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Original Article

A study on the relationship between stress and fatigue and the musculoskeletal symptoms experienced by Korean radiation workers

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Abstract. [Purpose] The purpose of this study was to examine the relationship between factors such as stress and fatigue on musculoskeletal symptoms experienced by radiologists who were working in clinics and hospitals. [Subjects and Methods] A survey was conducted for radiologists in clinics, general hospitals, and university hospitals across the nation in a 20-day period from July 10–31, 2011. [Results] According to the comprehensive results of this study, job stress, psychosocial stress, and fatigue felt by radiologists had impacts on musculoskeletal disease in multiple body regions. First, according to the analysis results, job stress was scored at 2.48 on average on a 4-point Likert scale, while psychosocial stress was scored at 2.27 on average on the same scale, which demonstrated that job stress had a slightly higher score than psychosocial stress. Second, job stress, psychosocial stress, and fatigue had impacts on musculoskeletal symptoms experienced by radiologists; the possibility of musculoskeletal symptoms on the neck area increased as the physical environment got worse, interpersonal conflicts got serious, stress from organizational system increased, and psychosocial stress went up. [Conclusion] We expect that the results of this study would be useful as basic data for systematic and efficient management of resources when taking preventative measures against musculoskeletal disease experienced by radiologists in the future.
Key words: Radiologist, Musculoskeletal disease, Job stress

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INTRODUCTION

Recently, the frequency of developing musculoskeletal disease has been increasing, subsequently resulting in soaring economic losses every day. Musculoskeletal disease develops in the musculoskeletal area of the body and is a functional disorder that appears when tissues in muscles, nerves, blood vessels, and ligaments are damaged due to working posture, work repetition number, weight of works, strength required for work, vibration, work speed, tool design, and personal factors. The disease appears mainly in the waist, neck, shoulder, arm, and wrist. However, injuries incurred by a sudden accident, slipping, falling, or collision among various causes of occurrence are excluded from this definition of musculoskeletal disease[1–4]. In the past, jobs with a high risk of developing musculoskeletal disease included simple repetitive work, work requiring handling heavy objects, work with hand tools and various kinds of machinery, work causing visual display terminal syndrome (VDT), various kinds of assembly work, packaging work, and meat processing work. Recently, however, the scope of the jobs has expanded to include work in the entire service industry, such as occupations in hospitals and hotels, distribution, and office work. In particular, hospitals providing medical service centered on patients and workplaces for health care that requires various technologies and intensive manpower have been included. Jobs in hospitals generally become more segmented as hospital organization becomes increasingly complex with growing numbers of departments and job titles. Further, vertical and horizontal work procedures have also increasingly diversified. As a result, one report showed that many musculoskeletal diseases had occurred among workers in hospital-related industries[5–7]. Radiologists among hospital workers in South Korea are professionals in charge of the primary imaging work that has a decisive effect on various diagnoses in their respective medical institutions, and their work has also been segmented. Furthermore, they have a heavy work load due to working posture, work intensity, environment of the doctor's office, conflict between occupations, and patient care. They have recently tended to develop musculoskeletal disease more frequently than before due to the introduction of new treatment technologies and an increase in the number of patients[8, 9]. Studies conducted for radiologists thus far have mainly focused on disease type and work level among radiologists[10], but no study on the relationship between stress

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and fatigue levels and the prevalence rate of musculoskeletal symptoms has yet been undertaken.

With this as the background, we utilized the Korean Occupational Stress Scale (KOSS), psychosocial stress (Psychosocial Well-being Index-Short Form or PWI-SF) survey, and the Multidimensional Fatigue Scale (MFS) tool. We also used the survey tool for the prevalence rate of musculoskeletal symptoms suggested by the National Institute for Occupational Safety and Health (NIOSH), targeting radiologists who were currently working in clinics and hospitals, to examine the relationships between job stress and fatigue and musculoskeletal symptoms experienced by the radiologists. Our intent was for the results of this study to contribute to establishment of preventative measures against the development of musculoskeletal symptoms in radiologists and improvement of their health and medical treatment productivity. In addition, the results were expected to be used as basic data for systematic and efficient resource management of radiologists.

SUBJECTS AND METHODS

In this study, a survey was conducted for radiologists in clinics, hospitals, general hospitals, and university hospitals across the nation from July 10–31, 2011. Seventy questionnaires were distributed in Gangwon Province, 130 in Seoul and Gyeonggi Province, 70 in Daejeon and Chungcheong Province, 70 in Gwangju and Jeolla Province, 90 in Daegu and North Gyeongsang Province, and 130 in Busan and South Gyeongnam Province for a total of 560 questionnaires. Among these, 475 questionnaires were returned. Three were excluded because they contained no answers or improper answers, which resulted in a final total of 472 questionnaires being used in the analysis. We used a structured questionnaire and conducted the survey by asking radiologists to answer the questionnaire on their own under the responsibility of their managers after we sufficiently explaining the purpose of the survey and how to answer the questionnaire to the hospital managers. All participants signed a written informed consent form approved by the Institutional Review Board of the Inje University. The SPSS 19.0 software (IBM Corp., Armonk, NY, USA) was used for data processing. The statistical methodology is described below in detail. First, we calculated descriptive statistics and the Pearson coefficient for basic analyses of job stress, psychosocial stress, and fatigue. Second, we performed χ^2 and simple logistic regression analyses to examine relationships and cause-and-effect between independent variables and the dependent variable, which were recorded as mentioned above.

RESULTS

Table 1 shows basic descriptive statistics, including the ranking based on minimum values, maximum values, averages, and standard deviations of job stress, psychosocial stress, and fatigue. Job stress was scored at 2.48 on average on a 4-point Likert scale, and psychosocial stress was scored at 2.27, which demonstrated that job stress was slightly higher than psychosocial stress. Fatigue was scored at 4.57 on average on a 7-point Likert scale, which was slightly higher than "medium" (Table 1).

According to each variable in the lower-level area of job stress, insufficient job control was scored at 2.59 on average, which was the strongest job stress. This was followed by organizational system at 2.58, job demand at 2.55, reward and occupational climate at 2.50, job insecurity at 2.40, physical environment at 2.35, and interpersonal conflict at 2.13.

Job stress was divided into low- and high-stress groups on the basis of the average. Total scores were calculated for the two evaluation methods, the psychosocial stress (PWI-SF) survey and the fatigue measurement tool (MFS). Then, subjects were classified into the "no-stress group", "potential-stress group", or "high-risk-stress group" if they scored 26 or lower points, 27–44 points, or 45 points or higher in the psychosocial stress measurements, respectively. In the meantime, they were classified into the "low-fatigue group", "medium-fatigue group", or "high-fatigue group" if they scored 73 points or lower, 74–94 points, or 95 points or higher on the fatigue measurement tool, respectively. Subesequently, we examined the frequencies and percentages for each group. Job stress showed that the percentage of low stress scores was similar to that of high stress for most of the lower-area stresses. However, interpersonal conflict was present in 61% of the low-stress group and 39% of the high-stress group. Psychosocial stress was present in 1.1% of the no-risk group, 75% of the potential-risk group, and 23.9% of

Table 1. Descriptive statistics on job stress, psychosocial stress, and fatigue

Category	Subcategory	Minimum value	Maximum value	Average	Standard deviation	Ranking
Job stress	Physical environment	1.00	3.75	2.35	0.42	7
	Job demand	1.38	3.88	2.55	0.36	3
	Insufficient job control	1.60	3.80	2.59	0.34	1
	Interpersonal conflict	1.00	4.00	2.13	0.42	8
	Job insecurity	1.33	4.00	2.49	0.36	5
	Organizational system	1.17	4.00	2.58	0.40	2
	Reward/Occupational climate	1.40	3.90	2.50	0.40	4
	Overall	1.65	3.23	2.48	0.24	6
Psychosocial stress		1.22	3.39	2.27	0.33	.
Fatigue		1.32	6.79	4.57	0.82	.

the high-risk group, while fatigue was seen in 17.8% of the low-fatigue group, 51.7% of the medium-fatigue group, and 30.5% of the high-fatigue group (Table 2).

Table 3 shows analysis results of the correlations between job stress, psychosocial stress, and fatigue. All of the seven lower areas of job stress showed positive correlations with psychosocial stress. In particular, reward/occupational climate showed the strongest positive correlation. Furthermore, the seven lower areas of job stress showed positive correlations with fatigue. Among them, reward/occupational climate revealed the strongest positive correlation. Lastly, psychosocial stress and fatigue had positive correlations with each other (Table 3).

The analysis results showed statistical significance in psychosocial stress and fatigue. More specifically, with respect to the prevalence rate of musculoskeletal disease symptoms in the leg/foot area, the high-risk group with psychosocial stress had a 1.745 times ($p<0.05$) higher rate than the no-risk/potential-risk groups, while the high- and medium-fatigue groups showed 2.584 and 1.557 times higher rates, respectively ($p<0.05$), than the low-fatigue group (Table 4).

To examine factors that influence the overall prevalence rate of musculoskeletal disease symptoms, we selected relevant factors by conducting univariate analyses before conducting multiple logistic regression analysis. The results are shown in Table 5.

The group with high-level stress from the reward/occupational climate among the factors of job stress had a 1.430 times higher prevalence rate of musculoskeletal disease symptoms than the group with low-level stress. The high-fatigue group showed a 1.803 times higher prevalence rate of musculoskeletal disease symptoms than the other groups.

Table 2. Distribution of job stress, psychosocial stress, and fatigue (n = 472)

Variable	Degree	Frequency	Percentage
Physical environment	Low	252	53.4
	High	220	46.6
Job demand	Low	234	49.6
	High	238	50.4
Insufficient job control	Low	194	41.1
	High	278	58.9
Interpersonal conflict	Low	288	61.0
	High	184	39.0
Job insecurity	Low	206	43.6
	High	266	56.4
Organizational system	Low	249	52.8
	High	223	47.2
Reward/Occupational climate	Low	214	45.2
	High	258	54.8
Psychosocial stress	No-risk group	5	1.1
	Potential-risk group	354	75.0
	High-risk group	113	23.9
Fatigue	Low	84	17.8
	Medium	244	51.7
	High	144	30.5

DISCUSSION

Musculoskeletal disease is a functional disorder that appears when extremely minute damage to muscle or tissue has accumulated due to repetitive work movement. The disease appears mainly in the waist, neck, shoulder, arm, and wrist[10, 11]. Musculoskeletal disease has been a major issue in the field of industrial safety and health, as it occurs among a large number of workers and a number of industrial disaster victims, who experience backache due to an accident. The disease also has been the major cause of labor-management conflict in manufacturing industries, such as the automobile industry, shipbuilding industry, and heavy industry, which has become a controversial issue across society. Recently, the disease has been spread throughout all types of industries, including the service industry, represented by hospitals, hotels, distribution-related work, and office work. In particular, hospitals provide medical services that center on patients and are workplaces for health care that require various technologies and intensive manpower. Hospital jobs generally get segmented as the hospital organization gets bigger, with an increasing number of departments and job titles. Additionally, vertical and horizontal work procedures have increasingly diversified. As a result, a report was published that indicated many musculoskeletal symptoms occurred among workers in hospital-related industries[5–7].

Among hospital workers in Korea, radiologists are pro-

Table 3. Analysis of correlations for job stress, psychosocial stress, and fatigue

Variable	Physical environment	Job demand	Insufficient job control	Interpersonal conflict	Job insecurity	Organizational system	Reward/Occupational climate	Psychosocial stress
Job demand	0.452							
Insufficient job control	0.373	0.329						
Interpersonal conflict	0.191	0.011	0.135					
Job insecurity	0.199	0.123	0.248	0.224				
Organizational system	0.222	0.114	0.350	0.334	0.294			
Reward/Occupational climate	0.297	0.112	0.390	0.415	0.321	0.639		
Psychosocial stress	0.584	0.501	0.618	0.500	0.541	0.713	0.806	
Fatigue	0.403	0.206	0.270	0.305	0.148	0.261	0.451	0.478

Table 4. Overall prevalence rate of musculoskeletal disease symptoms

Factor	Variable	Degree	Symptom	X^2 (p)	Odds ratio (95% CI)		
					Odds ratio	Lower bound	Upper bound
Job Stress	Physical environment	Low	145 (57.5)	1.560 (0.212)	1		
		High	139 (63.2)		1.266	0.874	1.835
	Job demand	Low	143 (61.1)	0.172 (0.679)	1		
		High	141 (59.2)		0.925	0.640	1.337
	Insufficient job control	Low	112 (57.7)	0.817 (0.366)	1		
		High	172 (61.9)		1.188	0.817	1.726
	Interpersonal conflict	Low	168 (58.3)	1.039 (0.308)	1		
		High	116 (63.0)		1.218	0.833	1.782
	Job insecurity	Low	125 (60.7)	0.040 (0.842)	1		
		High	159 (59.8)		0.963	0.664	1.397
	Organizational system	Low	145 (58.2)	0.825 (0.364)	1		
		High	139 (62.3)		1.187	0.820	1.718
	Reward/Occupational climate	Low	114 (53.5)	6.985 (0.008)	1		
		High	169 (65.5)		1.649	1.137	2.392
	Overall	Low	143 (58.8)	0.365 (0.546)	1		
		High	141 (61.6)		1.120	0.775	1.621
Psychosocial stress		No-risk group/Potential-risk group	205 (57.1)	5.883 (0.015)			
		High-risk group	79 (69.9)		1.745	1.110	2.746
Fatigue		Low	40 (47.6)	11.741 (0.003)	1		
		Medium	143 (58.6)		1.557	0.946	2.563
		High	101 (70.1)		2.584	1.480	4.512

Table 5. Factors that influence overall prevalence rate of musculoskeletal disease symptoms

Factor	Variable name	Group	Symptom N (%)	B	OR (95% CI)		
Job stress	Reward/Occupational climate	Low	114 (53.5)		1		
		High	169 (65.5)	0.357	1.430	0.949	2.153
Psychosocial stress		No-risk group/ Potential-risk group	205 (57.1)		1		
		High-risk group	79 (69.9)	0.258	1.294	0.767	2.182
Fatigue		Low	40 (47.6)		1		
		Medium	143 (58.6)	0.182	1.199	0.701	2.052
		High	101 (70.1)	0.589	1.803	0.970	3.353

fessionals in charge of the primary imaging work that has a decisive effect on various diagnoses in their medical institutions. Their work has also been segmented. Act stipulates that radiologists shall engage in the handling of ionizing and nonionizing radiation, nuclear medicine testing by using radioactive isotope, handling of medical imaging and ultrasonic imaging systems, and selection and management of radiation instruments and related equipment. As mentioned thus far, the work of radiologists has become more sophisticated and specialized. However, radiologists tend to have a heavy work load due to working posture, work intensity, environment of the doctor's office, conflict between job titles, and patient care. Additionally, they have recently become increasingly more susceptible to musculoskeletal disease and stress than before due to the introduction of new treatment technologies and an increase in the number of patients[10, 11]. Even though more radiologists have developed musculoskeletal disease in such an environment, few studies have targeted radiologists. Furthermore, the studies that have been conducted so far that have targeted radiologists focused only on the type of disease and relation with work. However, no study has assessed the relationship between stress level and fatigue and the prevalence rate of musculoskeletal disease. Against this backdrop, we utilized the KOSS, PWI-SF, and the MFS tool, as well as the musculoskeletal symptom prevalence rate survey tool suggested by the NIOSH, targeting radiologists who were currently working in clinics and hospitals.

Descriptive statistics on job stress, psychosocial stress, and fatigue demonstrated that job stress was slightly higher than psychosocial stress. The fatigue score was slightly above the "medium" level. The scores in the lower level of job stress suggest that more stress had been felt as work

load and psychological burdens snowballed, while treatment and rewards were inadequate with restriction on autonomy. To sum up, an environment that encourages radiologists to have an enough opportunity to make decisions concerning their work based on their expertise and judgment related to radiation and to participate actively in the decision-making process in their team or organization may reduce the level of job stress they experience.

No significant correlation was found between job demand and interpersonal conflict out of the job stress factors or between fatigue and the job stress factors, which included interpersonal conflict, job insecurity, and organizational system. However, correlations were very highly positive and significant between other variables. This means that psychosocial stress and fatigue tended to increase in most cases when job stress was high. It was increasingly likely that musculoskeletal disease would develop in the neck area when job stress was high, the physical environment worsened, interpersonal conflict got serious, stress from the organizational system increased, and when psychosocial stress increased. The group with high-level stress from the reward/occupational climate among the factors of job stress had a 1.430 times higher prevalence rate of musculoskeletal disease symptoms than the group with low-level stress. The high-fatigue group showed a 1.803 times higher prevalence rate of musculoskeletal disease symptoms than the other groups. According to reports on stress and musculoskeletal disease, stress increases muscle tension through reticular formation by the brain stem, which vitalizes the central nervous system[12–16]. Such tension itself may influence development of musculoskeletal disease by applying physical loads to muscles and tendons. In particular, it was reported that even though the mechanism and relationship have not been clearly established, the trapezius muscle is more sensitive to emotional stimuli than other muscles[12–16]. Furthermore, stress vitalizes the autonomic nervous system, which facilitates the secretion of catecholamines (epinephrine and norepinephrine). These hormones make their way into the blood, which leads to an increased heart rate and contraction of blood vessels. Therefore, if an individual remains under constant stress in the long term, this may cause coronary heart disease[17, 18]. Therefore, it is believed that job stress has an effect on musculoskeletal disease. According to the comprehensive results of this study, job stress, psychosocial stress, and fatigue felt by radiologists had impacts on musculoskeletal disease in multiple body regions. In conclusion, we expect that the results of this study would be useful as basic data for systematic and efficient management of resources when taking preventative measures against musculoskeletal disease experienced by radiologists in the future. We expect that the results of this study would be useful as basic data for systematic and efficient management of resources when taking preventative measures against musculoskeletal disease experienced by radiologists in the future.

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