference data by use of a t-test.

To explore the risk of health complaints associated with high exposure to work demands we compared the group with high exposure with a group with low exposure (reference group) and assessed them for health-related exposure. In order to assess these associations we calculated (crude and adjusted) odds ratios (ORs) and corresponding 95% confidence intervals (CIs) using binary logistic regression analysis between (high and low exposure of the) work demands and stomach complaints, hypertension, heart and sleep complaints, need for recovery, subjective fatigue, and heart, neck, back, shoulder, arm, knee and ankle complaints. Firstly, the dichotomous complaints were separately forced into the model as a dependent variable. Thus, the 'biomechanically demanding activities' and 'energetically demanding activities' scale and the variables 'need for recovery', 'subjective fatigue' and 'sleep complaints' were made dichotomous. In order to do this, we calculated the median score to distinguish between high ($>$ median score) and low ($\leq$ median score) exposure on these scales. Secondly, for each complaint all complaint-related work demands (dichotomous factor) were forced separately univariate (as a covariate) into the model. To prevent co-linearity, we calculated correlation coefficients (Pearson) between the independent variables. A high correlation was defined as a Pearson correlation of $r > 0.6$. In case a high correlation was found between two exposure factors, one was excluded from further analyses. The factor indicated as being the most relevant for predicting development of related complaints in the literature was then chosen for further analyses. To calculate the adjusted ORs we forced confounding variables into the model as additional covariates. Confounders were selected on the basis of relevance for predicting development of related complaints as indicated by the literature and 'co-linearity' (as mentioned previously). With regard to the 'relevance' and 'co-linearity' for the variables 'hypertension', 'heart complaints' and 'back complaints', 'age', 'gender' and 'BMI' were selected a priori as confounding factors. For all other variables 'age' and 'gender' were selected a priori as confounding factors. All data were analysed with SPSS 10.0. In all analyses differences were accepted at $P < 0.01$.

Results

A total of 901 (55%) firefighters and 505 (80%) office workers responded to the questionnaire. Overall, the response of the questionnaire was 62%.

Subjects

Twenty-nine office workers had worked as firefighters in the past and had left firefighting work because of health complaints. This resulted in a group of firefighters comprising 901 subjects and a group of office workers of 476 (505−29) subjects. The socio-demographic variables of the subjects are described in Table 1. The number of male subjects was significantly larger ($n = 877$) in the group of firefighters than in the office workers ($n = 324$). The firefighters were significant younger and had significantly more years 'in the service' than the office workers [mean 13.2 (SD 10.6) vs mean 7.2 (SD:8.2)].

Table 1 Socio-demographic variables of the subjects: gender and mean (SD) of age, BMI and 'years in the fire service of firefighters'

Variable	Firefighters ($n = 901$)	Office workers ($n = 476$)	Significance ($P < 0.01$)
Age (years)	39.2 (9.4), $n = 895$	43.0 (10.1), $n = 473$	0.00[a]
Male (n)	877	324	
Female (n)	23	150	0.00[b]
BMI (height/weight^2)	25.8 (7.8), $n = 892$	25.3 (4.3), $n = 468$	
Years in the fire service	13.2 (10.6), $n = 897$	7.2 (8.2), $n = 474$	0.00[a]

[a]Significant difference as indicated by a Mann–Whitney U-test
[b]Significant difference as indicated by a χ^2-test

Table 2 Mean values of exposure measures for firefighters and office workers for 'sitting', 'biomechanically demanding activities' and 'energetically demanding activities'. Performance of activities during work: *1* never, *2* seldom, *3* sometimes, *4* often

Firefighters	Firefighters [mean score (SD)] $n = 901$	Office workers [mean score (SD)] $n = 476$	Significance ($P < 0.01$)
Physical demands			
Sitting	3.2 (0.6), $n = 895$	3.8 (0.5), $n = 474$	0.00[a]
Biomechanically demanding activities (standing, lifting/carrying, pushing/pulling, kneeling/squatting, stooping, working in a twisted posture, jumping)	3.3 (0.5), $n = 897$	2.1 (0.7), $n = 464$	0.00[a]
Energetically demanding activities (running, walking, swimming, physical exercise as part of the job)	3.3 (0.4), $n = 894$	1.9 (0.6), $n = 469$	0.00[a]

[a]Significant difference as indicated by a Mann–Whitney *U*-test

'Age' and 'years in the fire service' correlated highly ($r = 0.67$). Because, according to the literature (De Zwart et al. 1997), 'age' has a strong relationship with development of health complaints, the variable 'years in the fire service' was excluded from further analyses.

Assessment of exposure variables

Mean scores for the firefighters and office workers on 'sitting' and the scales concerning 'biomechanically demanding activities' and 'energetic demanding activities' are described in Table 2. The activity 'sitting' is reported to be performed significantly less often by the firefighters [mean score (SD) 3.2 (0.6)] in comparison with office workers [3.8 (0.5)].

'Biomechanically demanding activities' and 'energetically demanding activities' were reported to be performed significantly more often by the firefighters than by the office workers. The mean scores for firefighters and office workers, respectively, were, for the 'biomechanically demanding activities' scale: 3.3 (0.5) and 2.1 (0.7) and for the 'energetically demanding activities' scale: 3.3 (0.4) and 1.9 (0.6). 'Energetically demanding activities' and 'working in 24-h shifts' correlated highly ($r = 0.61$). Therefore, based on the literature, in the further analyses, 'need for recovery', 'subjective fatigue', hypertension and heart, stomach and sleep complaints were related to 'working in 24-h shifts'.

Prevalence of health complaints and related disabilities

The relative (and absolute) 6-month prevalence of complaints according to two dimensions (complaints and disabilities) of the stomach, hypertension, heart, neck, back shoulder, arm, knee and ankle are presented in Table 3 for the firefighters and for the office workers. For stomach, hypertension, heart, neck, shoulder and arm complaints the prevalence rate was significantly lower for the firefighters than for the office workers. The prevalence rate of knee and ankle complaints was significantly higher for the firefighters than for the office workers. Only the prevalence rate of disabilities related to the back was significantly higher for the firefighters than for the office workers (47% [138] vs. 32% [48]).

For office workers, the mean score for 'subjective fatigue' and 'need for recovery' did not differ from that of the Dutch general working population. 'Need for recovery' and the sub-scale 'subjective fatigue' (CIS) for the firefighters were lower than those for the office workers [need for recovery 12.0 (SD = 19.5) vs 25.3 (SD = 29.0); subjective fatigue 47.7 (SD = 9.3) vs 40.5 (SD = 12.3)] and significantly lower than those for the Dutch general working population. The mean percentage score of sleep complaints was significantly lower for the firefighters [17.9 (SD = 23.8)] than in the office workers [21.3 (SD = 24.8)] but did not differ from that for the Dutch general working population [19.0 (SD = 22.9)].

Risk of health complaints

Crude and (age- and gender-) adjusted ORs for complaints and disabilities in relation to high exposure to physical work demands and/or 24-h shifts are presented

Table 3 The relative (and absolute) 6-month prevalence of complaints and disabilities concerning stomach complaints, hypertension, heart, neck, back, shoulder, arm, knee and ankle complaints) for firefighters and office workers

Parameter	Firefighters (%) [$n = 901$] vs office workers (%) [$n = 476$]	
	Complaints	Disabilities
Stomach	7 (62) vs 13 (60)[*,a]	29 (18) vs 18 (11)[b]
Hypertension	5 (42) vs 7 (33)[a,*]	12 (5) vs 12 (4)[b]
Heart	2 (18) vs 6 (26)[a,*]	39 (7) vs 35 (9)[b]
Neck	16 (141) vs 26 (124)[a,*]	34 (48) vs 26 (32)[b]
Back	32 (292) vs 32 (152)[a]	47 (138) vs 32 (48)[b,*]
Shoulder	14 (129) vs 16 (75)[*,a]	40 (52) vs 37 (28)[b]
Arms	6 (56) vs 14 (69)[a,*]	54 (30) vs 38 (26)[b]
Knees	20 (183) vs 14 (66)[a,*]	40 (74) vs 23 (15)[b]
Ankles	10 (94) vs 3 (15)[a,*]	47 (44) vs 20 (3)[b]

*Significant difference as indicated by a χ^2 test

[a]The relative distribution of cases of complaints between the two groups was tested

[b]The relative distribution of cases of disabilities was tested between the two groups only for the cases of complaints

Table 4 Crude and (age-, gender- and BMI-) adjusted ORs (and 95% CIs) for complaints (*N* cases) in relation to high exposure to physical work demands and/or 24-h shifts

	Cases	Crude	Adjusted
Stomach complaints	*N* = 12		
Reference group	*N* = 2	1.0	1.0
High exposed to 24-h shifts		0.5 (0.4–0.7)*	0.5 (0.4–0.8)*
Sleep complaints	*N* = 66		
Reference group	*N* = 6	1.0	1.0
High exposed to 24-h shifts		0.7 (0.6–0.9)*	0.8 (0.6–1.0)*
Need for recovery	*N* = 72		
Reference group	*N* = 9	1.0	1.0
High exposed to 24-h shifts		0.5 (0.4–0.6)*	0.5 (0.4–0.6)*
Subjective fatigue (CIS)	*N* = 68		
Reference group	*N* = 9	1.0	1.0
High exposed to 24-h shifts		3.1 (2.4–3.9)*	2.8 (2.3–3.6)*
Hypertension	*N* = 75		
Reference group		1.0	1.0
High exposed to 24-h shifts		0.7 (0.4–1.1)	0.9 (0.6–1.6)#
Heart complaints	*N* = 44		
Reference group		1.0	1.0
High exposed to 24-h shifts		0.4 (0.2–0.6)*	0.4 (0.2–0.8)*#
Neck	*N* = 26		
Reference group	*N* = 5	1.0	1.0
High exposed to sitting		1.7 (1.3–2.2)*	1.6 (1.2–2.1)*
Reference group		1.0	1.00.9 (0.7–1.2)
High exposed to biomechanically demanding activities		0.8 (0.6–1.1)	
Back	*N* = 44		
Reference group	*N* = 4	1.0	1.0
High exposed to sitting		1.1 (0.9–1.4)	1.0 (0.8–1.3)#
Reference group		1.0	1.01.3 (1.0–1.6)#
High exposed to biomechanically demanding activities		1.2 (1.0–1.5)	
Shoulder	*N* = 20		
Reference group	*N* = 4	1.0	1.0
High exposed to sitting		1.4 (1.1–1.9)*	1.3 (1.0–1.8)*
Reference group		1.0	1.01.1 (0.8–1.5)
High exposed to biomechanically demanding activities		1.1 (0.8–1.4)	
Arms	*N* = 12		
Reference group	*N* = 5	1.0	1.0
High exposed to sitting		1.8 (1.2–2.6)*	1.7 (1.1–2.4)*
Reference group		1.0	1.01.0 (0.7–1.4)
High exposed to biomechanically demanding activities		0.9 (0.6–1.3)	
Knees	*N* = 24		
Reference group	*N* = 9	1.0	1.0
High exposed to biomechanically demanding activites		1.5 (1.2–2.1)*	1.6 (1.2–2.1)*
Ankles	*N* = 10		
Reference group	*N* = 9	1.0	1.0
High exposed to biomechanically demanding activities		2.3 (1.5–3.4)*	2.0 (1.3–3.1)*

#adjusted for age-, gender-, and BMI (Body Mass Index)
*Significant

in Table 4. A significant lower risk was found for exposure to 24-h shifts and stomach complaints [adjusted odds = 0.5 (0.4–0.8)], sleep complaints [adjusted odds = 0.8 (0.6–1.0)] and need for recovery [adjusted odds = 0.5 (0.4–0.6)]. A significantly higher risk of subjective fatigue was found in relation to high exposure to 24-h shifts [adjusted odds = 2.8 (2.3–3.6)]. Also, higher risks were found for neck complaints [adjusted odds = 1.6 (1.2–2.1)], shoulder complaints [adjusted odds = 1.3 (1.0–1.6)] and arm complaints, in relation to high exposure to 'sitting' [adjusted odds = 1.7 (1.1–2.4)]. An increased risk was found for knee complaints in relation to biomechanically demanding activities [adjusted odds = 1.6 (1.2–2.1)]. For stomach complaints, hypertension, and neck, back, shoulder, arm, knee and ankle complaints relatively more firefighters were found to report complaints than office workers (see Table 4). In general, only small differences were observed between the crude and adjusted ORs. The adjustments did not change the significance of the results.

Discussion

The purpose of the present study was threefold: (1) to compare the work demands on firefighters and office workers, (2) to compare health complaints in those two groups, and (3) to explore the effects of physical

demands and 24-h shift work on the risk for health complaints. To begin by comparing the work demands on the two groups, the study indicates that firefighters involved in actual firefighting are exposed significantly less to 'sitting' and significantly more often to 'biomechanically demanding activities' and 'energetically demanding activities' than office workers.

The firefighters had a significantly higher prevalence rate of knee and ankle complaints (20% and 10%) than the office workers (14% and 13%). The firefighters had lower prevalence rates of hypertension, stomach, heart, neck, shoulder and arm complaints (5%, 7%, 2%, 16%, 14% and 6%, respectively) than the office workers (13%, 7%, 6%, 26%, 16% and 14%, respectively). The present study assessed 6-month prevalence, which ranged from 10% for ankle complaints and 32% for back complaints in firefighters. Other studies report a 12-month (not 6-month) prevalence of the following complaints in Dutch workers: back (47%–68%; firefighters 26.7%; refuse collectors 33%), neck (2%–25%), shoulder (9%–58%), arm (5%–20%), and knee (14%–20%) (De Zwart et al. 1997; Hildebrandt 1995a, b; Hoozemans et al. 2002a, b; Kuijer 2002). As regards stomach complaints (gastritis), hypertension, and cardiovascular complaints (angina pectoris, cardiac arrhythmia, varicose veins), prevalence rates of 15%, 9% and 4%–13%, respectively, have been reported among shift workers (Fischer et al. 2001).

Compared with the prevalence rates in those studies, the prevalence rates of stomach, cardiovascular and musculoskeletal complaints in our present study are low to moderate. The age and gender of workers might have influenced the prevalence rates of complaints: older workers generally report more complaints (De Zwart et al. 1997; Hales and Bernard 1996), as do female workers (De Zwart et al. 1997; Hales and Bernard 1996; Stewart-Brown and Layte 1997). Because the group of office workers in the present study was older and contained a larger proportion of women than the firefighters, the prevalence rates of the office workers' complaints might have been overestimated.

The prevalence rate of disabilities related to back complaints in the present study appeared to be significantly higher in the firefighters than in the office workers. This might indicate that firefighters have a higher risk of this kind of disability than office workers. This finding supports those of other authors, who report back complaints as the major cause of disability among firefighters (Malchaire et al. 2001; Himmelstein and Andersson 1988). The type of work may have affected the prevalence of disabilities among both groups: firefighters are likely to report more disabilities, for example, because the work comprises more physical tasks and activities and may be more demanding (Bos et al. 2004). The higher work demands involved in fire fighting may aggravate complaints among firefighters, thus causing more disabilities in their work situation.

The present study observed a clear tendency towards a higher risk of several complaints, as indicated by the increased ORs. In the high-exposure groups, a significantly higher risk of subjective fatigue was found in the case of 'energetically demanding activities' and of neck, shoulder and arm complaints related to 'sitting'. The ORs were not particularly high (the values did not exceed 2.8; see Table 4), but, because the firefighters were exposed more to biomechanically and energetically demanding activities than the office workers they may have a higher risk of subjective fatigue and knee and ankle complaints. As the variables 'energetically demanding activities' and '24-h shifts' correlated well ($r = 0.6$), the risks of subjective fatigue in relation to those variables are almost the same; indeed, the ORs for 'energetically demanding activities' and '24-h shifts' in relation to 'subjective fatigue' are very similar: 2.2 (1.7–2.7) and 2.8 (2.3–2.6), respectively. The risks of need for recovery, hypertension and heart complaints in relation to 'energetically demanding activities' and '24-h shifts' are also comparable. The increased risks of subjective fatigue in relation to 24-h shifts that we found. confirmed the findings of other studies (Bos et al. 2004; Harrington 2001; Saha 1979; Wu and Wang et al. 2001, 2002). Although those studies did not calculate ORs or relative risks (RRs), they did examine the relationship between peak-energy loads (short and longer duration) during tasks and activities in firefighting and/or shift work and the development of fatigue complaints. Fatigue might cause disability and human errors and accidents during firefighting. No other comparable studies were found with regard to disabilities related to fatigue complaints. The risk of knee and ankle complaints, especially, may also be higher, as the prevalence rates of those complaints were higher in firefighters than in office workers. No other studies were found with regard to knee and ankle complaints related to physical work demands in firefighters. Also, because the present study indicated that office workers are more exposed to 'sitting' than firefighters, this might point to a higher risk of arm, shoulder and neck complaints related to 'sitting' in office workers (OR = 1.4–1.7). Ariëns et al. (2000) reported comparable results in relation to the association between 'sitting' and neck pain (OR = 1.50–1.69) and neck/shoulder pain (OR = 1.06–1.32). The higher risk of neck, shoulder and arm complaints in office workers might also be explained by other factors that we did not assess: for example, several authors (Hales and Bernard 1996; Malchaire et al. 2001; Vasseljen et al. 1995) reported shoulder, neck pain and arm (wrist/hand) complaints as being related to other job-related factors (e.g., monotony and pressure of time, 'repetition' and 'posture') and stress symptoms (e.g., mental stress and fatigue) (OR or RR = 1.4–31.7). As we did not consider these job-related factors, the risk of neck and shoulder complaints related to 'sitting' might, thus, be somewhat lower in our study.

The present study only partly confirms the associations between work demands (physical demands and 24-h shifts) and health complaints in fire fighting that has been noted in other studies. It did not, in fact, confirm that firefighters had a higher risk of developing

hypertension, heart, fatigue, stomach or sleep complaints related to working 24-h shifts (Åakerstedt 1990; Bøggild and Knutsson 1999; Fischer et al. 2001; Gilberg 1998; Harma 1995; Morikowa et al. 1999; Paley and Tepas 2002; Peter et al. 1999). Other studies report an association between shift work and hypertension (OR = 2.2–4.0) (Morikowa et al. 1999; Peter et al. 1999) and heart complaints (e.g. acute myocardial infarction, angina pectoris, cardiac arrhythmia and ischaemic heart disease) (OR = 1.1–7.1) (Fischer et al. 2001; Morikowa et al. 1999). Although we observed a higher risk of complaints of subjective fatigue (OR = 2.2–2.8) owing to working in 24-h shifts and energetically demanding activities, the firefighters did not experience more fatigue complaints than the Dutch general working population. Nor did the present study confirm a higher risk of 'need for recovery' owing to 24-hour shifts and energetically demanding activities (Prins et al. 2000). This might indicate that fatigue among firefighters is not work-related, as the need for recovery scale represents a short period (2-weeks' prevalence) of fatigue and has been shown to be an indicator of 'work-related fatigue' (Van Veldhoven and Meijman 1994). We did not find a higher risk of sleep complaints owing to 24-h shifts (OR = 0.8). Firefighters probably enjoy good-quality sleep at night. This may be confirmed by a job analysis study that found a low frequency of alarms during the total shift (1.5), which indicated that firefighters are only occasionally 'active' at night (Bos et al. 2004). Nor did we observe an increased risk of stomach complaints (OR = 0.5). It might be that firefighters have more regular and healthy eating habits than other shift workers (e.g. in industry). Fischer et al. (2001), in fact, report an association between shift work and stomach complaints (gastritis) (OR = 4.4) in industrial workers. A possible explanation for the contradiction between the results of the present study and those of other studies is that—as mentioned previously—firefighters' 24-h shifts and industrial shift work are not fully comparable, after all, and involve different demands. The definition of shift work used here may also differ from definitions used in previous studies. Another explanation might be the 'healthy worker effect' (HWE) (Bernard and Choi 2000; Orris et al. 1995; Punnett 1996): firefighters are usually selected in such a way that they are in better health (and hence have a lower rate of health complaints). Also, for physically demanding jobs we would expect healthy workers usually to stay and unhealthy workers (those with severe cardiovascular, fatigue, sleep or musculoskeletal complaints) to leave their jobs earlier (the 'healthy worker survivor effect'). If a relatively large number of firefighters left their jobs in recent years, this might give an indication of the extent to which this bias affected the results. Although we assessed the number of office workers who had left their jobs due to health complaints, we did not look at the relative numbers of firefighters and office workers who had left their jobs in recent years. It is likely, however, that firefighters are extremely committed to their work, as indicated by the relatively long mean period of service (13.2 years) that we found. The effect of the healthy worker survivor effect on its own, then, is probably small here; overall, however, HWE (especially because of the selection of healthy workers when firefighters are appointed) may have had the effect of decreasing the prevalence rate of complaints and the ORs calculated.

Similarly, the present study confirmed the relationship between high exposure to biomechanically demanding activities and the development of musculoskeletal complaints in firefighters only in the case of ankle and knee complaints. In contradiction to our findings, other studies have, in the past, reported associations between other physical activities and musculoskeletal complaints. In a case–control study of New York City firefighters (Nuwayhid et al. 1993), several work activities (e.g. 'cutting structures', 'climbing ladders', 'breaking windows' and 'lifting objects with a weight heavier than 18 kg') appeared to increase the risk of development of low back pain (OR = 1.03–6.47). Other studies (not among firefighters) report associations between biomechanical activities and musculoskeletal complaints that contradict our findings: associations have been found, for example, between 'pushing and pulling' and shoulder complaints (OR = 1.1–6.1) and back complaints (OR = 1.42–2.25) (Fuortes et al. 1994; Hoogendoorn et al. 1999; Hoozemans et al. 2002a, b). Studies also report associations between 'lifting' and back complaints (OR or RR ranging from 1.1 to 5.8) (Hales and Bernard 1996; Kraus et al. 1997; Kuijper et al. 1999; Linton 1990; Macfarlane et al. 1997), shoulder complaints (OR = 3.3) (Hales and Bernard 1996) and neck complaints (OR = 1.4–1.8) (Linton 1990), and an association between 'twisting' and back complaints has been reported (OR = 4.77) (Fuortes et al. 1994). Apart from the possible effect of HWE, the reason for the conflict between our results and those in the literature concerning the above-mentioned biomechanically demanding activities and complaints remains unclear.

Certain methodological issues that relate to the design of the present study might have affected the results. Firstly, it must be realised that the associations between demands and health complaints explored in the present study are of limited causality because of the cross-sectional design. Secondly, it could be argued that a prevalence rate ratio (PRR) is a more appropriate and accurate measure for the prediction of the RR in a cross-sectional study than a prevalence odds ratio (POR). In our case, however, the POR was the most appropriate statistical method for the correct calculation of the association between health complaints and work demands. The error in both PRR and POR seems to depend on the prevalence of the outcome measure (Skov et al. 1998). At higher prevalence both PRR and POR overestimate RR (Zhang and Yu 1998). If there is a low prevalence of a certain condition, then the POR would be numerically similar to the PRR (Lee 1994). Based on the low-to-moderate prevalence values, then, the POR

values of the present study are good-to-moderate predictors of the association between work demands and health complaints.

The present study may have a number of practical implications. For the prevention of health complaints, more attention needs to be paid to the energetically and biomechanically demanding tasks and activities involved in fire-fighting and individual workloads should be minimised. The (individual) peak loads during fire fighting are high and could lead to biomechanical and energy overload (Bos et al. 2004). Although fire fighting is a task that is difficult to change or control, the biomechanic and energy demands could be reduced, e.g. by the use of lighter equipment, reorganisation of workstations (to make the handling of equipment in the area of the fire truck easier) and encouragement of co-operation and job rotation between team members. As regards health surveillance for firefighters, (more) attention needs to be paid to psychosocial factors, health complaints and the resulting disabilities that affect job performance (Lusa et al. 2002). Special attention should be paid to knee and ankle complaints related to biomechanically demanding activities and subjective fatigue complaints related to energetically demanding work. More attention also needs to be paid to the individuals that are experiencing disabilities related to back complaints. Ergonomic job design, worker assessment, specific job-placement tests and education or training (e.g., cardiovascular and strength training) could prevent the disabilities that result from health complaints. In the case of office workers, more attention needs to be paid to arm, shoulder and neck complaints related to increased sitting during work.

To sum up, firefighters involved in actual fire fighting appeared to be exposed less often to 'sitting' and more often to 'biomechanically demanding activities' and 'energetically demanding activities' than office workers. Only in the case of knee and ankle complaints and disabilities resulting from back complaints was the prevalence rate higher in firefighters than in office workers. Compared with office workers, firefighters reported less hypertension and fewer stomach, heart, neck, shoulder, and arm complaints. Firefighters may have a higher risk of knee and ankle complaints related to high exposure to 'biomechanically demanding activities' and subjective fatigue related to 'energetically demanding activities'. The present study did not confirm a higher risk of stomach or sleep complaints, hypertension, heart complaints or need for recovery in workers highly exposed to 24-h shifts and energetically demanding activities, respectively. The results may have to be confirmed by further analysis in a longitudinal study.

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