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Prevalence of Work-related Musculoskeletal Disorders in Auto-mission Assembly Plant Workers

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Objective: This study was performed to investigate the prevalence of musculoskeletal disorders in auto workers of a mission assembly plants.

Background: Most studies of musculoskeletal disorders have used car assembly line workers as their participants. However, little research has been done on musculoskeletal disorders afflictions of mission assembly line workers.

Method: Through a focus group interview with an ergonomist and a manager at a mission assembly plant site, a questionnaire was developed for musculoskeletal disorders. The questionnaire consisted of five parts, demographic factors, musculoskeletal disorder symptoms, and musculoskeletal disorder experiences; 137 workers participated in this survey. The surveys were analyzed by correlation and Chi-squared analysis.

Results: Musculoskeletal disorder symptoms and serious pain were reported in the neck, shoulder, back, and fingers. These problems were statistically related to various demographic factors, such as age, stature, stretching, and work satisfaction.

Conclusion: Treatment of musculoskeletal disorders should consider the workers' traits. If there is no specific cause of the pain, developing stretches and exercises before and after work should be applied to prevent musculoskeletal disorders.

Application: The results of this study can be used to develop guidelines to prevent injury in auto workers at mission assembly plants.

Keywords: Auto-mission-assembly plant workers; Work-related musculoskeletal disorders

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1. Introduction

Musculoskeletal disorders (MSDs) are caused by repetitive motions that over time stress the affected body parts, most often affecting the neck, shoulders, arms, elbows, wrist, hand nerves and muscles, or the areas surrounding these parts. However, it can be hard to distinguish the body parts where symptoms of MSDs occur, and workers may have some pain in both arms and legs. The most important component of the diagnosis of MSDs is a self-assessment of pain. This involves documenting when the pain starts, how the pain has progressed, what symptoms are present, and whether

the pain has worsened or not. The MSDs stem from fatigue of certain body parts due to repetitive and monotonous labor and physiological processes. Due to the subtle nature of MSDs, they are often more easily identified by the afflicted than by physicians; self-diagnosis is just as important as clinical diagnosis (Bird and Hill, 1992).

Bernard and Putz-Anderson (1997) found that MSDs relate to occupational factors, especially repetitive work (Onishi et al., 1976; Rossignol et al., 1987; Chiang et al., 1993; Ekberg et al., 1994; Kilbom, 1994; Ohlsson et al., 1995) and extreme and static posture (Ohlsson et al., 1995; Kilbom et al., 1986; Punnett et al., 2000). Jobs requiring excessive movements of the arms and hands (Aaras and Stranden, 1988; Veiersted, 1994; Viikari-Juntura et al., 1994) also may produce an account of pain in the upper extremity.

Tasks that require bending of the spine, such as heavy lifting or forceful movements (Punnett, et al., 1991), can lead to back pain (Vingård et al., 2000), while short cycle time (highly repetitive motion) is often the cause of carpal tunnel syndrome (Silverstein et al., 1986).

These types of pain could increase in frequency with an increase in productivity or automation. Brogmus et al. (1996) insisted that the more a company's productivity increase, the more laborers should work to keep up with the system of production, which allows more chances for MSDs to develop. Cummings et al. (1989) mentioned that automation narrowed the workers' tasks, making them more repetitive and thereby increasing the frequency of MSDs. Moreover, workers with incentives to complete extra work for more pay tended to overwhelm their bodies' capacities to earn additional money.

Based on a previous study concerning the prevalence of MSDs, car manufacturers reported a 65% loss of productivity per day at their factories because of bodily strains (Warner et al., 1998). Moreover, they found that 62% of assembly line workers had MSDs (Sadi et al., 2007). Ohlsson et al. (1989) researched car assembly workers' self-assessments of the pain they had suffered for more than a week at one time during the previous year. In this study, 39% of workers reported neck pain, 38% had shoulder pain, and 14% experienced arm pain, Luopajärvi et al. (1979) found that 37% of symptoms of MSDs in car assembly workers occurred in the neck, and 5.9% were in the hands.

Most studies of MSDs have used car assembly line workers as their participants. However, little research has been done on MSDs afflictions of mission assembly line workers. Therefore, the purpose of this study was to investigate the prevalence of musculoskeletal disorders in auto workers of the mission assembly plant to collect basic data from them to help understand and prevent MSDs. Also, another purpose of this study was to investigate the correlation between auto workers personal information (experience, age and so on.) and appearing body parts of musculoskeletal disorders.

2. Method

The research process that was used in this study is shown in Figure 1. This study consisted of a focus group interview, questionnaire development and a survey of symptoms using the questionnaire.

2.1 Focus group interview

The first step was to develop a MSDs questionnaire for the target group of workers on the car mission assembly line, so we selected several experts who could conduct our focus group, including MSD specialists from three factory and one ergonomist. We developed the preliminary MSDs for Auto-Mission-Assembly Plant Workers questionnaire based on the expert opinions expressed during our focus interview and using certain questions from previous questionnaires on studies of MSDs (Goldberg et al., 2001; Jenkinson et al., 2002; KOSHA, 2010; Polanyi et al., 1997). A pilot test was conducted to test the reliability and validity of the questionnaire.

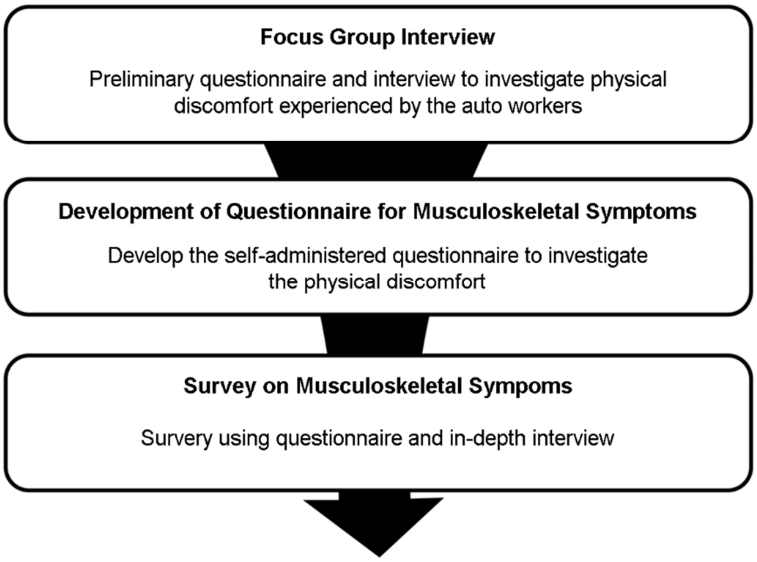

Figure 1. Flow chart of the present study

2.2 Questionnaire development

The final inventory of symptoms was developed based on the opinions of the ergonomist and various experts of MSDs. The questionnaire assessed personal factors, physical musculoskeletal symptoms and experiences of musculoskeletal disorders. The personal factors investigated were age, sex, height, weight, exercise habits, hobbies, drinking habits, smoking habits, job satisfaction, and employment status. The physical musculoskeletal symptoms explored were pain site and pain level. Finally, we examined experiences of diagnosed musculoskeletal disorders. Questions regarding uncomfortable body areas were rated on a 5-point scale. The questionnaire was returned via mail.

2.3 Musculoskeletal symptoms survey

The survey was conducted on workers at a car mission assembly factory of company 'A' in Korea. In all, 137 workers participated. The purpose and outline of the experiment were explained to the test participants. All participants provided written informed consent and ethics approval was obtained from the Human Subjects Research and Ethics Committee, Hanyang University, Seoul, Korea (Approval No: HY-12-06-02).

3. Results

3.1 Demographic characteristics

Of the 137 participants who returned the survey, all were male; none were female. The average age was 34.1 years, and the average height was 173.26cm. Participants had a mean weight of 72.19kg and an average body mass index (BMI) of 24.02kg/m^2. The percentage of respondents who reported taking part in regular stretching exercises was 35.5%; 71.8% of the participants had a drinking habit and 56.5% of them smoked cigarettes. Only 23.4% of people reported experiencing job satisfaction, and contract workers made up 43.8% of the survey participants (Table 1).

Table 1. Demographic characteristics

Characteristics	Mean (SD)	No. (%)
Gender		
Male	137	100.0
Female	0	0.0
Age	34.10 (6.03)	
Career (years)	6.80 (7.22)	
Physical index		
Height (cm)	173.26 (6.03)	
Weight (kg)	72.19 (19.38)	
Body mass index (kg/m^2)	24.02 (6.39)	
Stretching		
Yes	49	35.5
No	88	63.5
Drinking		
Yes	98	71.8
No	37	27.2
Working hour (weeks)	53.02 (12.57)	
Job satisfaction		
Satisfactory	32	23.4
Unsatisfactory	105	76.6
Previous disease		
Yes	27	19.7
No	110	80.3
Previous accident		
Yes	48	35.0
No	89	65.0
Employment forms		
Full-time job (permanent)	77	56.2
Part-time job (temporary)	60	43.8

3.2 Prevalence of musculoskeletal symptoms

In the car mission assembly line, the body parts with the highest incidence of musculoskeletal pain of a degree higher than 4 on a scale that went up to 5 were the fingers (4.32), neck (4.30), back (4.21), and shoulders (4.10) (Table 2). More than half of the respondents experienced MSDs in the neck (72.5%), back (65.1%), fingers (64.4%), and shoulders (51.7%) (Table 3).

Table 2. Degree of musculoskeletal symptoms in body parts

	Neck	Upper limb						
	Neck	Shoulder	Upper arm	Elbow	Forearm	Wrist	Palm	Finger
Degree of musculoskeletal symptoms in body parts	**4.3 (0.80)**	**4.1 (0.71)**	3.68 (0.64)	3.52 (0.60)	3.43 (0.51)	3.63 (0.53)	3.58 (0.50)	**4.32 (0.62)**
	Trunk	Lower limb						
	Back	Hip	Thigh	Knee	Calf	Ankle/feet		
	4.21 (0.70)	3.11 (0.81)	3.39 (0.50)	3.65 (0.54)	3.5 (0.56)	3.64 (0.69)		

Degree of musculoskeletal symptoms in body parts: workers were asked to mark degree of pain in 5 scale questionnaire
Boldfaced numbers indicate a score equal to 4 point and above

Table 3. Prevalence of musculoskeletal symptoms in body parts

	Neck	Upper limb						
	Neck	Shoulder	Upper arm	Elbow	Forearm	Wrist	Palm	Finger
Prevalence of musculoskeletal symptoms (%)	**72.5**	**51.7**	25.4	15.3	15.2	35	18.9	**64.4**
	Trunk	Lower limb						
	Back	Hip	Thigh	Knee	Calf	Ankle/feet		
	65.1	8.0	20.1	47.4	24.8	42.3		

Prevalence of musculoskeletal symptoms (%): ratio of workers who had musculoskeletal symptoms in whole workers in the plant
Boldfaced numbers indicate a score equal to 50% and above

3.3 An analysis of the relationship between demographic variables and factors and the prevalence of symptoms

To analyze the relationship between demographic variables and factors and the prevalence of symptoms, a Chi-square analysis was applied to assess the categorical data and a correlation analysis was used to examine the numeric data (Table 4). The results showed that age and height had statistical significance ($p<0.01$), as did stretching exercise ($p<0.1$), job satisfaction ($p<0.1$) and employment status ($p<0.05$).

In other words, taller workers experienced more MSDs, but older workers had fewer symptoms of MSDs. Workers who did not exercise reported more MSDs (63.5%) than workers who did stretching exercise regularly before work (35.5%). In the job satisfaction field, workers with a higher job satisfaction had fewer MSDs (23.4%) than others who were not satisfied with their jobs (76.6%). Regarding employment status, full-time workers (43.8%) reported fewer MSDs symptoms than contract workers (56.2%).

Table 4. Correlation and chi-square analysis between demographic variables and musculoskeletal experience

Age		Stature		Weight		BMI		Career	
r	*p*-value	*r*	*p*-value	*r*	*p*-value	*r*	*p*-value	*r*	*p*-value
-0.282***	0.001	0.232***	0.007	-0.114	0.187	0.003	0.968	0.068	0.511
Stretching exercise		Drinking		Smoking		Job satisfaction		Employment status	
χ^2	*p*-value	χ^2	*p*-value	χ^2	*p*-value	χ^2	*p*-value	χ^2	*p*-value
2.087*	0.068	1.213	0.271	0.074	0.785	3.515*	0.061	4.362	0.137

*p-0.1, **p-0.05, ***p-0.01

4. Discussion

This study investigated the prevalence of musculoskeletal symptoms, worker traits and MSDs history among the laborers in a car mission assembly line. Researchers collected data regarding the current state of MSDs of car mission assembly line workers with the hope that these data will be used to prevent MSDs for laborers. Deros et al. (2010) reported the most frequently affected parts of the MSDs in car assembly line workers were the back (24%) and the feet/ankle (20.8%). However, in the car mission assembly line, workers reported painful body parts to be the neck (72.5%) and back (65.1%). We could estimate that workers in the car assembly line use their entire body often, but workers who are in a mission line stand in one spot and instead move their necks, so workers from each section may have complaints in different body parts related to their specific tasks.

This study found that older workers had fewer musculoskeletal symptoms. Generally, because older workers have more experience, it would make sense that they would be more likely to have MSDs. However, the results showed opposite findings. A similar result was observed by other studies. Virokannas et al. (1999) investigated the correlation between 55-year-old workers' work careers and MSDs. The length of the work career was related to MSDs, but people who had advanced work careers actually experienced fewer MSDs symptoms. Salik and Özcan (2004) researched the correlation between the length of a physical therapists' work career and the presence of MSDs. Their results showed that therapists with shorter careers had more MSDs symptoms because of their lack of knowledge of therapy skills. Our study had similar results. The incidence of MSDs could be related to the techniques of workers. Taller workers had more symptoms of MSDs, which could be influenced by the car mission assembly line's conveyer height and the two-hour shift times. The current conveyer's height is not optimized for workers. Even though workers only work for two hours each shift, they spend the entire time by leaning their necks (Figure 2). Therefore, the conveyer's height should be ergonomically designed to fit with the workers' heights to prevent them from leaning their necks.

Stretching exercises have been traditionally used to help avoid MSDs. Stretching before work might prevent MSDs in some workers. This study found that stretching exercises lessened the symptoms of MSDs. According to studies by Pereira et al. (2013) and da Costa and Vieira (2008) stretching could be effective at preventing musculoskeletal disorders. It could also be useful to do stretching exercises before work to prevent MSDs.

Job satisfaction is also related to MSDs. Spector (1997) defined job satisfaction as how many workers liked their jobs. Loghmani et al. (2013) reported that higher job satisfaction lessened the symptoms of MSDs. Our study showed that workers who were not satisfied their work reported more MSDs symptoms. To reduce the incidence of MSDs, ergonomists should determine how to increase the workers' job satisfaction.

This study found that the car mission assembly line workers experienced various MSDs symptoms, and the neck was the worst

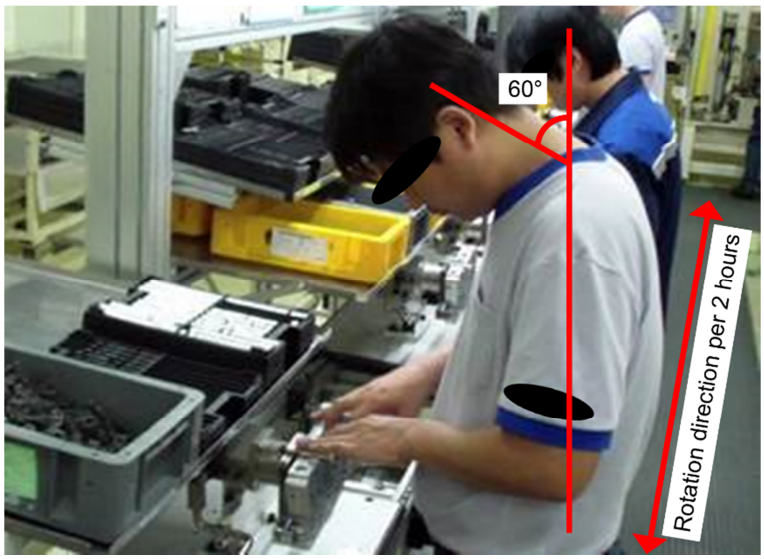

Figure 2. Neck bending angle and rotation direction of auto workers

and most painful part. MSDs cost companies workers and benefits. Therefore, companies need to take care to prevent workers from developing MSDs. A work hardening program could be a solution to help workers return to work before having serious physical issues. Work hardening is a clinic program of work for increasing productivity. It stretches the groups of muscles that workers use most often, which strengthens them and can prevent musculoskeletal disorders (Schonstein et al., 2003).

5. Conclusion

This study researched the causes of pain in people who worked on a car mission assembly plants. Based on our results, treatment of MSDs should consider the workers' traits. If there is no specific cause of the pain that is experienced, developing stretches and exercises to do both before and after work should be applied to prevent musculoskeletal disorders.

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