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ORIGINAL ARTICLE

Associations of job, living conditions and lifestyle with occupational injury in working population: a population-based study

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Abstract
Objectives To assess the roles of job demands, living conditions and lifestyle in occupational injury.
Methods The sample included 2,888 workers, aged ≥15 years, randomly selected from the north-eastern France. The subjects completed a mailed questionnaire. Data were analyzed with adjusted odds ratios (ORa) computed with the logistic model.
Results In total, 9.2% of workers had an injury during the previous 2 years. The high job demands: tasks at height, handling objects, pneumatic tools, other vibrating hand tools, work in adverse climate, physical workload, vibrating platform, machine tools, cold, heat, awkward posture, noise, hammer, and pace had crude odds ratios between 1.81 and 5.25 for injury. A strong exposure–response relationship was found between the cumulated job demands (CJD, defined by their number) and injury: OR 1.88 (95% CI 1.23–2.87) for CJD1, 4.39 (2.98–4.46) for CJD2–3, and 9.93 (6.70–14.7) for CJD ≥ 4, versus CJD0. These ORs decreased to 1.68, 3.70, and 7.15 respectively, when adjusted for sex, age, and living conditions/lifestyle confounders; and to 1.54, 2.99, and 5.45 respectively when also adjusted for job category. The following factors had significant ORa: age <30 years (1.54, 1.12–2.12), male (1.64, 1.18–2.30), smoking (1.60, 1.22–2.10), musculoskeletal disorders (1.54, 1.17–2.04), and frequent drug use for fatigue (2.03, 1.17–3.53). The workmen, farmers/craftsmen/tradesmen, and foremen had a 5.7–8.7-fold while the clerks and technicians a 2.7–3.6-fold higher risk compared with upper class. The risk associated with CJD was twofold higher among the workers aged ≥40 or with frequent drug use for fatigue compared with the others. Obesity had ORa 2.05 (1.11–3.78) among the subjects aged ≥40, and excess

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alcohol use had ORa 2.44 (1.26–4.72) among those free of disease.

Conclusions This study identified a wide range of job demands and living conditions/lifestyle which predicted injury. Preventive measures should be conducted to reduce job demands and to help workers to be aware of the risk and to improve their living conditions/lifestyle.

Keywords Occupational accident · Job · Living conditions · Lifestyle · Diseases · Disabilities

Introduction

It is estimated that approximately 100 million occupational injuries occur worldwide each year (Leigh et al. 1999). Their consequences could increase the social inequalities in health (Groupe de recherche Lorhandicap: Chau et al. 2004). They are mainly caused by work conditions (Gauchard et al. 2001; Ghosh et al. 2004; Jorgensen 1998; Melamed et al. 1999), and their incidence greatly differs between various job categories (Bhattacherjee et al. 2003; Caisse nationale de l'assurance maladie des travailleurs salariés (CNAMTS) 2002; Chau et al. 2004a, b; Smith and Veazie 1998). A wide range of job demands (handling objects, awkward posture, hammer, standing about and walking, noise, heat, cold, artificial light, heat radiation, work in adverse climate, working on a production line, vibrating platform, machine tools, screwdriver, vibrating hand tools, tasks at height, pace, physical workload, mental workload, etc.) daily affect a number of categories of workers (Caisse nationale de l'assurance maladie des travailleurs salariés (CNAMTS) 2002; Ghosh et al. 2004; Jorgensen 1998; Pan American Health Organization—World Health Organization 1999; Smith and Veazie 1998). They result in, among others, musculoskeletal disorders and other diseases, fatigue, stress, substance use, and disabilities (Bhattacherjee et al. 2003; Chau et al. 2004a, b; Chau et al. 2005a, b; Chau et al. 2007; ESEMeD/MHEDEA 2004; Lorhandicap group: Chau et al. 2004; Otero Sierra et al. 2002). Although a high impact on occupational injury is expected, their role has been little addressed, especially in large working populations (Chau et al. 2007; Ghosh et al. 2004; Melamed et al. 1999). Indeed, research undertaken on injury was focused on manual workers and certain job categories (Bhattacherjee et al. 2003; Chau et al. 2004a, b; Froom et al. 1996; Gauchard et al. 2003; Ghosh et al. 2004; Sprince et al. 2002; Zwerling et al. 1997).

In the last decades, research has shown that altered living conditions and unhealthy lifestyle (especially smoking, alcohol use, obesity, fatigue, sleep disorders, poor heath status, musculoskeletal disorders, other diseases and disabilities) are common and are associated with occupational injury (Chau et al. 2004a, b; Gauchard et al. 2001; Gauchard et al. 2003; Harma et al. 1998; McCaig et al. 1998; Sprince et al. 2002; Wells and Macdonald 1999; Zwerling et al. 1997). Indeed, they alter worker's physical and mental abilities, especially in task performance and in assessing/watching occupational hazards. It should be noted that higher job demands concern mainly workmen and also a number of other jobs such as craftsmen, farmers, foremen, and clerks. The effect of job demands on occupational injury may be higher among older workers due to altered physical and mental disabilities (Chau et al. 2005a, b; Mathiowetz et al. 1985). The aging of working population in the next years due to lengthening of working years would result in more workers with diseases and disabilities (Chau et al. 2005a, b) and could consequently increase the injury.

Key questions include (1) the role of job demands and the relative contributions of potential confounders such as sex, age, smoking, excess alcohol use, obesity, musculoskeletal, other diseases, and job category to occupational injury, and (2) whether these confounders mediate the risks associated with various levels of job demands. The knowledge of these risk patterns are useful when designing preventive measures in work place setting, and for the practitioners and occupational physicians to assist the workers to be more aware of the risks and to find remedial measures. However, there have been a few studies, which investigated a wide range of job demands and confounders (Ghosh et al. 2004; Houtman et al. 1998; Jorgensen 1998). Most studies on occupational injury have generally concerned specific populations (Chau et al. 2004a, b; Gauchard et al. 2003; Ghosh et al. 2004; Melamed et al. 1999).

The present study assessed the relationship of job demands to occupational injury in working people, and its change when taking into account sex, age, obesity, smoking, alcohol use, frequent drug use for fatigue or sleep disorders, musculoskeletal disorders, other diseases, and seeing, hearing, and cognitive disabilities. It also assessed whether the association of job demands was higher among the workers aged ≥40 and those with frequent drug use for fatigue.

Materials and methods

Subjects

The initial sample consisted of all the individuals aged 15 years or more from 8,000 households randomly selected from the Lorraine population (north-eastern France). The selection of the households was made from those possessing a telephone.

Study design

Before the survey, a campaign was conducted for 3 months with the help of the media (television, journals, and radio) to make the population sensitive to the survey. The investigation had received a favourable opinion from the "*Commission Nationale de l'Informatique et des Libertés*" and written consents were obtained from the participants.

The study protocol included: (a) a request of participation by means of a questionnaire to ascertain the number of people in the household, and then (b) sending out standardized auto-questionnaires, three times with a covering letter and a pre-paid envelope to reply at a 1-month interval. When the number of individuals was unknown, two questionnaires were sent first, and a complementary one was sent later. The standardized auto-questionnaires were filled in by the subjects themselves. The adolescents were free to ask their parents or tutors if they did not understand some questions.

The questionnaires included: birth date, height, weight, job coded according to the INSEE classification (Paris, 1983), job demands, smoking habit, excess alcohol use via the DETA questionnaire including four items: (1) consumption considered as excessive by the subject himself/herself, (2) by people around the subject, (3) wish to reduce the consumption, and (4) consumption on waking; an excess of consumption was defined by at least two positive responses out of these four items (Baudier and Arène 1997; Bhattacherjee et al. 2003; Cohidon et al. 2005), various diseases diagnosed by the physician, frequent drug use for fatigue (Challier et al. 2000), frequent use of sleeping pills (Challier et al. 2000), reported-disabilities according to the WHO international classification (Organisation Mondiale de la Santé OMS 1988), and the presence of at least one occupational injury during the previous 2-year period. For disabilities, the following were considered: (1) sensorial disabilities with two items, seeing and hearing, and (2) cognitive disabilities with four items: (a) thinking, concentration, and attention, (b) orienteering, (c) problem-solving, and (d) memory. The question for each item was "*Indicate the response which corresponds to your abilities for the following activities*". The response was: without difficulty/with some difficulty/with many difficulties/unable. Concerning the job demands, 20 items with the following question "Please indicate the high job demands for your work" were chosen: handling objects, awkward posture, use of hammer, standing about and walking, noise, heat, cold, artificial light, heat radiation, work in adverse climate (bad weather), working on a production line, vibrating platform, use of machine tools, use of screwdriver, use of pneumatic tools, use of vibrating hand tools (other than pneumatic tools), tasks at height, pace of working, physical workload, and mental workload (Chau et al. 2005a, b); Lorhandicap group: Chau et al. 2004. The occupational injury was defined as damage to body, whatever may be its severity, which resulted from an accident at work with a sick leave of at least 1 day in addition to the day when the accident occurred and for which the subject got compensation (salary paid for sick leave, additional payment). A 2-year period was chosen to have a sufficient number of occupational injuries.

Among the 8,000 households included in the sample, 193 (2%) mails were lost due to wrong addresses or death. From the 7,807 households contacted, 3,460 (44.3%) participated, out of which in 86% of the cases every member of the family participated. In total, 6,234 subjects filled in a questionnaire. By eliminating 18 individuals with unknown sex or age, the sample, which was considered, included 6,216 subjects. The distributions of the sample gathered according to age and sex are close to those of the Lorraine population (Institut National de la Statistique et des Etudes Economiques (INSEE) 1993) (Table 1). This study only concerned the individuals who were employed at the time of the survey, and which consisted of 2,888 subjects.

Statistical analysis

This study examined the association between job demands and occupational injury and its change when adjusting for some other risk factors/confounding factors: age, sex, obesity (body mass index ≥ 30 kg/m^2) (Chau et al. (2004a, b), smoking, excess alcohol use, frequent drug use for fatigue, frequent use of sleeping pills, musculoskeletal disorders,

Table 1 Distribution according to gender and age of the sample studied and of the Lorraine general population (Institut National de la Statistique et des Etudes Economiques (INSEE) 1993) (%)

	The sample studied	The Lorraine general population
No. of subjects	6,216	1,848,579
Percentage of women	52.4	51.5
Age (years)		
15–19	5.4	9.6
20–24	8.0	9.8
25–29	9.7	9.7
30–34	10.4	9.6
35–39	10.5	9.6
40–44	7.9	9.3
45–49	8.5	5.9
50–54	6.0	6.6
55–59	6.3	6.8
60–64	7.2	6.6
65–69	7.5	5.7
70 or over	12.6	10.8

The people aged 15 or more were only considered

other diseases, seeing, hearing, and cognitive disabilities. The age was categorized into four groups: <30, 30–39, 40–49, and ≥ 50. For the job category, seven groups were considered: executives, intellectual professionals, and teachers; workmen; farmers, craftsmen, and tradesmen; clerks; technicians; foremen; and others (Chau et al. 2005b; Otero Sierra et al. 2002). First, the association between each factor and injury was assessed via crude odds ratios (OR) and 95% confidence intervals. For the job demands, the principal component analysis was made to verify their unidimensionality (Falissard 1998) by considering the items related with injury with $P < 0.10$ only (Table 2). Then, the cumulated job demands (CJD) score was calculated which was defined by the number of these items. The CJD score was divided into four categories: 0, 1, 2–3, and ≥4. Next, the odds ratios (OR) for CJD1, CJD2–3, CJD ≥ 4 groups versus CJD0 were computed via the logistic model; then their ORs were adjusted for (1) age and sex, (2) all confounding factors considered except the job category, and (3) all factors. To assess the relationships between the CJD and injury for the two age groups <40 and ≥40 were calculated the odds ratios adjusted for sex, smoking, excess alcohol use, and obesity. To assess the relationships between the CJD and injury for the workers who had frequently used drug for fatigue and those who did not were calculated, the odds ratios adjusted for sex, age, smoking, excess alcohol use, and obesity. The analyses were performed via the Stata program (Texas: Stata Corporation 1997).

Results

The sample included 2,888 subjects. The characteristics of subjects are shown in Table 2. In total, 9.2% of workers had at least one injury during the previous 2-year period. Note that 34.4% of subjects were smokers, 5.9% were obese, 9.2% had excess alcohol use, 4.0% frequently used drug for fatigue, 4.6% frequently used sleeping pills, 45.3% experienced musculoskeletal disorders, and 32.7% were suffering from other diseases. Seeing, hearing and cognitive disabilities affected 13.2, 9.3, and 26.6% of subjects, respectively.

Every job demand considered affected between 1 and 28.1% of subjects. Tasks at height, handling objects, use of pneumatic tools, use of other vibrating hand tools, work in adverse climate, physical workload, vibrating platform, use of machine tools, cold, heat, awkward posture, noise, use of hammer, and pace were marked risk factors for injury (crude ORs between 1.81 and 5.25). The results obtained with the principal component analysis show that these job demands are unidimensional and thus validate the calculation of cumulated job demands (CJD). Indeed, the first eigenvalue (2.64) is markedly higher than the 2nd and the 3rd eigenvalues (0.61 and 0.36) (Falissard 1998). Note that 27.3% of subjects had CJD 1, 21.2% CJD 2–3, and 11.6% CJD ≥ 4.

Table 2 shows that age<30 years, male, smoking, excess alcohol use, frequent drug use for fatigue, musculoskeletal disorders, other diseases, and cognitive disabilities had significantly high crude ORs. There were marked differences between various job categories (crude ORs between 2.73 and 8.74).

Table 3 reveals a strong exposure–response relationship between the CJD and injury. Sex, age<30 years, smoking, musculoskeletal disorders, and frequent drug use for fatigue had high adjusted odds ratios (ORa, 1.54 to 2.03). Markedly higher ORa (2.20 to 3.39) were found for various job categories versus upper class. The ORa associated with CJD1, CJD2–3, and CJD ≥ 4 decreased to 1.68, 3.70, and 7.15, respectively, when adjusted for sex, age <30 years, smoking, musculoskeletal disorders, and frequent drug use for fatigue; and to 1.54, 2.99, and 5.45, respectively, when also adjusted for job category.

Table 4 summarizes the risks associated with CJD and their magnitude when successively taking into account the confounders. The factors age <30 years, sex, smoking, musculoskeletal disorders, and frequent drug use for fatigue reduced the ORa for the CJD1, CJD2–3, and CJD ≥ 4 to 89, 84, and 72%, respectively. When the job category is also taken into account, these ORa decreased to 82, 68, and 55%, respectively.

Excess alcohol use had an ORa close to significance (1.40, 95% CI 0.95–2.06). This would be due to its strong relationship with presence of diseases (crude OR 1.89, 1.43–2.48). Excess alcohol use had a significant ORa (adjusted for age, sex, smoking, CJD, and obesity) of 2.44 (1.26–4.72) among the workers free of diseases and a non-significant ORa of 1.11 (0.69–1.79) among the workers with at least one disease.

Table 5 shows an exposure–response relationship between the CJD and injury that was twofold stronger for the workers aged ≥40 than for those aged <40. Obesity was associated with a higher risk of injury among the subjects aged ≥40: ORa (adjusted for sex, smoking, excess alcohol use, and CJD) 2.05 (1.11–3.78). There was also an exposure–response relationship between the CJD and injury and it was twofold stronger among the workers with frequent drug use for fatigue than among the others.

Discussion

The present study shows that many workers were exposed to a wide range of job demands and that there was a strong exposure–response relationship between the cumulated job demands (CJD) and occupational injury. It reveals that sex, age<30 years, job category, and living conditions/lifestyle

Table 2 Relationships between various factors and occupational injuries: % and crude odds ratios (OR) and 95% confidence intervals (2888 subjects)

	%	OR	95% CI
Age: vs. <30 years			
30–39	36.0	0.74	0.53–1.03
40–49	28.6	0.75	0.53–1.06
50 or more	15.2	0.68	0.45–1.05
Men	56.5	2.33‡	1.75–3.09
Obese (body mass index $\geq$ 30 kg/m^2)	5.9	1.33	0.82–2.17
Current smokers	34.4	1.87‡	1.45–2.41
Excess alcohol use	9.2	1.93‡	1.35–2.77
Frequent drug use for fatigue	4.0	2.04†	1.22–3.39
Frequent use of sleeping pills	4.6	1.48	0.88–2.51
Disease			
Musculoskeletal disorders	45.3	1.92‡	1.49–2.48
Other diseases	32.7	1.42†	1.10–1.84
Sensory disabilities			
Seeing	13.2	1.11	0.77–1.59
Hearing	9.3	1.44§	0.98–2.12
Line sensory disabilities	26.6	1.40*	1.07–1.83
Job demands			
Tasks at height	3.3	5.25‡	3.35–8.22
Vibrating hand tools (other than pneumatic tools)	5.1	3.94‡	2.67–5.82
Handling objects	13.4	3.83‡	2.89–5.08
Pneumatic tools	2.3	3.65‡	2.07–6.43
Work in adverse climate (bad weather)	6.4	3.59‡	2.50–5.16
Physical workload	10.0	3.37‡	2.47–4.61
Vibrating platform	3.9	2.97‡	1.87–4.73
Machine tools	2.3	2.94‡	1.63–5.30
Cold	16.3	2.77‡	2.09–3.66
Heat	18.6	2.29‡	1.73–3.01
Awkward posture	14.5	2.15‡	1.60–2.90
Noise	28.1	2.09‡	1.61–2.70
Screwdriver	1.0	2.07	0.78–5.46
Hammer	1.6	2.04§	0.95–4.42
Pace	18.2	1.81‡	1.35–2.41
Working on a production line	3.5	1.49	0.82–2.71
Standing about and walking	18.6	1.27	0.94–1.73
Heat radiation	1.6	0.93	0.33–2.62
Artificial light	20.9	0.88	0.64–1.22
Mental workload	26.2	0.82	0.61–1.11
Job category: vs. executives, intellectual professionals, and teachers (18.2%)			
Workmen	21.9	8.74‡	4.86–15.7
Farmers, craftsmen, tradesmen	5.0	5.67‡	2.71–11.9
Clerks	35.2	2.73‡	1.49–5.00
Technicians	5.9	3.56‡	1.64–7.73
Foremen	4.8	5.86‡	2.79–12.3
Others	9.0	3.81‡	1.90–7.64

* P<0.05, † P < 0.01, ‡ P < 0.001. §Close to significance (P < 0.10)

confounders such as smoking, musculoskeletal disorders, frequent drug use for fatigue were also strongly associated with injury, and they decreased more the magnitude of the risk for CJD2–3 and CJD≥4 than that for CJD1. The risk associated with CJD was twofold higher among the workers aged ≥40 and among those with frequent drug use for

Table 3 Relationships between cumulated job demands (CJD) and occupational injuries: adjusted odds ratios (ORa) and 95% confidence intervals (2,888 subjects)

	ORa	95% CI
Logistic regression model including CJD only		
CJD [a]: vs. CJD = 0		
1	1.88†	1.23–2.87
2–3	4.39‡	2.98–4.46
≥4	9.93‡	6.70–14.7
Logistic regression model including all factors[b] with stepwise forward procedure retaining significant factors ($P < 0.05$) only		
CJD: vs. CJD = 0		
1	1.68*	1.10–2.58
2–3	3.70‡	2.50–5.49
≥4	7.15‡	4.73–10.8
Age < 30 years	1.55†	1.13–2.13
Men	1.76‡	1.30–2.38
Smoking	1.60‡	1.22–2.10
Musculoskeletal disorders	1.59†	1.20–2.09
Frequent drug use for fatigue	2.01†	1.16–3.48
Logistic regression model including all factors considered [b] and also job category, with stepwise forward procedure retaining significant factors ($P < 0.05$) only[c]		
CJD: vs. CJD = 0		
1	1.54*	1.00–2.37
2–3	2.99‡	1.98–4.51
≥4	5.45‡	3.51–8.46
Age < 30 years	1.54†	1.12–2.12
Men	1.64†	1.18–2.30
Smoking	1.60‡	1.22–2.10
Musculoskeletal disorders	1.54†	1.17–2.04
Frequent drug use for fatigue	2.03†	1.17–3.53
Job category: vs. executives, intellectual professionals, and teachers		
Workmen	3.24‡	1.74–6.04
Farmers, craftsmen, tradesmen	2.97†	1.38–6.43
Clerks	2.20†	1.18–4.10
Technicians	2.20*	1.00–4.88
Foremen	2.89†	1.34–6.26
Others	3.39‡	1.66–6.93

* $P < 0.05$, † $P < 0.01$, ‡ $P < 0.001$

[a] Defined by the number of the items related with injuries with $P < 0.10$ (Table 2)

[b] Only the factors related with injuries with $P < 0.05$ and sleeping pills use were considered (Table 2) except excess alcohol use which had adjusted odds ratio 1.40, $P < 0.09$, 95% CI 0.95–2.06

[c] Were non significant the factors: obese, diseases other than musculoskeletal disorders, excess alcohol use, frequent use of sleeping pills, hearing and cognitive disabilities

fatigue. This work is a part of the Lorhandicap study conducted to assess the prevalence of injuries and disabilities, their causes and consequences in the Lorraine population (2.3 million inhabitants in the north-eastern France) (Chau et al. 2005a, b; Gauchard et al. 2006; Groupe de recherche Lorhandicap: Chau et al. 2000).

The bias of selection of the sample would be small. Indeed, the households possessing a telephone represented 96%. The households with confidential telephone number represented only 16%. According to several associations for persons with disabilities, this list would not be related with health status and life conditions. The participation rate was similar with that reached for surveys with mailed questionnaire in France (ESEMeD/MHEDEA 2004; Groupe de recherche Lorhandicap: Chau et al. 2000). The distributions according to age and sex of the sample are close to those of the Lorraine population (Institut National de la Statistique et des Etudes Economiques (INSEE) 1993). The quality of the filling in of the questionnaire was very good (non-responses for various items <4%). As previously mentioned, all factors studied were validated and used in other studies (Baudier and Arène 1997; Challier et al. 2000; Chau et al. 2005a, b; Chau et al. 2004a, b; Gauchard et al. 2003; Lorhandicap group: Chau et al. 2004). The personal factors concerned the period of time before and around the injury occurring. The calculation of the CJD is valid because the job demands considered were unidimensional (Falissard 1998). The sum of items represents in fact the number of job demands concerned.

Table 4 Relationships between cumulated job demands (CJD) and occupational injuries: adjusted odds ratios (ORa) and 95% confidence intervals and their decreased values (%) when including successively another factor/confounder in the logistic model (2,888 subjects)

	CJD 1		CJD 2–3		CJD ≥ 4	
	ORa (95% CI)	(1)	ORa (95% CI)	(1)	ORa (95% CI)	(1)
Logistic model with						
CJD only	1.88† (1.23–2.87)	100	4.39‡ (2.98–4.46)	100	9.93‡ (6.70–14.7)	100
+ Age<30 years	1.86† (1.22–2.84)	99	4.42‡ (3.00–6.50)	101	9.92‡ (6.68–14.7)	100
+ Sex	1.77‡ (1.16–2.71)	94	4.06‡ (2.75–6.00)	92	8.49‡ (5.68–12.7)	85
+ Smoking	1.76† (1.15–2.69)	94	3.97‡ (2.69–5.87)	90	8.37‡ (5.59–12.5)	84
+ Musculoskeletal disorders	1.69* (1.10–2.59)	90	3.74‡ (2.52–5.54)	85	7.24‡ (4.79–10.9)	73
+ Frequent drug use for fatigue	1.68* (1.10–2.58)	89	3.70‡ (2.50–5.49)	84	7.15‡ (4.73–10.8)	72
+ Job category	1.54* (1.00–2.37)	82	2.99‡ (1.98–4.51)	68	5.45‡ (3.51–8.46)	55

* $P < 0.05$, † $P < 0.01$, ‡ $P < 0.001$

(1) Ratio between the ORa and that in the first line (%) for model with CJD only

Table 5 Relationships between cumulated job demands (CJD) and occupational injuries: adjusted odds ratios (ORa) and 95% confidence intervals (2,888 subjects)

	CJD 1[a]		CJD 2–3[a]		CJD ≥ 4 [a]	
	ORa	95% CI	ORa	95% CI	ORa	95% CI
Age						
Age < 40 years (n = 1266)	1.40	0.81–2.39	3.30‡	2.01–5.42	6.04‡	3.61–10.1
Age ≥ 40 years (n = 1622)	2.48†	1.24–4.96	5.21‡	2.73–9.94	13.47‡	6.93–26.2
Frequent drug use for fatigue						
No (n = 2,774)	1.74†	1.12–2.68	3.86‡	2.58–5.78	8.21‡	5.41–12.5
Yes (n = 109)	2.27	0.31–16.5	6.20*	1.08–35.5	12.70†	1.86–86.7

* $P < 0.05$, † $P < 0.01$, ‡ $P < 0.001$

[a] vs. CJD = 0, adjusted for sex, smoking, excess alcohol use, and body mass index

n number of subjects

The main finding is the strong exposure–response relationship between the CJD and injury: OR 1.88 for CJD1, 4.39 for CJD2–3, and 9.93 for CJD ≥ 4 versus CJD0. The unidimensionality of the job demands studied results from the fact that many workers were concomitantly exposed to several of them so that they were strongly interdependent. Another important finding is the association between a wide range of job demands and injury. These hazards were chosen as they concern daily working activities of most workers which could generate injuries (Caisse nationale de l'assurance maladie des travailleurs salariés (CNAMTS) 2002). They influence fatigue and psychosomatic disorders, injury and disabilities (Chau et al. 2005a, b; Lorhandicap group: Chau et al. 2004). Akerstedt et al. (2004) underlined that high work demands generate fatigue. Work conditions can have an impact on health and workers' ability (Caisse nationale de l'assurance maladie des travailleurs salariés (CNAMTS) 2002; Chau et al. 2005a, b; Houtman et al. 1998; Leigh et al. 1999; Pan American Health Organization—World Health Organization 1999) which can increase the risk of injury (Zwerling et al. 1997). Our results point out that "everyday" exposure to a number of job demands represents a high risk of injury (Gauchard et al. 2001; Ghosh et al. 2004; Jorgensen 1998; Melamed et al. 1999; Smith and Veazie 1998). Our study demonstrates that tasks at height, handling objects, use of pneumatic tools and other vibrating hand tools, work in adverse climate, and physical workload were associated with the highest risks (3.4–5.2-fold). It also shows that working on vibrating platform, use of machine tools, working in cold or heat environment, awkward posture, noise, use of hammer, and pace were associated with a 1.8–3-fold higher risk. These hazards mainly concern workmen, mechanics, machinists, joiners, workers in iron, foremen, farmers, craftsmen, etc., of many professional sectors, and especially those most at risk (for example construction industry, mining, factories, craft industry, maintenance and repairing for car and various materials). This finding is consistent with a study on railway workers which found that most injuries were caused by environmental hazards (25%), technical dysfunctions

(16%), lack of know-how (18%), lack of job knowledge (5%) and lack of work organization (14%) (Chau et al. 2007). So, prevention measures should be performed to reduce these hazards and to improve job knowledge, know-how, materials, and tools. Our study does not reveal use of screwdriver, working on a production line, standing about and walking, heat radiation, artificial light, and mental workload as risk factors for injury. These hazards would concern more upper class or employees in some professional sectors less at risk for injury (for example tertiary sector).

Another important finding is the lesser roles of the various confounding factors, which were investigated, in this study compared with that of the CJD. Male, age<30 years, smoking, musculoskeletal disorders, and frequent drug use for fatigue were associated with a 1.5–2-fold higher risk. They clearly mediated the risks associated with the CJD except for age <30 years. Indeed, they decreased the odds ratio to 72% for CJD≥4, 84% for CJD2–3, and 89% CJD1. Therefore, higher the CJD level, higher the magnitude of decrease in odds ratio. This finding is not surprising because it was expected that the job hazards are the main causes of injury and the confounding factors would play a greater role when these hazards are high. All the confounders studied generally alter the workers' physical/mental abilities. The individuals concerned would have altered abilities of working and watching occupational hazards. The quality of performing tasks could also be deteriorated. The role of smoking and diseases are well documented (Bhattacherjee et al. 2003; Chau et al. 2004a, b; Gauchard et al. 2003; Sprince et al. 2002; Wells and Macdonald 1999). Smoking generates a number of diseases and affects physical functions and psychomotor speed and is associated with cognitive flexibility and degenerative forms of cognitive impairment (Cicconetti et al. 2004; Kalmijn et al. 2002; Nelson et al. 1994). It is associated with sleep disorders and sick leave (Hoffstein 2002; Van Tuinen and Land 1986). Our study highlights the fact that musculoskeletal disorders were associated with a 1.5-fold higher risk whereas the other diseases had a lower risk. Musculoskeletal disorders are more common among the workmen and are generally related to the job demands studied. The role of younger age and sex are well known (Bhattacherjee et al. 2003; Chau et al. 2004a, b; McCaig et al. 1998; Sprince et al. 2002). Young age is associated with lack of experience in job and work environment knowledge (Chau et al. 2007). The higher risk in men than in women would be explained in part by the differences in jobs and tasks for the same job category, and possibly by the differences in perception of risks and behaviour.

The present study found that the workmen, farmers, craftsmen, tradesmen, and foremen had a 5.7–8.7-fold while the clerks and technicians had a 2.7–3.6-fold higher risk compared with the upper class. These risks reflect their working conditions. We show that job category and the previous confounders decreased the ORa of CJD≥4 to 55%, that for CJD2–3 to 68%, and that for CJD1 to 82%. So, the parts of job category was high enough for CJD≥4 and CJD2–3. They would include: (1) other occupational hazards (for example chemical hazards, dust, etc.), and (2) the social inequalities for health status, education level, income, lifestyle, and living conditions. Indeed, the low job categories have altered health status, more diseases, impairments and disabilities, and are more likely to be smokers, alcohol users, etc. (Chau et al. 2005a, b; Cohidon et al. 2005; Gauchard et al. 2006; Otero Sierra et al. 2002).

Our study shows that the role of CJD was twofold higher among the workers aged ≥40 and among those with frequent drug use for fatigue. These results were expected as the subjects aged ≥40 have decreased physical strength (Mathiowetz et al. 1985) and markedly increased prevalence of various physical and mental impairments (after 40 years, more than 30% of subjects experience an impairment and a number of them had several impairments) and disabilities (Chau et al. 2005a, b; Gauchard et al. 2006) while they were still working and did not have reduced activities. The subjects aged ≥40 have more falls (Gauchard et al. 2006). Our finding supports the hypothesis that the incidence of injury would increase in the coming years due to the lengthening of working years which would result in more workers with diseases and disabilities. This would be a major issue for the European community and other countries. Note that the improvement of work conditions reduces work-related diseases, which in turn lead to improved living conditions and health status.

Obesity was associated with a twofold higher risk of injury in the workers aged ≥40. It should be noted that the frequency of obesity strongly increases with age (Paeratakul et al. 2002) and that obesity is associated with a number of diseases, depression, social/employment discrimination and work disability (Aronne 2002). Obesity increases the risk of developing back disorders among the men over 40 years of age (Kostova and Koleva 1999), fall with longer sick leave (Gauchard et al. 2003) and of injury in environment with high ergonomic stress (Froom et al. 1996). Cognitive disabilities were found here to be associated with a higher risk of injury in univariate analysis but not in multivariate analysis. Cognitive disabilities favour injury and fall (Gauchard et al. 2006; Zwerling et al. 1997). Note that regular medication use, working disabilities, blindness, deafness, hearing impairment have been reported as risk factors for injury (Zwerling et al. 1997).

Excess alcohol use was separately associated with an increased risk of injury (crude OR 1.93), but its ORa was close to significance (1.40, 95% CI 0.95–2.06) when adjusted for all factors considered. Our study reveals that

excess alcohol use had ORa of 2.44 among the subjects with no disease. This finding suggests that the subjects free of disease with excess alcohol use are less aware of the risk. In the literature the role of alcohol use is well known (Gauchard et al. 2003; Wells and Macdonald 1999). Alcohol is causally related to a number of medical conditions and disabilities (Room et al. 2005), and it reduces vestibule-ocular reflex and affects balance control (Tianwu et al. 1995). Alcohol use also generates a number of diseases and deteriorates living conditions.

This study has some limitations. First, this study was a cross-sectional study. The job demands were those reported as demanding by the subjects. Many hazards, for example, chemical hazards, dust, etc., were not considered. It should be noted that most subjects generally have one main job during the working life so that they would be aware of their job demands. Second, the study used a self-administered questionnaire. Thus, although this study was conducted on a large sample, the interpretation of the results needs caution, especially due to the presence of a possible selection bias. However, self-administered occupational health history questionnaire is reliable and valid (Lewis et al. 2002). A study analyzing the non-response bias in a mailed health survey showed that the respondents and non-respondents were of similar sex and age distributions and the proportion of persons having a health care expenditure was very slightly higher in respondents (75 vs. 69%) (Etter and Pernejer 1997). Similar observation was reported in the Maastricht Cohort Study (Kant et al. 2003). The use of a self-administered questionnaire based on self-reported responses would be appropriate for assessing disabilities as consequences of diseases or ageing (Organisation Mondiale de la Santé (OMS) 1988). In population-based studies, self-assessment of seeing is similar between participants and non-participants (Munoz et al. 1999), and self-assessment of memory and hearing disorders is generally valid (Hashimoto et al. 2004; Turvey et al. 2000). Note that the prevalence of various variables of the sample was similar with the directly standardized adjusted rate computed in reference to the Lorraine population (Institut National de la Statistique et des Etudes Economiques (INSEE) 1993). This is due, as quoted above, to the similarities of the distributions according to age and sex of the sample and the Lorraine population. Although the study was conducted in 1996, the issue still remains a problem of public health which is not well documented in the literature and the characteristics of the population does not greatly change (Institut National de la Statistique et des Etudes Economiques (INSEE) 2006). The results were not published earlier because of the time spent for the survey, data management and control and other works concerning these data.

This study identified a wide range of job demands which were highly associated with injury. It found a strong exposure–response relationship between the CJD and injury. The confounding factors age, sex, smoking, musculoskeletal disorders, frequent drug use for fatigue were significant risk factors and they partly mediated the relationship between the CJD and injury. The CJD was associated with a twofold higher risk among the workers aged $\geq$40 and among those with frequent drug use for fatigue compared with the others. A higher risk was observed for obese subjects among the workers aged $\geq$40 and for excess alcohol users among the workers free of disease. The workplace can be a natural setting for a broad discussion on working conditions, preventing diseases and promoting health, which in addition to addressing determinants of health directly related to the working conditions, also addresses such issues as smoking, drug use, and health care. Job demands are a simple index that may be useful for health professionals who may need to monitor the subjects most at risk during working life.

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