［Original］

Relationships Between Chronic Musculoskeletal Pain and Working Hours and Sleeping Hours: A Cross-sectional Study

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Abstract **:** Ten to twenty percent of the population of Japan has chronic pain. Although studies have confirmed a relationship between sleeping hours and chronic pain, it remains unclear whether there is an association between working hours and chronic pain, especially chronic musculoskeletal pain (CMP), in workers. A self-administered questionnaire that sought information regarding background characteristics and work-related factors was sent to 118 enterprises; finally, 1,747 participants were included in the analysis and were classified into CMP (n＝448) and non-CMP (n＝1299) groups. Logistic regression analysis revealed that age (odds ratio [OR]＝1.02, 95% confidence interval [CI]: 1.01−1.03), sex (reference: female, OR＝0.68, 95% CI: 0.52−0.88), working hours (OR＝1.11, 95% CI: 1.03−1.20), and sleeping hours (OR＝0.84, 95% CI: 0.75−0.95) were significantly associated with CMP. Participants were categorized into four groups according to working hours (long: ≥9 hours/day [long-work], short: <9 hours/day [short-work]) and sleeping hours (long: ≥7 hours/day [long-sleep], short: <7 hours/day [short-sleep]). Furthermore, logistic regression analysis showed that the CMP OR was 2.02 (95% CI: 1.46−2.78) times higher in 'long-work plus short-sleep workers' and 1.47 (95% CI: 0.94−2.30) times higher in 'long-work plus long-sleep workers' than in 'short-work plus long-sleep workers'. Thus, working hours are associated with CMP frequency, but sleeping sufficiently may prevent CMP in workers even if they work for long hours. In conclusion, adequate instructions on sleeping hours should be provided by occupational health staff, as this may be effective in preventing CMP.

Keywords **:** chronic musculoskeletal pain, occupational health, overtime work, sleeping hours, working hours.

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Introduction

Studies have shown that 10−20% of the Japanese population experience chronic pain, and most of these cases involve musculoskeletal pain such as lumbar, neck, and shoulder pain [1−5]. A study conducted at 15 World Health Organization collaborative centers in Asia, Africa, Europe, and the Americas showed that 22.0% of 26,000 participants had chronic pain [6]. In Europe, 19.0% of 46,394 people were found to have chronic pain [7]. Despite the relatively high prevalence of chronic pain in Japan, only a few studies

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have investigated the factors associated with chronic musculoskeletal pain (CMP), particularly in workers. A previous study reported that work performance and productivity is negatively affected by CMP [8]. Hence, clarifying the factors associated with the progression of musculoskeletal pain to a chronic state, and the prevention of CMP in workers, is an important issue for occupational health.

Working and sleeping hours are known to affect workers' health, both physically and mentally, and sleeping hours have been shown to be affected by working hours [9]. Although the official, legal standard working hours per week is 40 hours, some workers work overtime and thus develop insomnia. Liu *et al* [10] reported that 21.4% of Japanese adults experience insomnia, 14.9% experience daytime sleepiness, and 6.3% use alcohol or sleeping pills. According to the National Health and Nutrition Survey conducted by the Japanese Ministry of Health, Labour and Welfare, 23% of Japanese have insomnia. Several studies have investigated the association between working hours and health and reported that working hours are associated with acute myocardial infarction [11−14]. Nakashima *et al* [15] reported that long working hours are associated with the quality of sleep, while Virtanen *et al* reported that long working hours are associated with shorter sleep duration and difficulty in falling asleep [16] as well as with major depressive episodes [17]. Nakata showed that long working hours are associated with higher frequencies of workplace injury [18]. However, the relationships between working hours, sleeping hours, and CMP remain poorly understood. Therefore, we aimed to determine whether long working hours and short sleeping hours, which are major social concerns in Japan, worsen CMP in workers.

Subjects and Methods

Study design and participants

In this cross-sectional study, conducted from 2016 to 2017, self-administered questionnaires were distributed to 3,091 employees in 118 enterprises involved in three categories of business (manufacturing, finance, and retail). The completed questionnaires were sealed in an envelope and sent back to us.

Measurement of background characteristics and work-related factors

The self-administered questionnaire consisted of three parts: background characteristics, work-related factors, and chronic pain. The background characteristics included sex, age, smoking status, present illness, and educational background. Smoking status was classified as smoker, ex-smoker, and non-smoker, but in this study, ex-smokers were classified as non-smokers. The question about present illness required the participants to add the name of the disease that they were being treated for. Educational background was classified as junior high school, senior high school, vocational school, junior college, college, and graduate school graduates.

Work-related factors included working hours, night-shift work, sleeping hours, quality of sleep, and job title. Working hours were calculated as the average number of working hours per day. Night-shift work was determined via a yes/no response. In Japan, night-shift work is defined as working between 22:00 and 5:00 the next morning. Sleeping hours were calculated as the average number of sleeping hours during an off-peak period at work. Quality of sleep was determined using a 4-point Likert scale and was scored as follows: 1. feel content with the sleep; 2. feel slightly discontent with the sleep; 3. feel discontent with the sleep; and 4. feel extremely discontent with the sleep or cannot sleep at all. Regarding job title, the participants were required to write down their job position, which was then classified as executive or non-executive.

Measurement of chronic musculoskeletal pain

The items in the questionnaire regarding chronic pain sought information about the existence, location, frequency, and duration of pain. Only pain that affected work performance was inquired about. The location of pain was determined by asking the participant to select the locations on a body chart that showed the following parts: neck, shoulders, upper limbs, back, lumbar, hip joints, knees, and others. The frequency of pain was calculated by using a 4-point Likert scale and scored as follows: 1. almost every day; 2. 2−5 days per week; 3. 1 day per week; and 4. 1−2 times per month. The duration of pain was determined using a 3-point Likert scale and scored as follows: 1. ≤1 month; 2. 1−3

months; and 3. ≥3 months. The location, frequency, and duration of pain affecting work performance the most were inquired about.

Definition of chronic pain

Chronic pain was defined as persistent or recurrent pain lasting longer than three months per the criteria established by the International Association for the Study of Pain [19]. Accordingly, participants with CMP were categorized into a CMP group and the others into a non-CMP group. However, for the purpose of this study, pain that occurred <2 times a week (scoring 3 and 4 on the 4-point Likert scale) and that did not affect work performance was classified as non-CMP.

Grouping

Working and sleeping hours were treated as continuous variables and were also categorized into four groups: short working hours (<9 hours) and long sleeping hours (≥7 hours), ('short-work plus long sleep'); short working hours and short sleeping hours (<7 hours), ('short-work plus short-sleep'); long working hours (≥9 hours) and long sleeping hours, ('long-work plus long-sleep'); and long working hours and short sleeping hours ('long-work plus short-sleep'). The average working hours of the participants was 8.56 hours. According to the Monthly Labour Survey conducted by the Ministry of Health, Labour, and Welfare in 2017, the national average working hours were 8.4 hours; therefore we categorized working hours into long working hours (≥9 hours [long-work]) and short working hours (<9 hours [short-work]). The average sleeping hours of the participants was 6.13 hours. According to the Survey on Time Use and Leisure Activities conducted by the Statistics Bureau, Ministry of Internal Affairs and Communications in 2016, the national average sleeping hours were 7.40 hours; therefore, we categorized sleeping hours into long sleeping hours (≥7 hours [long-sleep]) and short sleeping hours (<7 hours [short-sleep]).

Statistical analysis

The student's *t*-test and chi-square test were used to compare values and ratios between groups. Logistic regression analysis was conducted to estimate the odds ratio (OR) of CMP by potential predictors after simultaneously controlling for potential confounders. Variables considered in the models were sex (reference: female), age, working hours, and sleeping hours. Age, working hours and sleeping hours were continuous variables. Correlation coefficient between variables was confirmed in order to avoid multiple collinearity. Job title and present illness were not included as independent variables because these factors were strongly correlated with age (job title; $r=0.243$, $P<0.001$, present illness; $r=0.375$, $P<0.001$). Quality of sleep was also excluded because it strongly correlated with sleeping hours ($r=-0.347$, $P<0.001$). We observed a weak correlation between working hours and sleeping hours ($r=-0.178$, $P<0.001$); therefore, they were included as independent variables. Further logistic regression analysis was conducted to estimate the odds ratio of CMP by working and sleeping hour groups. In all the statistical analyses, differences were considered significant if the *P*-value was <0.05. The data were analyzed using IBM SPSS version 24.0 (IBM Corp., Armonk, NY, USA).

Ethical approval

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Medical Research, University of Occupational and Environmental Health, Japan (No. H28-001). The researchers provided an overview of this study to each company's occupational health staff, and the questionnaire also included this information. Informed consent was obtained from all participants.

Results

Of the 3,091 workers who received the questionnaire, 1,963 (63.5%) completed and returned the questionnaire. Because of missing values regarding sex, sleeping hours, and working hours, 206 workers were excluded from the analysis. Another 10 who had chronic pain that was not musculoskeletal (*e.g.*, headache) were also excluded. Finally, 1,747 participants were included in the analysis.

Background characteristics of the participants

The background characteristics of the participants are shown in Table 1. The background characteristics

Table 1. Background characteristics and work-related factors of the participants

Variables	Total (n=1747)	Non-CMP (n=1299)	CMP (n=448)	Statistics	*P*-value
Background characteristics					
Sex					
Male	1360	1029	331	$\chi^2=5.49$	0.021*
Female	387	270	117		
Age (y)	42.1 (12.3)	41.4 (12.4)	44.1 (11.8)	$t=4.11$	<0.001***
Smoking status					
Non-smoker	1133	833	300	$\chi^2=1.18$	0.302
Smoker	614	466	148		
Present illness					
None	1327	1021	306	$\chi^2=19.3$	<0.001***
Exist	420	278	142		
Educational background					
Junior high school	54	42	12	$\chi^2=4.57$	0.207
Senior high school	855	640	215		
Vocational school	167	113	54		
College	671	504	167		
Work-related factors					
Working hours (hours/day)	8.56 (1.46)	8.51 (1.44)	8.70 (1.48)	$t=2.42$	0.016*
Night shift					
No	1386	1020	366	$\chi^2=2.05$	0.156
Yes	361	279	82		
Sleeping hours (hours/day)	6.13 (0.95)	6.18 (0.962)	5.99 (0.930)	$t=3.61$	<0.001***
Quality of sleep					
Content	524	441	83	$\chi^2=68.4$	<0.001***
Slightly discontent	953	700	253		
Discontent	238	145	93		
Extremely discontent	32	13	19		
Job title					
Non-executive	1419	1072	347	$\chi^2=5.61$	0.021*
Executive	328	227	101		
Business type					
Manufacturing	1061	788	273	$\chi^2=0.073$	0.964
Finance	460	344	116		
Retail	226	167	59		

The data are expressed as the mean (standard deviation) or number. CMP: chronic musculoskeletal pain, *: $P<0.05$, ***: $P<0.001$

of pain are shown in Table 2. The prevalence of musculoskeletal pain was 46.7%, while the prevalence rate of CMP was 25.6%. The CMP group consisted of 331 male and 117 female participants, and the non-CMP group consisted of 1,029 male and 270 female participants.

Work-related factors

The average number of working hours observed in the CMP group was 8.70 (SD 1.48) hours, and that in the non-CMP group was 8.51 (SD 1.44) hours. The average number of sleeping hours in the CMP group was 5.99 (SD 0.930) hours, and that in the non-CMP

Table 2. Background characteristics of the pain

Background characteristics of the pain	Neck Shoulder n=289	Upper limb n=76	Back n=32	Lumber n=297	Hip joint n=80	Knee n=14	Others n=27	Total n=815
Lasting ≤ 1 month								
Almost everyday	8	3	3	11	7	2	2	36
≥ 2/week	9	6		10	3	1	1	30
1/week	3	5		4	1	1		14
1−2/month	8			13	1		1	23
Lasting 1−3 months								
Almost everyday	14	11	1	5	3	1	2	37
≥ 2/week	14	4	2	6	5			31
1/week	3		2	8	4			17
1−2/month	3	2	1	8	1			15
Lasting ≥ 3 months								
Almost everyday	109	26	9	88	34	6	5	277
≥ 2/week	68	13	10	63	10	1	6	171
1/week	25	1	3	42	6	1	5	83
1−2/month	25	5	1	39	5	1	5	81

group was 6.18 (SD 0.962) hours. In terms of quality of sleep in the CMP group, 83 (18.5%) reported being content, 253 (56.5%) reported slight discontentment, 93 (20.8%) reported being discontent, and 19 (4.2%) reported being extremely discontent. In the non-CMP group, these values were 441 (33.9%), 700 (53.9%), 145 (11.2%), and 13 (1.0%), respectively.

Comparison of characteristics between the CMP and non-CMP groups

The student's *t*-test and chi-square tests showed a significant difference in age ($t=4.11$, $P<0.001$), sex ($\chi^2=5.49$, $P=0.021$), sleeping hours ($t=3.61$, $P<0.001$), working hours ($t=2.42$, $P=0.016$), quality of sleep ($\chi^2=68.4$, $P<0.001$), job title ($\chi^2=5.61$, $P=0.021$), and present illness ($\chi^2=19.3$, $P<0.001$) between the two groups (Table 1). We observed a significant correlation between age and job title ($r=0.243$, $P<0.001$) and age and present illness ($r=0.375$, $P<0.001$). There was a significant but weak correlation between sleeping and working hours ($r=-0.178$, $P<0.001$).

Factors associated with CMP

The logistic regression analysis revealed that age (OR = 1.02, 95% confidence interval [CI]: 1.01−1.03), sex (reference: female, OR = 0.68, 95% CI: 0.52−0.88), working hours (OR = 1.11, 95% CI: 1.03−1.20), and sleeping hours (OR = 0.84, 95% CI: 0.75−0.95) were significantly associated with CMP (Table 3). Further logistic regression analysis showed that CMP was 2.02 (95% CI: 1.46−2.78) times more frequent in 'long-work plus short-sleep workers' when compared with 'short-work plus long-sleep workers'. Furthermore, CMP was 1.47 (95% CI: 0.94−2.30) and 1.37 (95% CI: 1.00−1.86) times more frequent in 'long-work plus long-sleep' as well as 'short-work plus short-sleep workers', respectively, when compared with 'short-work plus long-sleep workers' (Fig. 1).

Table 3. Factors associated with chronic musculoskeletal pain

Variables	β	SE	*P*-value	OR	95% CI
Age (y)	0.02	0.00	<0.001	1.02	1.01 − 1.03
Sex (ref: female)	−0.39	0.13	0.004	0.68	0.52 − 0.88
Sleeping hours (h/day)	−0.17	0.06	0.004	0.84	0.75 − 0.95
Working hours (h/day)	0.10	0.04	0.009	1.11	1.03 − 1.20
Constant	−1.39	0.57	0.014	0.25	

SE: standard error, OR: odds ratio, CI: confidence interval, y: years, ref: reference. Age, working hours, and sleeping hours are continuous variables.

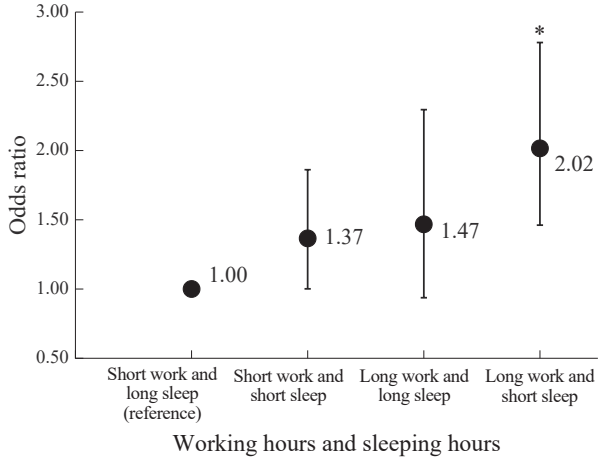

Fig. 1. Odds ratio for the association between chronic musculoskeletal pain and working hours and sleeping hours. Error bars show the 95% confidence interval, Short work: working <9 hours/day; Long work: working ≥9 hours/day; Short sleep: sleeping <7 hours/day; Long sleep: sleeping ≥7 hours/day. *: $P<0.05$.

Discussion

In this study, 25.6% of the workers had CMP. The definition of CMP is pain that: 1) lasted longer than 3 months; 2) occurred more than 2 times a week; 3) affected work performance; and 4) consisted of only musculoskeletal pain. Yamada *et al* reported the prevalence rates of a narrowly defined chronic pain to be 12.3% among Japanese workers, but differences in the definition of chronic pain were noted. Their study accounted for pain other than musculoskeletal pain, ignored work performance and limited the intensity of pain to that scored as >5 out of 10 points [20]. Therefore, the prevalence rate observed in our study was higher than that in the previous study. Nakamura *et al* reported that 15.4% of Japanese people have CMP [21]. Their definition of CMP was pain that: 1) presented within the past month; 2) persisted for at least six months; and 3) corresponded to a visual analog scale score of at least five. The difference in the definition lies in the duration and intensity of pain. Their study showed that over 50% of the participants experienced pain that lasted <6 months. In our study, the participants reported CMP lasting for three months, and this result is therefore not contradictory to the results of the study by Nakamura *et al*.

The most common location of CMP in our participants was in the neck and shoulders, lumbar area, and hip joints, in the descending order of prevalence. Yamada *et al* reported that the most common location of chronic pain that affected work was the lumbar, shoulders, head, neck, and lower limbs, in order of descending prevalence [20]. Our study excluded headache, but neck, shoulder, and lumbar regions were the common locations of CMP in both studies.

Our study revealed that 25.6% of the workers experienced CMP that affected operational efficiency. Several studies have shown a relationship between musculoskeletal pain and presenteeism [22−24]. To improve presenteeism, it is important to improve musculoskeletal pain. In Japan, at a time when the labor force is shrinking because of the falling birthrate and the aging population, it is very important to improve presenteeism and the productivity of workers.

We hypothesized that there would be a strong correlation between long working hours and short sleeping hours, but the results showed only a weak correlation. Therefore, even if workers worked long hours but had long sleeping hours, they were less likely to have CMP. Long working hours is a social concern in Japan, but the findings of this study suggest that CMP may be preventable via longer sleeping hours, despite the presence of long working hours. Workers in Japan who work overtime (>100 hours/month) and have accumulated fatigue can avail themselves of counseling with a physician per the Industry Safety and Health Act. Providing guidance about the importance of sufficient sleep at those interviews may help reduce the frequency of CMP and depression. Indeed, working hours are also an important factor associated with CMP. In Japan, there have been some positive changes in the work style and in the long working hours. We believe that both decreasing working hours and getting adequate sleeping hours may improve or prevent CMP as well as improve workers' presenteeism and productivity.

In this study focusing on both working hours and sleeping hours, we showed a relationship between CMP, working hours, and sleeping hours. A relationship between sleeping hours and chronic pain, without including working hours, has previously been reported [25], and the results of our study corroborated

this report. Regarding the relationship between other diseases, working hours, and sleeping hours, Nakata *et al* reported that workers working >10 hours/day, sleeping <6 hours/day, and reporting insufficient sleep were, respectively, 37, 43, and 97% more likely to be depressed than those working 6−8 hours/day, sleeping 6−8 hours/day, and reporting sufficient sleep. Participants working >10 or 8−10 hours/day with <6 hours of sleep/day were more likely to be depressed than workers in the same working hours category with over 6 hours of sleep/day [26]. Thus, sufficient sleeping hours may prevent depression as well as CMP, even if the working hours are long.

This study had some limitations. First, it was cross-sectional in nature. Therefore, a causal relationship between CMP and working and sleeping hours cannot be confirmed. Second, a self-administered questionnaire was used in this study, which may have entailed inaccurate answers and introduced recall bias. Concerning CMP, consultation with a doctor was not conducted, therefore we could not sufficiently determine whether or not it was musculoskeletal pain. The duration of pain was categorized into only three groups, and whether pain affects work performance was determined only subjectively. To obtain detailed information regarding CMP, more detailed questionnaire-based analyses and consultation with a doctor would be necessary. Third, only three business types were analyzed, and the nature of work was not taken into consideration; thus, the results of this study may not be applicable to other business types and forms of work. Fourth, there were several definitions of chronic pain, and these were not standardized. A standardized definition of chronic pain is needed to accurately compare the studies. In the future, a longitudinal survey is needed, in which participants are recruited from several business types and companies.

In conclusion, long and short working hours with long sleeping hours were less likely to predispose individuals to CMP than working the same hours with short sleeping hours. We recommend that occupational health staff manage off-work sleeping hours of workers in order to prevent CMP, rather than solely focusing on managing working hours.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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筋骨格系慢性疼痛と労働時間・睡眠時間との関連性についての検討

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要　　旨：日本においては慢性疼痛の有訴率が約10～20%であり，労働者の業務効率や生産性に影響を及ぼしている．慢性疼痛と睡眠時間については先行研究において関係性が明らかにされているが，労働時間が影響するか否かについては十分に検討されておらず，特に職域における筋骨格系慢性疼痛についてはほとんど報告がない．我々は118事業所を対象に質問紙調査を実施し，最終的に1,747名が解析対象となった．対象者は筋骨格系慢性疼痛あり群（n=448）となし群(n=1299)の2群に分類した．ロジスティック回帰分析にて，年齢,性別（基準：女性），労働時間，睡眠時間は有意に筋骨格系慢性疼痛に関連していた．労働時間を9時間以上と9時間未満に，睡眠時間を7時間以上と7時間未満に分類した4群で解析を行ったところ，労働時間が9時間未満・睡眠時間7時間以上群と比較して，労働時間9時間以上・睡眠時間7時間未満群では2.02倍（95%信頼区間:1.46 − 2.78），労働時間9時間以上・睡眠時間7時間以上群では1.47倍（95%信頼区間:0.94 − 2.30），筋骨格系慢性疼痛が多かった．筋骨格系慢性疼痛は労働時間が長い場合でも十分な睡眠時間を確保することで発症を減らせる可能性がある．このことから，産業保健スタッフによる適切な睡眠時間についての指導は筋骨格系慢性疼痛の予防に繋がる可能性がある．

キーワード：筋骨格系慢性疼痛，産業保健，過重労働，睡眠時間，労働時間．

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