Industrial Health 2010, **48**, 29–37 **Original Article**

Subjective Musculoskeletal Symptoms in Winter and Summer among Indoor Working Construction Electricians

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Received December 22, 2008 and accepted June 22, 2009

Abstract: To evaluate the effects of cold exposure on the musculoskeletal system, two surveys on the subjective musculoskeletal symptoms among male electricians working in the buildings under construction were performed in winter (N=74) and summer seasons (N=83). A self-administered questionnaire was used to collect information on age, occupational career, working habit, present illness, and subjective musculoskeletal symptoms. Mean age, occupational career and daily smoking of the supervisors were significantly higher than those of the other subjects. In general, prevalence rates of stiffness, numbness, pain and Raynaud's phenomenon in the fingers, finger cold sensation, dull movement of the fingers, pain in the wrist, knee joint pain, pain and numbness in the foot and foot cold sensation in winter were significantly higher than those in summer. These results were marked especially in the workers except supervisors. In winter, there were no significant differences in the prevalence rates of subjective musculoskeletal complaints between the supervisors and the other workers. On the other hand, in summer, prevalence of stiffness and pain in the shoulder, stiffness and pain in the neck, dullness and pain in the arm, finger cold sensation, low back dullness and low back pain in the supervisors were significantly higher than those in the other workers. These results suggest that effects of cold on the musculoskeletal symptoms markedly appeared in the workers except supervisors.

Key words: Subjective musculoskeletal symptoms, Winter, Summer, Electricians, Questionnaire

Introduction

There are very few studies documenting cold exposure as a risk factor for musculoskeletal symptoms. Bang *et al.*[1)] investigated the relation between feeling cold at work and the risk of symptoms from muscles, skin, and airways among 1,767 seafood industry workers. They showed that moderate cooling, caused by a cold indoor working environment, may increase musculoskeletal symptoms. The associations between indoor cold exposure and some musculoskeletal disorders such as low back pain, knee pain and shoulder pain[2)], carpal tunnel syndrome[3)], and neck and shoulders[4)] have been reported. It has been shown that musculoskeletal symptoms are more frequent in cold store work and in related conditions than in neutral temperature work and that symptoms seems to increase when the working time in the cold environment increases[5)]. We also suggested of the increase of the prevalence of subjective complaints such as lumbago and low-back cold sensation among female workers in a consumer cooperative under the air conditioning in summer[6)]. In a recent study, Dovrat and Katz-Leurer[7)] reported that male workers in the cold store room at temperature of –20˚C had increased odds ratio of reporting back symptoms in the previous 12 months and during work compared with their colleagues working in storerooms at regular temperatures.

However, a causal relation between cold exposure and musculoskeletal symptoms is nevertheless questionable. Griefahn *et al.*[8)] stated that pains in the shoulders and in the extremities complained of by workers were caused by

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repetitive physical activities rather than by cold. Their conclusions were on the basis of the evidence gained from a questionnaire survey performed among workers in the food industry, mainly from distributors, meat productions and from breweries, whose main occupational activities were manual material handling and heavy lifting, in moderately cold environments (–5 to 15˚C). They also reported that lumbago was associated with changes in temperature or frequently interrupted exposures to cold by moving frequently between different rooms. However, frequent changes in temperature in the classification work place were not observed. In addition, as classification workers did not move to other rooms except at rest times, they were exposed to cold uninterruptedly.

Ueno *et al.*[9] reported of the high prevalence of musculoskeletal symptoms among construction electricians. To evaluate the effect of moderate cold exposure on musculoskeletal symptoms, the present study was undertaken. We compared the prevalence of musculoskeletal symptoms in summer and winter among indoor working electricians whose job were mainly in buildings under construction.

Subjects and Methods

Subjects and questionnaire

This study was conducted among 120 male electricians working in the buildings under construction located in "N" City in the central part of Japan. Work load of electricians was estimated to be at relative metabolic rate (RMR) 3–4[10]. Through the headquarters of the company, a self-administered questionnaire not requiring a signature covering age, body dimensions, occupational career, working days in a week as well as daily working hours, lifestyles (Morimoto's 8 items[11] such as smoking, alcohol drinking and physical exercise), present illness, general subjective symptoms during summer or winter (21 items), regional musculoskeletal symptoms during the last one month (21 items), and discomfort and distress in daily life during the last one month (32 items) was distributed and collected. The questionnaire was almost the same as that used in the previous study[12]. The participants were questioned as to whether they had had any of the investigated symptoms in winter or summer. The subjective symptoms were classified into three categories of frequency: frequently, sometimes, or almost none. In order to be able to present and to discuss the results obtained, selection of "frequently" or "sometimes" was taken to indicate the presence of the symptom. The survey was carried out in February 2003 (winter survey) and in August 2003 (summer survey). In the winter survey 74 (61.6%) and in the summer survey 83 subjects (69.2%) replied to the questionnaire. Thus, it is estimated that overlap rates of the subjects between winter survey and summer survey were from 50.0 to 100.0%.

In analysis, the subjects were divided into "supervisors" and "other workers".

The study was approved by the Ethical Committee of Gifu University School of Medicine.

Statistics

The significance of differences among values was tested using χ^2 test and *t*-test. When the frequency was low (below 5), Fisher's exact test was used. The significance level was set at $p<0.05$. Statistical analysis was conducted with the SPSS software, version 12 (SPSS, Inc., Chicago, IL).

Results

Table 1 shows the characteristics of the subjects. There were no significant differences in the characteristics between subjects surveyed in winter and those in summer. In the surveys both in winter and summer, mean age, occupational career and daily smoking of the supervisors were significantly higher than those of the other workers.

Table 2 shows the present illness of the subjects. In the other workers and the total subjects, percentages of the subjects who had at least one disease in winter were significantly higher than those in summer ($p<0.01$). In summer, percentage of the subjects who had lumbago in the supervisors was significantly higher than that in the other workers ($p<0.05$).

Table 3 shows the prevalence of subjective symptoms among the study subjects. In the total subjects, prevalence rates of stiffness in the fingers, Raynaud's phenomenon (white finger occurred at the exposure to a cold environment) in the fingers, pain in the wrist, knee joint pain, abdominal pain, weakness of stomach and intestines, bad abdominal condition, constipation, pollakisuria in the night, dull head, palpitation, cough and sputum in winter were significantly higher than those in summer ($p<0.01$ or $p<0.05$). On the other hand, prevalence of weakness of stomach and intestines in summer was significantly higher than that in winter ($p<0.01$). In the supervisors, prevalence of stiffness in the fingers, and cough in winter were significantly higher than those in summer ($p<0.01$). On the other hand, prevalence of weakness of stomach and intestines in summer was significantly higher than that in winter ($p<0.01$). In the other workers, prevalence rates of stiffness in the fingers, Raynaud's phenomenon in the fingers, pain in the wrist, knee joint pain, constipation, pollakisuria in the night, cough and sputum in winter were significantly higher than those in summer ($p<0.01$ or $p<0.05$). On the other hand, prevalence of

Table 1. Characteristics of the subjects

	Rank				Total	
	Supervisors		Other workers			
	Winter (N=26)	Summer (N=26)	Winter (N=47)	Summer (N=57)	Winter (N=73)	Summer (N=83)
Age (yr)	41.6 ± 12.9 (20–65) +	42.6 ± 11.7 (23–58) ++	33.3 ± 13.3 (19–63)	30.0 ± 11.6 (18–73)	36.2 ± 13.8 (19–65)	34.0 ± 13.0 (18–73)
Height (cm)	169.4 ± 6.9 (158–183)	169.4 ± 6.5 (158–180)	169.8 ± 6.2 (159–185)	170.4 ± 6.4 (160–193)	169.6 ± 6.5 (158–185)	170.1 ± 6.5 (158–193)
Body weight (kg)	68.7 ± 9.3 (53–86)	68.3 ± 10.2 (52–95)	66.9 ± 12.7 (50–100)	66.2 ± 10.3 (45–100)	67.5 ± 11.7 (50–100)	66.8 ± 10.3 (45–100)
Body mass index (kg/m^2)	24.0 ± 3.3 (19.4–33.6)	23.8 ± 2.8 (19.4–31)	23.2 ± 3.6 (17.3–32.2)	22.8 ± 3.1 (16.5–32.8)	23.5 ± 3.5 (17.3–33.6)	23.1 ± 3.1 (16.5–32.8)
Occupational career (yr)	19.8 ± 10.7 (4.5–42) ++	22.2 ± 11.0 (5.3–42.3) ++	12.3 ± 11.3 (0.3–43)	8.6 ± 7.8 (0.3–35)	15.0 ± 11.7 (0.3–43)	12.7 ± 10.9 (0.3–42.3)
Working frequency (d/month)	25.4 ± 1.3 (22–28)	25.4 ± 1.7 (22–30)	24.8 ± 2.3 (17–30)	25.2 ± 1.3 (20–28)	25.1 ± 2.0 (17–30)	25.3 ± 1.5 (20–30)
Daily working time (h/d)	8.6 ± 0.9 (8–12)	8.3 ± 0.9 (8–12)	8.2 ± 0.5 (7–10)	8.2 ± 1.1 (4–14)	8.3 ± 0.7 (7–12)	8.2 ± 1.0 (4–14)
Sleeping period (h/d)	0.6 ± 0.3 (0–1.5)	0.6 ± 0.3 (0.2–1.5)	0.6 ± 0.4 (0–1.5)	0.6 ± 0.5 (0–2.5)	0.6 ± 0.4 (0–1.5)	0.6 ± 0.5 (0–2.5)
Years of cigarette smoking	6.4 ± 0.9 (4–8)	6.5 ± 1.0 (5–8)	6.5 ± 1.1 (4–9)	6.4 ± 1.2 (3–9)	6.4 ± 1.1 (4–9)	6.4 ± 1.1 (3–9)
Daily smoking (cigarettes/d)	19.0 ± 12.8 (0–45) +	18.3 ± 13.8 (0–40) ++	11.9 ± 13.0 (0–43)	8.9 ± 10.5 (0–43)	14.4 ± 13.4 (0–45)	11.9 ± 12.4 (0–43)
Frequency of drinking (d/wk)	19.1 ± 12.0 (0–40)	18.6 ± 13.4 (0–40)	16.5 ± 11.5 (0–40)	15.2 ± 11.6 (0–40)	17.4 ± 11.8 (0–40)	16.3 ± 12.3 (0–40)
Drinking volume (Japanese Sake, gou/d)$	2.0 ± 2.6 (0–12.7)	1.4 ± 1.3 (0–5)	1.3 ± 1.8 (0–10)	1.3 ± 1.4 (0–6.3)	1.6 ± 2.2 (0–12.7)	1.3 ± 1.3 (0–6.3)
Score of life style (Morimoto's 8 items)	4.5 ± 1.3 (1–7)	4.2 ± 1.5 (1–7)	4.8 ± 1.0 (2–7)	4.4 ± 1.4 (1–8)	4.7 ± 1.2 (1–7)	4.3 ± 1.4 (1–8)

Each value represents the mean ± SD (minimum–maximum).

$^+p<0.05$, $^{++}p<0.01$, compared with the other workers.

$: one "gou" is about 180 ml.

Table 2. Present illness of the subjects

	Rank				Total	
	Supervisors		Other workers			
	Winter (N=26)	Summer (N=26)	Winter (N=48)	Summer (N=57)	Winter (N=74)	Summer (N=83)
☆	6 (23.1)	4 (15.4)	13 (27.1) **	3 (5.3)	19 (25.7) **	7 (8.4)
Hypertension	0 (0.0)	1 (3.8)	4 (8.3)	2 (3.5)	4 (5.4)	3 (3.6)
Cardiac disease	1 (3.8)	1 (3.8)	0 (0.0)	0 (0.0)	1 (1.4)	1 (1.2)
Diabetes mellitus	1 (3.8)	0 (0.0)	2 (4.2)	1 (1.8)	3 (4.1)	1 (1.2)
Lumbago	2 (7.7)	3 (11.5) +	4 (8.3)	0 (0.0)	6 (8.1)	3 (3.6)
Peripheral nervous pain	0 (0.0)	0 (0.0)	1 (2.1)	0 (0.0)	1 (1.4)	0 (0.0)
Chronic arthritis	0 (0.0)	0 (0.0)	2 (4.2)	0 (0.0)	2 (2.7)	0 (0.0)
Peptic ulcer	2 (7.7)	1 (3.8)	0 (0.0)	0 (0.0)	2 (2.7)	1 (1.2)
Liver disease	0 (0.0)	1 (3.8)	1 (2.1)	0 (0.0)	1 (1.4)	1 (1.2)
Others	1 (3.8)	0 (0.0)	1 (2.1)	0 (0.0)	2 (2.7)	0 (0.0)

☆, subjects who had at least one disease of the following items.

Each value represents the number (%) of the subjects.

$^{**}p<0.01$, compared with summer; $^+p<0.05$, compared with the other workers.

Table 3. Prevalence of subjective symptoms among subjects

Subjective symptoms	Rank				Total	
	Supervisors		Other workers			
	Winter (N=26)	Summer (N=26)	Winter (N=48)	Summer (N=57)	Winter (N=74)	Summer (N=83)
Stiffness in the fingers	17 (65.4) **	4 (15.4)	28 (58.3) **	3 (5.3)	45 (60.8) **	7 (8.4)
Raynaud's phenomena in the fingers	9 (34.6)	4 (15.4)	9 (18.8) *	2 (3.5)	18 (24.3) **	6 (7.2)
Pain in the wrist	11 (42.3)	9 (34.6)	21 (43.8) **	10 (17.5)	32 (43.2) **	19 (22.9)
Knee joint pain	9 (34.6)	6 (23.1)	17 (35.4) *	9 (15.8)	26 (35.1) *	15 (18.1)
Appetite loss	6 (23.1)	11 (42.3)	10 (20.8)	17 (29.8)	16 (21.6)	28 (33.7)
Stomach discomfort	10 (38.5)	13 (50.0) ++	10 (20.8)	11 (19.3)	20 (27.0)	24 (28.9)
Abdominal pain	9 (34.6)	3 (11.5)	9 (18.8)	4 (7.0)	18 (24.3) **	7 (8.4)
Weakness of stomach and intestines	8 (30.8) **	24 (92.3)	6 (12.5) **	52 (91.2)	14 (18.9) **	76 (91.6)
Diarrhea	16 (61.5) +	12 (46.2)	18 (37.5)	20 (35.1)	34 (45.9)	32 (38.6)
Bad abdominal condition	17 (65.4)	10 (38.5)	22 (45.8)	18 (31.6)	39 (52.7) *	28 (33.7)
Constipation	5 (19.2)	4 (15.4)	17 (35.4) **	5 (8.8)	22 (29.7) **	9 (10.8)
Pollakisuria in the night	7 (26.9)	3 (11.5)	12 (25.0) **	2 (3.5)	19 (25.7) **	5 (6.0)
Dull head	10 (38.5)	5 (19.2)	10 (20.8)	5 (8.8)	20 (27.0) *	10 (12.0)
Headache	9 (34.6)	7 (26.9)	13 (27.1)	12 (21.1)	22 (29.7)	19 (22.9)
Dizziness	4 (15.4)	3 (11.5)	10 (20.8)	5 (8.8)	14 (18.9)	8 (9.6)
Palpitation	6 (23.1)	4 (15.4)	11 (22.9)	5 (8.8)	17 (23.0) *	9 (10.8)
Cough	17 (65.4) **	6 (23.1)	23 (47.9) **	12 (21.1)	40 (54.1) **	18 (21.7)
Sputum	14 (53.8)	9 (34.6)	19 (39.6) *	10 (17.5)	33 (44.6) **	19 (22.9)
Tinnitus	10 (38.5)	5 (19.2)	12 (25.0)	9 (15.8)	22 (29.7)	14 (16.9)
Defective hearing	10 (38.5)	5 (19.2)	10 (20.8)	10 (17.5)	20 (27.0)	15 (18.1)
Vertigo	5 (19.2)	2 (7.7)	11 (22.9)	11 (19.3)	16 (21.6)	13 (15.7)

Each value represents the number (%) of the subjects.
*p<0.05, **p<0.01, compared with summer; +p<0.05, ++p<0.01, compared with the other workers.

weakness of stomach and intestines in summer was significantly higher than that in winter (p<0.01). In winter, prevalence of diarrhea in the supervisors was significantly higher than that in the other workers (p<0.05). In summer, prevalence of stomach discomfort in the supervisors was significantly higher than that in the other workers (p<0.01).

Table 4-1 and Table 4-2 show the prevalence of subjective musculoskeletal symptoms during the last one month among subjects. In both sides of the total subjects, prevalence of pain in the fingers, finger cold sensation, dull movement of the fingers, pain in the foot, foot numbness and foot cold sensation in winter were significantly higher than those in summer (p<0.01 or p<0.05). Only in the left side of the total subjects, prevalence of pain in the arm in winter was significantly higher than those in summer (p<0.05). In both sides of the supervisors, prevalence of foot cold sensation in winter was significantly higher than that in summer (p<0.05). In both sides of the other workers, prevalence of pain in the shoulders, pain in the arm, finger cold sensation, dull movement of the fingers, foot numbness and foot cold sensation in winter were significantly higher than those in summer (p<0.01 or p<0.05). Only in the right side of the other workers, prevalence of numbness in the arm in winter was significantly higher than those in summer (p<0.05). Only in the left side of the other workers, prevalence of numbness in the fingers and pain in the foot in winter were significantly higher than those in summer (p<0.05). In winter, there were no significant differences in the prevalence of any subjective musculoskeletal symptoms between the supervisors and the other workers. In summer, in both sides, prevalence of pain in the shoulders, neck stiffness, pain in the neck, pain in the arm, numbness in the arm, finger tremor and low back dullness in the supervisors were significantly higher than those in the other workers (p<0.01 or p<0.05). In summer, only in the right side, prevalence of shoulder stiffness in the supervisors was significantly higher than that in the other workers (p<0.05). Both in winter and summer, there were no significant right and left differences in the prevalence of any subjective musculoskeletal symptoms neither among total subjects, among supervisors nor among other workers.

Table 5 shows the prevalence of discomfort and distress in daily life during the last one month among the subjects. In the total subjects, prevalence of low back pain when stretching out or leaning back, having diffi-

Table 4-1. Prevalence of subjective muscloskeletal (right side) symptoms during the last one month among subjects

	Rank				Total	
	Supervisors		Other workers			
Subjective symptoms	Winter (N=26)	Summer (N=26)	Winter (N=48)	Summer (N=57)	Winter (N=74)	Summer (N=83)
Shoulder stiffness	15 (57.7)	15 (57.7) +	20 (41.7)	19 (33.3)	35 (47.3)	34 (41.0)
Pain in the shoulders	9 (34.6)	9 (34.6) ++	12 (25.0) *	5 (8.8)	21 (28.4)	14 (16.9)
Neck stiffness	14 (53.8)	16 (61.5) ++	19 (39.6)	16 (28.1)	33 (44.6)	32 (38.6)
Pain in the neck	8 (30.8)	9 (34.6) ++	6 (12.5)	5 (8.8)	14 (18.9)	14 (16.9)
Back dullness	6 (23.1)	9 (34.6)	11 (22.9)	11 (19.3)	17 (23.0)	20 (24.1)
Back pain	7 (26.9)	7 (26.9)	10 (20.8)	10 (17.5)	17 (23.0)	17 (20.5)
Dullness in the arm	10 (38.5)	9 (34.6)	13 (27.1)	9 (15.8)	23 (31.1)	18 (21.7)
Pain in the arm	6 (23.1)	6 (23.1) ++	8 (16.7) *	1 (1.8)	14 (18.9)	7 (8.4)
Numbness in the arm	6 (23.1)	6 (23.1) +	9 (18.8) *	2 (3.5)	15 (20.3)	8 (9.6)
Dullness in the fingers	6 (23.1)	4 (15.4)	8 (16.7)	5 (8.8)	14 (18.9)	9 (10.8)
Pain in the fingers	6 (23.1)	2 (7.7)	7 (14.6)	4 (7.0)	13 (17.6) *	6 (7.2)
Numbness in the fingers	4 (15.4)	3 (11.5)	9 (18.8)	4 (7.0)	13 (17.6)	7 (8.4)
Finger tremor	5 (19.2)	3 (11.5)	5 (10.4)	5 (8.8)	10 (13.5)	8 (9.6)
Finger cold sensation	11 (42.3)	5 (19.2) +	20 (41.7) **	2 (3.5)	31 (41.9) **	7 (8.4)
Dull movement of the fingers	5 (19.2)	3 (11.5)	12 (25.0) *	4 (7.0)	17 (23.0) *	7 (8.4)
Low back dullness	13 (50.0)	13 (50.0) +	14 (29.2)	13 (22.8)	27 (36.5)	26 (31.3)
Lumbago	12 (46.2)	13 (50.0)	24 (50.0)	22 (38.6)	36 (48.6)	35 (42.2)
Dullness in the foot	11 (42.3)	9 (34.6)	12 (25.0)	13 (22.8)	23 (31.1)	22 (26.5)
Pain in the foot	6 (23.1)	4 (15.4)	11 (22.9)	5 (8.8)	17 (23.0) *	9 (10.8)
Foot numbness	7 (26.9)	1 (3.8)	11 (22.9) **	2 (3.5)	18 (24.3) **	3 (3.6)
Foot cold sensation	10 (38.5) *	2 (7.7)	20 (41.7) **	1 (1.8)	30 (40.5) **	3 (3.6)

Each value represents the number (%) of the subjects.
*p<0.05, **p<0.01, compared with summer; ^{+}p<0.05, ^{++}p<0.01, compared with the other workers.

Table 4-2. Prevalence of subjective muscloskeletal (left side) symptoms during the last one month among subjects

	Rank				Total	
	Supervisors		Other workers			
Subjective symptoms	Winter (N=26)	Summer (N=26)	Winter (N=48)	Summer (N=57)	Winter (N=74)	Summer (N=83)
Shoulder stiffness	14 (53.8)	14 (53.8)	22 (45.8)	19 (33.3)	36 (48.6)	33 (39.8)
Pain in the shoulders	8 (30.8)	8 (30.8) +	12 (25.0) *	4 (7.0)	20 (27.0)	12 (14.5)
Neck stiffness	13 (50.0)	16 (61.5) ++	20 (41.7)	15 (26.3)	33 (44.6)	31 (37.3)
Pain in the neck	7 (26.9)	9 (34.6) ++	8 (16.7)	5 (8.8)	15 (20.3)	14 (16.9)
Back dullness	6 (23.1)	9 (34.6)	11 (22.9)	11 (19.3)	17 (23.0)	20 (24.1)
Back pain	7 (26.9)	8 (30.8)	11 (22.9)	11 (19.3)	18 (24.3)	19 (22.9)
Dullness in the arm	11 (42.3)	9 (34.6)	13 (27.1)	9 (15.8)	24 (32.4)	18 (21.7)
Pain in the arm	6 (23.1)	5 (19.2) +	7 (14.6) *	1 (1.8)	13 (17.6) *	6 (7.2)
Numbness in the arm	6 (23.1)	6 (23.1) +	7 (14.6)	2 (3.5)	13 (17.6)	8 (9.6)
Dullness in the fingers	6 (23.1)	4 (15.4)	7 (14.6)	5 (8.8)	13 (17.6)	9 (10.8)
Pain in the fingers	7 (26.9)	2 (7.7)	8 (16.7)	4 (7.0)	15 (20.3) *	6 (7.2)
Numbness in the fingers	3 (11.5)	3 (11.5)	11 (22.9) *	4 (7.0)	14 (18.9)	7 (8.4)
Finger tremor	5 (19.2)	3 (11.5)	5 (10.4)	5 (8.8)	10 (13.5)	8 (9.6)
Finger cold sensation	10 (38.5)	5 (19.2) +	20 (41.7) **	1 (1.8)	30 (40.5) **	6 (7.2)
Dull movement of the fingers	4 (15.4)	3 (11.5)	11 (22.9) *	4 (7.0)	15 (20.3) *	7 (8.4)
Low back dullness	12 (46.2)	12 (46.2) +	14 (29.2)	14 (24.6)	26 (35.1)	26 (31.3)
Lumbago	12 (46.2)	13 (50.0)	24 (50.0)	22 (38.6)	36 (48.6)	35 (42.2)
Dullness in the foot	10 (38.5)	9 (34.6)	13 (27.1)	12 (21.1)	23 (31.1)	21 (25.3)
Pain in the foot	6 (23.1)	4 (15.4)	12 (25.0) *	5 (8.8)	18 (24.3) *	9 (10.8)
Foot numbness	6 (23.1)	1 (3.8)	12 (25.0) **	2 (3.5)	18 (24.3) **	3 (3.6)
Foot cold sensation	9 (34.6) *	2 (7.7)	20 (41.7) **	1 (1.8)	29 (39.2) **	3 (3.6)

Each value represents the number (%) of the subjects.
*p<0.05, **p<0.01, compared with summer; ^{+}p<0.05, ^{++}p<0.01, compared with the other workers.

Table 5. Prevalence of discomfort and distress in daily life during the last one month among the subjects

Discomfort and distress	Rank				Total	
	Supervisors		Other workers			
	Winter (N=26)	Summer (N=26)	Winter (N=48)	Summer (N=57)	Winter (N=74)	Summer (N=83)
Arm dullness when hanging out the washing or dressing one's hair	4 (15.4)	3 (11.5)	6 (12.5)	2 (3.5)	10 (13.5)	5 (6.0)
Having difficulty holding a receiver	4 (15.4)	2 (7.7)	5 (10.4)	3 (5.3)	9 (12.2)	5 (6.0)
Having difficulty continuing to write for a long time	11 (42.3)	9 (34.6)	19 (39.6)	16 (28.1)	30 (40.5)	25 (30.1)
Difficulty in wringing a wet towel in the bath	1 (3.8)	2 (7.7)	2 (4.2)	0 (0.0)	3 (4.1)	2 (2.4)
Waking up due to nubmness in the night	2 (7.7)	4 (15.4)	7 (14.6)	5 (8.8)	9 (12.2)	9 (10.8)
Arm dullness when holding a strap	2 (7.7)	2 (7.7)	2 (4.2)	3 (5.3)	4 (5.4)	5 (6.0)
Shoulder pain when putting on or taking off one's shirt	3 (11.5)	4 (15.4)	3 (6.3)	3 (5.3)	6 (8.1)	7 (8.4)
Difficulty doing up a bottom	2 (7.7)	2 (7.7)	5 (10.4)	2 (3.5)	7 (9.5)	4 (4.8)
Having difficulty eating meat of a fish by chopsticks	3 (11.5)	2 (7.7)	4 (8.3)	3 (5.3)	7 (9.5)	5 (6.0)
Frequently dropping an object	4 (15.4)	7 (26.9)	12 (25.0)	9 (15.8)	16 (21.6)	16 (19.3)
Low back pain when getting out of bed in the morning	9 (34.6)	13 (50.0)	18 (37.5)	19 (33.3)	27 (36.5)	32 (38.6)
Low back pain when washing one's face	8 (30.8)	7 (26.9)	14 (29.2)	10 (17.5)	22 (29.7)	17 (20.5)
Low back pain when streching out or leaning back	9 (34.6)	10 (38.5) +	20 (41.7) **	10 (17.5)	29 (39.2) *	20 (24.1)
Low back pain when sitting on the chair for a long time	18 (69.2)	13 (50.0)	27 (56.3)	24 (42.1)	45 (60.8)	37 (44.6)
Low back pain when standing for a long time	12 (46.2)	12 (46.2)	21 (43.8)	23 (40.4)	33 (44.6)	35 (42.2)
Low back pain when sitting down or standing up	8 (30.8)	10 (38.5)	21 (43.8) *	14 (24.6)	29 (39.2)	24 (28.9)
Knee joint pain when going down the stairs	8 (30.8)	7 (26.9)	17 (35.4)	12 (21.1)	25 (33.8)	19 (22.9)
Frequently stumbling over an object	7 (26.9)	10 (38.5)	22 (45.8)	16 (28.1)	29 (39.2)	26 (31.3)
Tiredness of feet after long walking	14 (53.8)	12 (46.2)	27 (56.3)	27 (47.4)	41 (55.4)	39 (47.0)
Having difficulty using the cold water (shower, bath, kitchen, etc.) even in the seasons except winter	6 (23.1)	2 (7.7)	11 (22.9) **	0 (0.0)	17 (23.0) **	2 (2.4)
Feeling sick when bad weather	4 (15.4)	5 (19.2)	7 (14.6)	6 (10.5)	11 (14.9)	11 (13.3)
More discomfortable than before when exposed to air conditioning during summer season	5 (19.2)	1 (3.8)	4 (8.3)	4 (7.0)	9 (12.2)	5 (6.0)
Getting an unpleasant feeling when exposed to wind just for a short time	3 (11.5)	2 (7.7)	1 (2.1)	1 (1.8)	4 (5.4)	3 (3.6)
Dreaming an unpleasant dream or a horrible dream frequently	4 (15.4)	2 (7.7)	5 (10.4)	6 (10.5)	9 (12.2)	8 (9.6)
Not having patience to read a book for a long time	13 (50.0)	12 (46.2)	22 (45.8)	19 (33.3)	35 (47.3)	31 (37.3)
Failing to catch speeches of others or increase of a mistake	11 (42.3)	8 (30.8)	22 (45.8)	22 (38.6)	33 (44.6)	30 (36.1)
Quickly getting an unpleasant feeling when talking	7 (26.9)	4 (15.4)	11 (22.9)	5 (8.8)	18 (24.3) *	9 (10.8)
Hope to lie down at free time as far as possible	15 (57.7)	15 (57.7)	21 (43.8)	26 (45.6)	36 (48.6)	41 (49.4)
Feeling sick due to bad body condition	5 (19.2)	4 (15.4)	3 (6.3)	4 (7.0)	8 (10.8)	8 (9.6)
Difficulty continuing to work due to symptoms of arm and shoulder	6 (23.1)	4 (15.4)	9 (18.8) *	2 (3.5)	15 (20.3) *	6 (7.2)
Difficulty continuing to work due to low back symptoms	9 (34.6)	10 (38.5) +	13 (27.1)	10 (17.5)	22 (29.7)	20 (24.1)
Difficulty continuing to work due to poor spirit	8 (30.8)	7 (26.9)	9 (18.8)	12 (21.1)	17 (23.0)	19 (22.9)

Each value represents the number (%) of the subjects.
*$p<0.05$, **$p<0.01$, compared with summer; $^{+}p<0.05$, compared with the other workers.

culty using the cold water (shower, bath, kitchen, etc.) even in the seasons except winter, quickly getting an unpleasant feeling when talking and difficulty continuing to work due to symptoms of arm and shoulder in winter were significantly higher than those in summer ($p<0.01$ or $p<0.05$). In the supervisors, there were no significant differences in the prevalence of any subjective musculoskeletal symptoms between winter and summer. In the other workers, prevalence of low back pain when stretching out or leaning back, low back pain when sitting down or standing up, having difficulty using the cold water (shower, bath, kitchen, etc.) even in the seasons except winter and difficulty continuing to work due to symptoms of arm and shoulder in winter were significantly higher than those in summer ($p<0.01$ or $p<0.05$). In winter, there were no significant differences in the prevalence of discomfort and distress in daily life between the supervisors and the other workers. In summer, prevalence of low back pain when stretching out or leaning back and difficulty continuing to work due to low back pain in the supervisors were significantly higher than those in the other workers ($p<0.05$).

Discussion

The effect of moderate cold exposure on musculoskeletal symptoms among electricians working in various buildings under construction was evaluated by comparing their prevalence of musculoskeletal symptoms in summer to those in winter. The study indicates that effects of cold on the musculoskeletal symptoms markedly appear in the workers except supervisors.

In this study, we could not visit any buildings under construction. Therefore, we could not obtain adequate information on general air-conditioning or spot air-conditioning in the sites, or measure the working environmental conditions. According to N City local metrological observatory, averaged of mean, maximal and minimum temperatures in a day between December 2002 and February 2003 in N City were 5.5˚C, 10.0˚C and 1.6˚C, respectively. Numbers of the snowy days between December 2002 and February 2003 in N City were 14 d. On the other hand, averaged of mean, maximal and minimum temperatures in a day between June 2003 and August 2003 in N City were 24.4˚C, 28.7˚C and 21.1˚C, respectively.

Ueno *et al*.[9] reported that among construction electricians, prevalence rates of pain in the hand and arm, shoulder and low back were 18%, 27%and 50%, respectively. In the winter survey of this study, we observed almost the same prevalence of these symptoms in both sides. Prevalence of pain in the hand and arm, and shoulder among construction electricians were higher than those among visual display terminal workers[13, 14]. These results suggest that construction electricians have high prevalence of musculoskeletal problems concerning the hands, arms and shoulders. However, in the summer survey of this study, these prevalence rates were lower, compared with those obtained from the winter study. In addition, prevalence rates of left arm pain and finger pain in both sides in winter were significantly higher than those in summer. Prevalence rate of right arm pain in winter were higher than that in summer, but not significant. In the workers except supervisors, prevalence of shoulder pain and arm pain in both sides in winter were significantly higher than those in summer. Concerning the discomfort and distress in daily life during the month preceding the survey, among the subjects, in the total workers and the workers except supervisors, prevalence of difficulty continuing to work due to symptoms of arms and shoulders and low back pain when stretching out or leaning back in winter were significantly higher than those in summer. In the workers except supervisors, prevalence of low back pain when sitting down or standing up in winter was significantly higher, compared with that in summer.

Ose[15] surveyed the prevalence of musculoskeletal symptoms dividing into right and left parts of body among cooks providing school lunch service, but did not refer to the statistical right and left differences in the prevalence of musculoskeletal symptoms. We surveyed the musculoskeletal symptoms among construction electricians referring to the questionnaire used by Ose. Thus, we did not surveyed musculoskeletal symptoms in the central part of the body. In this study, both in the winter and summer time, there were no significant right and left differences in the prevalence of any subjective musculoskeletal symptoms either among total subjects, among supervisors or among other workers.

Exposure to a cold environment induces pain in patients with chronic inflammatory conditions such as rheumatoid arthritis, and this pain is a serious problem that interferes in the involved subjects' every day lives[16]. It is suggested that the facilitated responses of the primary afferent nerves are associated with cold hypersensitivity in chronic inflamed conditions[17]. Workers in the cold environment were reported to have high prevalence of rheumatic symptoms, numbness and cold sensation in the hands and feet, Raynaud's phenomenon, respiratory symptoms, cardiovascular symptoms, defective hearing and so on[1–8, 18, 19]. In the present study, we also observed in the electricians that the prevalence rates of stiffness, numbness, pain and Raynaud's phenomenon in the fingers, finger cold sensation, dull movement of the fingers, pain in the wrist, knee joint pain, pain and numbness in the foot, foot cold sensation, cough, sputum and palpitation in winter were significantly higher than those in summer. In addition, prevalence of pollakisuria in the night, constipation, abdominal pain, and weakness of stomach and intestines in winter were significantly higher than those in summer. These results were markedly experienced in the workers except supervisors whose occupational career was significantly shorter and daily smoking was significantly fewer than the supervisors.

Prevalence of Raynaud's phenomenon in the fingers among construction electricians in winter and summer were 43.2% and 7.2%, respectively, although it cannot be said in an assertive tone whether or not the subject had Raynaud's phenomenon in the fingers because we did not show the subjects a typical figure of the attack of Raynaud's phenomenon in the fingers. These values are higher than that in male subjects of the general population in Japan (1–3%)[20]. Almost over 95% of electricians used vibrating tools on their jobs. Vibrating tools which used by the subjects were electric drill, hand-held sander, electric driver, impact wrench, hand-held portable grinder, road breaker and so on whose vibration level had high or moderate risk of vibration syndrome according to Health and Safety Executive in England[21] (data not shown).

Therefore, it is considered that high prevalence of Raynaud's phenomenon among construction electricians is mainly caused by hand-arm vibration exposure.

Concerning the work load of construction electricians, contents of work except managing job of the supervisors were not different from those of the other workers. However, years of vibrating tool usage among supervisors were significantly longer than those among other workers, and numbers of kinds of vibrating tools used among the supervisors were more than those among the other workers (data not shown). These are considered to be one of the reasons why the prevalence of Raynaud's phenomenon in the fingers among supervisors was higher than that among other workers.

In the present study, in winter, there were no significant differences in the prevalence of subjective complaints except diarrhea between the supervisors and the other workers. On the other hand, in summer, prevalence of stomach discomfort, shoulder stiffness in the right side and shoulder pain, neck stiffness, neck pain, arm dullness, arm pain, and finger cold sensation, low back dullness in the both sides and low back pain when stretching out or leaning back in the supervisors were significantly higher than those in the other workers. In addition, in summer, percentage of the subjects who had lumbago under treatment in the supervisors was significantly higher than that in the other workers. Some researchers reported that low back pain is significantly related to smoking[22–24]. Thus, although it cannot be said in an assertive tone because the subjects in summer and winter were not the same subjects completely, it can be considered that effects of cold on the musculoskeletal symptoms are markedly appeared in the workers except supervisors whose occupational career was shorter and daily smoking was fewer. From an another point of view, it might be considered that musculoskeletal complaints in winter among workers except supervisors whose occupational career was shorter and daily smoking was fewer, were not stable and have a possibility to disappear easily by body warming.

Prevalence of weakness of stomach and intestines only among subjective symptoms surveyed in the construction electricians was significantly higher in summer than that in winter. It is considered that the inhibition of gastric motility through a vagal-cholinergic pathway induced by heat stress, frequent cold water or meal intake as a countermeasure against the heat in summer which might weaken gastric juice and etc. resulting in impaired digestion, might be the factors causing this result[25, 26].

In the present study, as described before, we also observed among construction electricians that prevalence of abdominal pain in winter was significantly higher than that in summer. Recently, Saps *et al.*[27] reported that in children, the rates of chronic abdominal pain consultations were higher in winter months than in summer months. It seems that daylight hours and cold stress proposed by them[27] play a possible role in the genesis of our results.

The limitations of this study are as follows. We used a self-administered questionnaire and did not make any direct observations of the tasks performed at work. Secondly, as already pointed out we did not perform any meteorological measurements in summer or winter. A third limitation is that we used a cross-sectional design and had incomplete work place participation, producing possible bias and limited ability to draw any causal inferences.

Acknowledgements

We are grateful to M. Okumura for her helping data analysis. The present study was supported by a Grant-in-Aid for Scientific Research, the Japanese Ministry of Health, Labour and Welfare.

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