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Non-fatal occupational injury among active and passive smokers in small- and medium-scale manufacturing enterprises in Japan

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Abstract

Active smoking is a risk factor for occupational injury, whereas its association with passive smoking is unknown. To evaluate the contribution of active and passive smoking to non-fatal occupational injury in manufacturing sectors, 2302 randomly selected workers aged 16–83 years working in 244 small- and medium-scale enterprises in Yashio city, Japan, were surveyed by means of a self-administered questionnaire. Smoking history, exposure to passive smoking, and occupational injury were evaluated by self-report. Exposure levels to passive smoking were assessed separately at work and at home as never, occasional, or regular exposure. Overall, 61.4% of men and 22.3% of women were current smokers. Among never smokers, 62.2% of men and 68.6% of women reported exposure to passive smoking either at work or home. Prevalence of occupational injuries was 36.2% for never, 43.3% for former, and 41.2% for current smokers among men and 19.7% for never, 22.2% for former, and 25.2% for current smokers among women. Among never smoking men, odds ratios (ORs) of occupational injury were 2.11 when regularly exposed to passive smoking at work or at home ($p = 0.025$), 2.27 at work ($p = 0.015$), and 3.08 at home ($p = 0.106$), in comparison to never smoking men who were never exposed to passive smoking either at work or at home (referent group). These associations were attenuated to be non-significant, after controlling for potential confounders. Never smoking men with occasional exposure to passive smoking were not significant ORs (1.11–1.19). In contrast, current and former smoking men had significant increases in adjusted ORs (1.57–2.00). In women exposed to smoking there was a non-significant increase in occupational injury. The present study indicates an expected increase in the risk of, occupational injury for current and former smoking men and suggests that exposure to passive smoking is a possible risk factor for never smoking men.

Keywords: Smoking; Passive smoking; Occupational injury; Manufacturing; Small- and medium-scale enterprises; Japan

Introduction

According to estimates by the International Labor Organization (ILO) in 2005, the number of work-related accidents in the world is increasing,

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especially in Asia and Latin America. There are 270 million occupational accidents each year, causing 1.1 million work-related deaths throughout the world (ILO, 2005).

Smoking has been proposed as one of the most significant, but controllable, risk factors for occupational accidents and injuries (Sack & Nelson, 1994). To date, three prospective (Ryan, Zwerling, & Orav, 1992; Swaen, van Amelsvoort, Bultmann, Slangen, & Kant, 2004; Wen et al., 2005) and 10 case-control or cross-sectional studies (Chau et al., 2002; Chau, Mur, Touron, Benamghar, & Dehaene, 2004; Gauchard et al., 2003; Hartman et al., 2004; Naus, Engler, Hetychova, & Vavreckova, 1966; Oleckno, 1987; Sprince et al., 2002; Tsai, Cowles, & Ross, 1990; Wadworth, Simpson, Moss, & Smith, 2003; Wong, 1994) have found positive associations between smoking and occupational accidents or injuries in various occupational groups, with smokers being 1.1–3.1 times more likely to be injured than non-smokers (Table 1). In 11 of these studies, the associations were statistically significant. By meta-analysis, it was estimated that cigarette smoking predicted relative risks of injury death of 1.61 (95% confidence interval (CI) 1.44–1.81) for current and 1.31 (95% CI 1.25–1.55) for former smokers compared to non-smokers (Leistikow, Martin, Jacobs, & Rocke, 1998). The conclusion that "smoking may be a leading contributor to injuries and that injury may be a leading burden from smoking, both nationally and globally" was based on the analysis of a 1990–1995 United States national cohort study (Leistikow, Martin, & Samuels, 2000). These estimates do not take into consideration the contribution of passive smoking to injury, despite the rapid accumulation of evidence pointing to the health hazard of passive smoking (Environmental tobacco smoke, Risk assessment, 1999). When non-smokers exposed to passive smoking were treated as the reference group, as in most past studies, the relationship between smoking and accident or injury might be obscured. If this reasoning is true, re-evaluation of previous findings is necessary.

The prevalence of smoking in the Japanese general population is high. The rate of smoking was estimated to be 48.3% for men and 13.6% for women in 2003 (Health and Welfare Statistics Association, 2004) making it likely that exposure to passive smoking is widespread. Indeed, a 2002 nationwide survey in Japan showed that 33.1% (37.1% for men and 29.8% for women) of non-smokers were exposed to passive smoking at work almost every day and 39.7% (40.4% for men and 39.2% for women) were exposed occasionally (Statistical Database, Ministry of Health, Labor and Welfare, Japan, 2002), suggesting a lack of awareness of passive smoking at work. A previous study in an electric power plant reported that 77.5% of male non-smokers were exposed to a high level of passive smoking, either at work or at home (Nakata, Tanigawa, Araki, Sakurai, & Iso, 2004).

In Japan for the year 2002, there were 132,339 occupational injuries requiring sick leave for 4 days or more among approximately 63.3 million workers (Japan Industrial Safety and Health Association, 2002). Among the injuries, 125,356 (95%) occurred in small- and medium-scale enterprises (SMEs). The 36,244 (29%) reported injuries in the manufacturing sector of SMEs were the highest of all industry sectors.

Because of the high prevalence of passive smoking in Japan and occupational injuries in SMEs, this study was done to investigate the association of both passive and active smoking with occupational injury in the manufacturing sectors of SMEs.

Subjects and methods

Study design

The study design was cross-sectional and data were collected by a self-rating questionnaire from August to December 2002. Subjects were workers in SMEs with 1–158 workers in Yashio city, Saitama prefecture, Japan. The city has the highest percentages of both manufacturing plants and people working in manufacturing in the prefecture. In this area, 1813 small- and medium-scale manufacturing factories were listed in the 2000 edition of the city commercial directory. We randomly selected 329 factories from the directory depending on the distribution of types of businesses in this city ($n = 3514$). We contacted each factory by telephone and requested participation in a questionnaire survey concerning "lifestyle and health". Of these, 248 factories agreed to participate in the survey and questionnaires were distributed during visits to each factory and were given to 2591 full-time workers. Finally, responses were obtained from 2302 workers from 244 factories, representing a response rate of 65.5%.

Items on the questionnaire concerned demographics, current job types, industry sectors,

Table 1
Occupational injury and accident risks among current or former smokers compared to nonsmokers

Study	Population	No. of subjects (cases/controls)	Male%	Crude OR/RR (95%CI)	Adjusted OR/RR (95%CI)	Confounders adjusted for
Prospective studies						
Ryan et al.	Postal employees	2537	66	/	CS 1.40 (1.11–1.77)	Age, gender, race, drug use, exercise habits, job classification
Swaen et al.	Employees from multiple sectors	7051	73	CS 2.04 (1.38–3.00)	/	
Wen et al.	Civil servants, teachers, individuals residing in both rural and urban area	64,319	100	/	CS 2.91 (1.00–8.42)	Age, alcohol use
Case-control/cross-sectional studies						
Chau et al.	Construction workers	1760 (880/880)	100	CS 1.30 (1.07–1.59)	CS 1.27 (1.04–1.76)	Age, job experience, physical activity, physical disabilities, sleep disorders
Chau et al.	Railway workers	2610 (1305/1305)	100	CS 1.28 (1.09–1.52)	CS 1.25 (1.06–1.48)	Age, job experience, physical activity, sleep disorders
Sprince et al.	Farmers	678 (205/473)	/	/	CS 1.03 (0.60–1.75) FS 1.15 (0.79–1.67)	Age
Hartman et al.	Farmers	394 (142/252)	97	/	CS 1.66 (1.08–2.56)	Age, BMI, gender, duration of work, job type
Tsai et al.	Refinery/petrochemical plant workers[a]	6601	87	NS 1.1, FS 2.0, CS 2.8[b]	/	
Oleckno et al.	Injury patients addmitted to hospital (74% employed workers)	869 (213/656)	82	CS 3.04 (2.20–4.18)	CS 2.52 (1.79–3.55)	Age, sex, drinking status
Naus et al.	Machine workers	1500	50	Accident rate NS 10%, CS 18%	/	
Wadsworth et al.	Random individuals	1548	44	/	CS 2.15 (1.45–3.18)	Age, gender, employment status, alcohol, work and general stress, health symptoms, anxiety, depression, income
Gauchard et al.	Railway workers	854 (427/427)	100	CS 1.58 (1.17–2.14)	CS 1.53 (1.13–2.07)	Age, BMI, job experience, physical activity, alcohol consumption, sleep dosorders
Wong	Employees from multiple sectors	244 (122/122)	100	CS 3.1 (1.5–6.1) FS 2.3 (0.8–6.5)	/	

OR, odds ratio; RR, relative risk; CI, confidence interval; CS, current smokers; FS, former smokers; NS, non-smokers; /, not stated; BMI, body mass index.
[a]Three-year frequency rates of injury per 100 employees.
[b]Significantly higher than non-smokers at $p<0.05$.

occupational injury, lifestyle, height and body weight, and presence of physical/psychological diseases currently under treatment. Questions about demography, smoking history, and occupational injury were completed by 1416 men and 694 women (Table 2).

The study was approved by the Medical Ethical Committee of the University of Tokyo, and written informed consent was obtained from all participants.

Smoking status

Smoking status and exposure to passive smoking were assessed by the following three questions: (1) Are you a current, former, or never smoker? (2) If you are a current smoker, how many cigarettes a day do you smoke and how many years have you been smoking? (3) Are you currently exposed to cigarette smoke from other people? Smoking exposure and work and at home were considered separately and responses were categorized as no exposure, occasional exposure, and regular exposure (Kawachi et al., 1997).

Occupational injury

A "yes or no" question to assess occupational injury was "Have you ever been injured during your work, including minor scratches and cuts in the previous 1-year period?"

Other potential confounding variables

Other potential confounding variables included those related to demographics such as age, educational level, marital status, job type, industry sector, lifestyle, and physical/psychological health condition (Table 2). Lifestyle factors included daily alcohol consumption (number of alcoholic drinks consumed a day, with one drink estimated as about 9 g of pure ethanol) and daily caffeine intake (cups of tea or coffee). Physical/psychological health conditions included body mass index (BMI), which was calculated as weight in kilograms divided by the square of height in meters, insomnia symptoms, and presence of self-reported physical/psychological disease(s) currently under treatment. Insomnia symptoms were defined as being present if the subject had at least one following sleep symptoms: taking more than 30 min to fall asleep, awakening during sleep, or early morning awakening more than 3 times/week (Nakata et al., 2000, 2004a, b). Types of reported physical/psychological diseases included hypertension, hyperlipidemia, diabetes mellitus, menopausal syndrome, heart disease, cancer, liver disease, renal disease, peptic ulcer, gastrointestinal diseases, neurological diseases, musculoskeletal disorders, and psychiatric illnesses.

Statistical analyses

Prevalence of occupational injury by smoking status was compared by the χ^2 test. Risk of occupational injury was estimated using univariable and multivariable logistic regression with odds ratios (ORs) and the 95% CI as measures of association. The multivariable model adjusted for all potential mediators associated with occupational injury in the univariable analyses ($p<0.05$) was as follows. For men, the model adjusted for 10-year age groups, marital status (married/not married), highest educational level (junior high school, high school, vocational/college/university), BMI (<20.0, 20.0–22.5, 22.6–25.0, $25.0<$), insomnia symptoms (yes/no), job type (managerial/clerical, sales/service, technical, manufacturing, driving, other), and work experience (<3, 3–7, $7>$ years), whereas for women the model adjusted for 10-year age groups, caffeine intake (almost none, 1–3 or more cups of coffee or tea), insomnia symptoms, job type, and work experience. Pearson correlation coefficients and partial correlation coefficients adjusting for confounders were used to examine the linear relationship between occupational injury and smoking category. This was done solely for the never smoking group but also for all smoking subgroups including never, former, and current smokers. The significance level for all statistical analyses was $p<0.05$ (two-tailed test). All data were analyzed using the Statistical Package for the Social Sciences version 11.5 (SPSS Inc., Chicago, USA).

Results

The characteristics of participants in the study are shown in Table 2. Overall, 61.4% of men and 22.3% of women were current smokers. The average age of former smokers was higher than that of never and current smokers in men; in contrast, the average age of former smokers was lower than that of never and current smokers in women.

In men, 41.2% of current and 43.3% of former smokers responded that they had experienced an

Table 2
Characteristics (%) of survey respondents by smoking status[a]

Characteristics	Men			Women		
	Smoking status			Smoking status		
	Never	Former	Current	Never	Former	Current
Number of subjects (%)	376 (26.6)	171 (12.1)	869 (61.4)	503 (72.5)	36 (5.2)	155 (22.3)
Sociodemographics						
Age (years), mean (SD)	44.9 (14.7)	51.7 (12.7)	43.6 (12.7)	46.8 (13.9)	38.3 (11.2)	42.7 (12.9)
Age group						
16–29	20.0	6.4	15.2	17.0	27.0	21.5
30–39	21.3	14.4	28.9	13.9	29.7	19.0
40–49	12.9	16.4	19.2	13.7	29.7	18.4
50–59	26.5	34.5	24.9	37.8	10.8	32.9
60 and over	19.3	28.7	11.7	17.6	2.7	8.2
Married	64.0	74.7	70.8	69.5	54.1	67.7
Highest education						
Junior high school	24.5	30.9	23.6	22.3	11.8	21.7
High school	40.9	41.8	46.8	53.8	58.8	54.1
Vocational/college/university	34.6	27.3	29.7	23.9	29.4	24.2
Lifestyle and physical/psychological condition						
Alcohol consumption (g ethanol/day)						
Non-drinker (0.0)	29.2	27.9	22.3	62.3	32.4	41.1
0.01–4.9	18.9	7.0	11.0	22.9	29.7	24.7
5.0–14.9	25.6	21.5	21.5	11.9	18.9	19.0
15.0–25.0	14.2	21.5	21.4	2.3	10.8	9.5
>25.0	12.1	22.1	23.9	0.6	8.1	5.7
Caffeine intake (cups of coffee or tea/day)						
Almost none	17.7	14.0	5.0	7.6	0.0	4.5
1–2	44.9	48.0	45.5	48.1	71.1	31.4
3 or more	37.4	38.0	49.4	44.3	28.9	64.1
Body mass index (kg/height (m)^2)						
<20.0	12.0	11.6	18.2	23.6	26.5	36.6
20.0–22.5	27.2	25.4	33.9	35.5	35.3	35.9
22.6–25.0	32.4	34.7	27.7	23.4	23.5	17.6
>25.0	28.3	28.3	20.3	17.6	14.7	9.8
Disease(s) currently under treatment (Yes)	30.5	46.0	22.0	25.7	15.8	21.3
Insomnia symptoms (Yes)[b]	25.0	25.9	22.3	23.8	10.5	29.0
Occupational						
Occupational injury (Yes)	36.6	43.3	41.2	19.0	22.2	25.2
Job type						
Managerial/clerical	18.5	20.8	14.9	47.0	51.4	54.3
Sales/service	7.8	11.7	10.7	1.3	8.1	0.7
Technical	4.1	7.1	4.2	2.6	0.0	2.1
Manufacturing	53.5	42.2	52.2	35.5	29.7	27.1
Driving	1.5	1.3	2.7	0.0	0.0	1.4
Others	14.6	16.9	15.4	13.6	10.8	14.3
Industry sector						
Leather	0.9	1.7	2.2	3.4	5.3	3.1
Textile	1.1	2.9	2.2	3.6	2.6	6.9
Food	5.6	5.2	4.4	10.5	7.9	13.8
Printing	2.0	3.4	2.2	2.4	2.6	7.5
Chemical	14.9	13.8	17.8	19.7	13.2	13.8
Wood	1.1	0.0	0.6	2.1	0.0	0.6
Metal	45.0	43.1	41.7	36.6	18.4	29.4

Table 2 (*continued*)

Characteristics	Men			Women		
	Smoking status			Smoking status		
	Never	Former	Current	Never	Former	Current
Paper	6.7	4.0	7.1	7.3	15.8	7.5
Machine	15.8	20.7	17.7	11.6	28.9	10.0
Stone, clay, and glass	2.4	1.7	1.9	0.2	5.3	2.5
Others	4.5	3.4	2.4	2.6	0.0	5.0
Work experience (in years)						
Less than 3	19.5	13.5	18.0	23.0	45.9	29.2
3–7	16.6	8.2	15.1	17.9	27.0	16.2
More than 7	63.9	78.4	67.0	59.1	27.0	54.5

[a]Data may not total 100% due to rounding.

occupational injury in the previous 1-year period (Table 3). Injury prevalence was 49.2% among never smoking men regularly exposed at work or at home; when calculated for exposure at work, prevalence was 48.0% and when calculated for exposure at home, prevalence was 55.6%. For men with occasional exposure, injury prevalence was 37.7% for exposure at work or at home, 36.1% for exposure at work, and 46.4% for exposure at home. Injury prevalence among never smoking males was 28.9% in all three categories. In women, 25.2% of current and 22.2% of former smokers reported that they had had an injury. Among never smokers, injury prevalence among women who were regularly exposed at work or at home was 23.7%, regularly exposed at work was 24.6%, and regularly exposed at home was 22.6%. Also, for those women occasionally exposed at work or at home was 19.9%, and prevalence for occasional exposure at work was 21.4% and at home was 18.0%. Among never exposed females, 16.5% reported injuries in each of the three categories.

Among never smokers, 62.2% of men and 68.6% of women reported exposure to passive smoking either at work or at home (Table 4). Men were more often exposed at work (52.4%) than women (38.1%), while women were exposed at home (30.4%) more often than men (9.8%).

Relationships between smoking status and occupational injury in men and women are shown in Table 5. Compared to male never smokers who were never exposed to passive smoking (referent group), unadjusted ORs of occupational injury among never smokers reporting regular exposure at work or at home were 2.11 (95% CI 1.10–4.07), at work 2.27 (95% CI 1.17–4.41), and at home 3.08 (95% CI 0.79–12.0); after adjustment for potential confounders, the ORs were 1.54 (95% CI 0.73–3.24), 1.72 (95% CI 0.81–3.66), and 1.43 (95% CI 0.31–6.62), respectively, for the corresponding exposure category. In women, unadjusted ORs of occupational injury among never smokers reporting regular exposure at work or at home were 1.45 (95% CI 0.76–2.78), at work 1.66 (95% CI 0.81–3.40), and at home 1.49 (95% CI 0.69–3.21); the ORs were 1.24 (95% CI 0.57–2.71), 1.43 (95% CI 0.58–3.55), and 1.21 (95% CI 0.50–2.95), respectively, for the corresponding exposure category after controlling for confounders. Subjects reporting occasional exposure had a non-significant increase in occupational injury. In male former smokers, ORs were significant, between 1.99 and 2.00, but were non-significant, between 1.23 and 1.42, in female former smokers by multivariable analyses. Similarly, significant ORs (1.56–1.58) were found for male current smokers but not for female current smokers (ORs 1.48–1.57). No significant dose-response relationship between exposures to passive smoking in never smokers and occupational injury was found in both men and women.

Discussion

These data indicate an expected increase in the risk of occupational injury for current and former smoking men and suggests exposure to passive smoking as its possible risk factor for never smoking men in the small- and medium-scale manufacturing population. Although the passive smoking effect appeared to be small, the results of this study indicated that tobacco control at the workplace/home is important in avoiding injuries at work.

Table 3
Prevalence of occupational injury by smoking status stratified by sex

	Smoking status														
	Never									Former			Current			
	Exposure to passive smoking															
	Never[a]			Occasional			Regular									p[b]
	N	*n*	%	*N*	*n*	%	*N*	*n*	%	*N*	*n*	%	*N*	*n*	%	
Men																
Exposure at work or home	142	41	28.9	175	66	37.7	59	29	49.2	171	74	43.3	869	358	41.2	0.048
Exposure at work	142	41	28.9	147	53	36.1	50	24	48.0	171	74	43.3	869	358	41.2	0.028
Exposure at home	142	41	28.9	28	13	46.4	9	5	55.6	171	74	43.3	869	358	41.2	0.042
Women																
Exposure at work or home	158	26	16.5	231	46	19.9	114	27	23.7	36	8	22.2	155	39	25.2	0.401
Exposure at work	158	26	16.5	131	28	21.4	61	15	24.6	36	8	22.2	155	39	25.2	0.409
Exposure at home	158	26	16.5	100	18	18.0	53	12	22.6	36	8	22.2	155	39	25.2	0.394

[a]Neither exposed at work nor at home.
[b]Obtained by χ^2 test.

Table 4
Percent of never smokers exposed to passive smoking (95% Confidence Interval)[a]

	Exposure to passive smoking							
	n	Never[b]	At work or home		At work		At home	
			Occasional	Regular	Occasional	Regular	Occasional	Regular
Men	376	37.8 (32.9–42.7)	46.5 (41.5–51.6)	15.7 (12.0–19.4)	39.1 (34.2–44.0)	13.3 (9.9–16.7)	7.4 (4.8–10.1)	2.4 (0.8–3.9)
Women	503	31.4 (27.4–35.5)	45.9 (41.6–50.3)	22.7 (19.0–26.3)	26.0 (22.2–29.9)	12.1 (9.3–15.0)	19.9 (16.4–23.4)	10.5 (7.9–13.2)

[a]Data may not total 100% due to rounding.
[b]Neither exposed at work nor at home.

Our finding of an increased injury risk in smokers is consistent with many previous reports that include various occupations (Chau et al., 2002, 2004; Gauchard et al., 2003; Hartman et al., 2004; Naus, Engler, Hetychova, & Vavreckova, 1966; Wen et al., 2005; Oleckno, 1987; Ryan et al., 1992; Sprince et al., 2002; Swaen et al., 2004; Tsai et al., 1990; Wadworth et al., 2003; Wong, 1994). Compared to these previous studies, the strength of this study is that we considered the effect of passive smoking exposure in never smokers on occupational injuries and accounted for a broad range of associated confounders. In this way, we can estimate the risk of injury due to exposure to tobacco smoke more accurately. There was a non-significant increase in occupational injury in never smokers regularly exposed to passive smoking compared to never smokers unexposed to passive smoking in both men and women, although this increase may be due to chance or to the effect of adjusted/unknown confounding factors. Former smokers had an increased risk, which is consistent with several previous studies but the effect was greater than those reported previously (Sprince et al., 2002; Tsai et al., 1990; Wong, 1994). Former smokers may have quit smoking because of illnesses/injuries (Table 2) or had nicotine withdrawal problems that induced injuries. Current smokers had a significantly increased risk of injury but the effect was smaller than in former smokers. One possible explanation for this discrepancy is that current smokers may under-report their occupational injury because they may have difficulty in recalling their injury. This hypothesis could be supported by the fact that heavy smoking is associated with cognitive impairment/decline in middle-aged people (Richards, Jarvis, Thompson, & Wadsworth, 2003). Alternatively, they may smoke during work to avoid sleepiness since nicotine has the effect of increasing alerting (Åkerstedt et al., 2002; Benowitz, 1996; Takahashi et al., 2005). Further research with a larger sample size including widespread never smoker exposures to smoking and reasons for smoking during work is needed to draw a definite conclusion.

In this survey, two-thirds of never smokers were exposed to passive smoking at work or at home, which was a similar rate shown in both the nationwide survey (Statistical Database, Ministry of Health, Labor and Welfare, 2002) and a previous report (Nakata et al., 2004) in Japan. In contrast, annual incidence rate of occupational injury was much higher than that reported by the Japan Industrial Safety and Health Association (2002) which defined injuries as accidents requiring sick leave for 4 days or more. The higher incidence in this study could be possibly due to the definition of injury that included both major and minor injuries; the incidence of injury is expected to be higher when minor injuries are reported as in a previous study in car assembly plant (13–38%) (Tucker, Folkard, & Macdonald, 2003). Although 45% of injuries in manufacturing are comprised of cuts, scratches, jams, pinches, or compression (Japan Industrial Safety and Health Association, 2002), failure to investigate the nature, severity, or circumstance of an injury is a major limitation of this study. Also, lack of data on lost days, interruption in work, or hospitalization due to injury prevents us from learning of the aftereffects of injuries among passive and/or active smokers.

In addition, some methodological limitations need to be kept in mind when interpreting the study results. First, response bias may have occurred if the non-respondents differed from the respondents with respect to smoking status and occupational injury.

Table 5
Unadjusted and adjusted odds ratios for occupational injury by smoking status stratified by sex

	Smoking status										
	Never						Former		Current		
	Exposure to passive smoking										
	Never[a]	Occasional		Regular							
		OR (95% CI)	p	OR (95% CI)	p	p for trend[d]	OR (95% CI)	p	OR (95% CI)	p	p for trend[e]
Men											
Exposure at work or at home											
Unadjusted OR	1.00	1.53 (0.95–2.49)	0.083	2.11 (1.10–4.07)	0.025	0.016	1.88 (1.17–3.01)	0.009	1.73 (1.17–2.54)	0.006	0.022
Adjusted OR[b]	1.00	1.19 (0.68–2.09)	0.539	1.54 (0.73–3.24)	0.260	0.142	1.99 (1.15–3.42)	0.014	1.57 (1.01–2.46)	0.048	0.036
Exposure at work											
Unadjusted OR	1.00	1.39 (0.85–2.28)	0.193	2.27 (1.17–4.41)	0.015	0.015	1.88 (1.17–3.01)	0.009	1.73 (1.17–2.54)	0.006	0.011
Adjusted OR[b]	1.00	1.11 (0.63–1.96)	0.722	1.72 (0.81–3.66)	0.158	0.102	1.99 (1.15–3.42)	0.014	1.58 (1.01–2.47)	0.045	0.028
Exposure at home											
Unadjusted OR	1.00	2.14 (0.93–4.88)	0.072	3.08 (0.79–12.0)	0.106	0.021	1.88 (1.17–3.01)	0.009	1.73 (1.17–2.54)	0.006	0.023
Adjusted OR[b]	1.00	1.18 (0.43–3.23)	0.743	1.43 (0.31–6.62)	0.646	0.397	2.00 (1.16–3.46)	0.013	1.56 (1.00–2.46)	0.052	0.080
Women											
Exposure at work or at home											
Unadjusted OR	1.00	1.21 (0.70–2.10)	0.490	1.45 (0.76–2.78)	0.263	0.258	1.45 (0.60–3.54)	0.413	1.71 (0.98–2.97)	0.059	0.048
Adjusted OR[c]	1.00	1.03 (0.53–2.01)	0.924	1.24 (0.57–2.71)	0.592	0.534	1.33 (0.47–3.79)	0.593	1.49 (0.75–2.94)	0.254	0.130
Exposure at work											
Unadjusted OR	1.00	1.38 (0.76–2.50)	0.287	1.66 (0.81–3.40)	0.169	0.142	1.45 (0.60–3.54)	0.413	1.71 (0.98–2.97)	0.059	0.072
Adjusted OR[c]	1.00	1.34 (0.53–2.35)	0.434	1.43 (0.58–3.55)	0.441	0.222	1.42 (0.49–4.10)	0.520	1.57 (0.79–3.14)	0.203	0.180
Exposure at home											
Unadjusted OR	1.00	1.11 (0.58–2.16)	0.748	1.49 (0.69–3.21)	0.313	0.337	1.45 (0.60–3.54)	0.413	1.71 (0.98–2.97)	0.059	0.043
Adjusted OR[c]	1.00	0.84 (0.38–1.86)	0.838	1.21 (0.50–2.95)	0.672	0.798	1.23 (0.43–3.53)	0.697	1.48 (0.74–2.96)	0.263	0.145

OR; odds ratio, CI; confidence interval.
[a]Indicates referent group.
[b]Adjusted for 10-year age groups, marital status, educational level, BMI, insomnia symptoms, job type, and work experience.
[c]Adjusted for 10-year age groups, caffeine intake, insomnia symptoms, job type, and work experience.
[d]p for trend in never smokers only.
[e]p for trend in never, former, and current smokers combined.

The non-responding population may have more problems related to occupational injury or smoking. Of a total of 3514 subjects, 923 (26.3%) refused to or could not participate in the survey. Reasons for non-response were: the person responsible for the worksite did not have enough time to recruit workers, workers declined participation, the factory was too far to visit, the worker had retired, and workers did not show any interest in the survey. However, we could not examine this possible bias because detailed non-respondent data were unavailable. Second, the data in this study comes from a single survey of workers in a geographically small area (Yashio city) with a small sample size. As only 26.6% of men were never smokers, this could lead to a low statistical power for the effect of passive smoking; this is also true for women with a smaller sample size. Third, smoking status was obtained by self-reporting, which may introduce recall/reporting bias. Current smokers were defined as those who smoked at the time of the study but they may also be exposed to passive smoking, which may underestimate the risk of occupational injury in smokers exposed to passive smoking. Although a meta-analysis of the validity of self-reported smoking showed high levels of both sensitivity (87.5%) and specificity (89.2%) (Patrick et al., 1994) and self-reports on current exposure to passive smoking are modestly correlated (Pearson correlations between 0.2 and 0.5) with salivary (Emmons et al., 1994) and urinary cotinine (Cummings et al., 1990), reliance of self-reporting does carry a risk of misclassification (Wells, English, Posner, Wagenknecht, & Perez-Satble, 1998). Fourth, the inherent nature of the cross-sectional design does not permit the conclusion that active smoking causes occupational injury. Fifth, some confounding variables that may have an impact on smoking and injury, such as hours of work and habitual exercise, were not included in the broad range of other confounders in this study.

There are several possible explanations as to why active smokers have a high prevalence of occupational injury. First, active smokers may experience blurred vision or hearing dysfunction (Cruickshanks et al., 1998; Nakanishi, Okamoto, Nakamura, Suzuki, & Tatara, 2000; NIOSH, 1979), which may increase the chance of being injured. Second, carbon monoxide and other chemicals from smoking may have direct adverse effects on safety at work. Exposure to carbon monoxide results in reduced vision in the dark and low scores in vision and performance tests (Havelius & Hansen, 2005; Hosko, 1979). Third, smoking is associated with poor sleep and sleep problems can cause injury at work (Balter & Uhlenhuth, 1992; Chau et al., 2002, 2004; Leger, Guilleminault, Bader, Levy, & Paillard, 2002; Nakata et al., 2005). Smokers have been shown to have significantly shorter sleep duration, longer sleep latency, more problems in staying asleep, and greater daytime sleepiness than non-smokers (Phillips & Danner, 1995; Soldatos, Kales, Scharf, Bixler, & Kales, 1980; Wetter & Young, 1994). These findings may partly support the hypothesis that active smokers will sustain occupational injuries.

It should be appreciated that non-smokers exposed to passive smoking could be involved in accidents and injuries caused by active smokers. When non-smokers are exposed to passive smoking, it is likely that the active smokers who are at increased risk for injury are nearby (Leistikow, Martin, & Milano, 2000; Wen et al., 2005).

In conclusion, despite the fact that smoking status and occupational injury were assessed by self-report, as well as other limitations, these data indicated an increase in the risk of occupational injury for current and former smoking men and suggested that exposure to passive smoking was its possible risk factor for never smoking men among small- and medium-scale manufacturing factory workers. The finding underscores the need for further investigation of whether implementing smoke-free workplaces/homes will reduce the occurrence of occupational injury.

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