

Effect of a Workplace-Based Work-Conditioning Program on Management of Work-Related Musculoskeletal Disorders

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Abstract

The purpose of this study was to investigate the effects of a workplace-based work-conditioning program (WCP) on the management of work-related musculoskeletal disorders (WRMDs) in an automobile-parts manufacturing company. In total, 1,110 subjects with WRMDs participated in workplace-based WCP emphasizing function-centered management and ergonomics. We investigated the incidence of WRMDs variables (number of persons diagnosed with industrial accident-related WRMDs, number of cases of WRMD) and financial benefits (cost of workers' compensation insurance and lost work days related to WRMDs) per year before and after WCP. Additionally, we compared self-reported pain intensity and functional disability in subjects with musculoskeletal pain before and after the WCP. Pain intensity was measured using a visual analog scale (VAS), and functional disability was measured by the neck disability index (NDI) and the Oswestry disability Index (ODI). The number of person diagnosed with industrial accident-related WRMDs, the number of cases of WRMD, the cost of workers' compensation insurance and lost work days related to WRMDs per year decreased by 51%, 37%, 34%, and 47%, respectively, and VAS, NDI, and ODI scores decreased significantly after implementation of WCP ($p < .05$). Thus, the results of the present study suggest that function-centered, workplace-based WCP was effective in managing WRMDs at an automobile-parts manufacturing company.

Key Words: Ergonomics; Function-centered management; Work-conditioning program; Work-related musculoskeletal disorders.

Introduction

Musculoskeletal disorders are injuries or dysfunction affecting muscles, bones, nerves, tendons, ligaments, joints, cartilage, and spinal discs (Deeney and O'Sullivan, 2009). They include sprains, strains, tears, and connective tissue injuries. Work-related muscu-

loskeletal disorders (WRMDs) may occur, for example, as a result of over-exertion, cumulative load, and/or contact of body parts with equipment or furniture (da Costa and Vieira, 2008). WRMDs can be characterized by symptoms of pain, numbness, stiffness, and eventually weakness, depending on the type of disorder and body location (Rempel et al,

1992). Repetitive and forceful work activities, awkward or static postures, and mechanical pressure associated with work tasks have been cited as important etiological factors for WRMDs (Faucett et al, 2002). Recently, WRMDs have become a major problem in many industrialized countries (Morken et al, 2002). The US Federal Occupational Safety and Health Administration (OSHA) reported that as many as 2% of the entire American workforce suffers a WRMD every year, and these disorders account disproportionately for over one-third of all workers' compensation costs for medical care and lost wages (Faucett et al, 2002). The incidence of WRMDs was high in manufacturing industries, such as the automobile, shipping, and heavy industries. WRMDs are also a major cause of conflict in labor relations (Choi, 2003). In Korea, the incidence of WRMDs is increasing each year, and 6,223 patients experienced WRMDs in 2006 (Kim et al, 2009). Roh (2005) reported that the number of lost work days related to WRMDs was more than twice that of days lost due to injuries in crush accidents and collisions.

Methods of managing WRMDs in manufacturing industries have been classified into two types. One approach is pain-centered management, which has been used more frequently (Rainville et al, 2000), and the other is function-centered management (Kool et al, 2005). The primary goal of pain-centered management is pain reduction (Kool et al, 2007), and pain-centered management relies on a biomedical model of musculoskeletal disorders that is focused primarily on somatic issues. Diagnosis of the underlying pathological condition provides the basis for rational physical treatment of the illness, and physical therapy intervention in this management includes joint mobilization and passive pain-modulating treatments such as hot packs, electrotherapy, or massage (Kool et al, 2005; Kool et al, 2007).

Function-centered management relies on a biopsychosocial model, emphasizing the role of psychological factors, such as personal beliefs, illness behavior, and fear avoidance, as well as social factors, such as fam-

ily, work, and the wider social network, in the development and maintenance of symptoms (Fritz and George, 2002; Kool et al, 2005). Based on this management approach, functional restoration programs were developed with the intent of overcoming dysfunction and illness, and ergonomic and social interventions were implemented to facilitate return to work (Kool et al, 2005; Mayer et al, 1987). The treatment protocol did not contain pain-modulating passive treatments because such passive treatments do not facilitate an increase in activity or self-efficacy, nor has the research literature shown them to be effective (Kool et al, 2005). Treatment activities were chosen based on the capacities required of a client as identified in work-related assessments (Kool et al, 2007).

Work-conditioning programs (WCP) have focused on functional improvement in activities of daily living and restoration of work-related function (Franklin et al, 1994). WCP evolved in the late 1970s and early 1980s in an effort to minimize the economic and human costs of work-related injuries (Weir and Nielson, 2001). A WCP is defined as a single-discipline treatment approach that addresses physical or functional needs using physical conditioning and functional activities related to work (Cole et al, 2009). WCP is a work-related, intensive, goal-oriented treatment program specifically designed to restore a client's systemic neuromusculoskeletal (strength, endurance, movement, flexibility, motor control) and cardiopulmonary function with the aim of restoring the client's physical capacity and functioning so that the client can safely return to work (Hart et al, 2007). Thus, WCP emphasizes physical conditioning through strengthening, stretching, endurance, and coordination exercises. To examine the effect of WCP, recovery rates of physical impairment and return to work were investigated (Beissner et al, 1996). In some studies, patients completed a self-report survey describing how they perceived their functional status. For example, the Oswestry low-back pain disability questionnaire and the neck disability index are reliable, valid, and responsible

measurement tools for low-back pain and neck pain, respectively (Fritz and Irrgang, 2001; Hart et al, 2007). Some research has used another patient self-report tool, a visual analog scale, which measures pain intensity and has adequate reliability and validity (Hart et al, 2007; Jensen et al, 1999).

Although the effects of functional WCP have been demonstrated in other countries, to the author's knowledge, no study on the practice of workplace-based WCP in Korea has been reported. Thus, the aim of this study was to examine the effects of WCP on the management of WRMDs in an automobile-parts manufacturing company in Korea by investigating the incidence of WRMDs (number of persons diagnosed with industrial accident-related WRMDs, number of cases of WRMD) and financial benefits (cost of workers' compensation insurance and lost work days related to WRMDs) per year before and after the implementation of a WCP. Additionally, self-reported pain intensity and functional disability of subjects with musculoskeletal pain were measured before and after workplace-based WCP.

Methods

Subjects

This study was conducted as a part of a Yonsei University-industry cooperation project. The study was conducted in branches of automobile-parts manufacturing company located in Wonju, Iksan, and Pyongtaek in Korea from 2007 to 2009. During this period, 1,110 male subjects with WRMDs participated in WCP. The age, height, and weight of the subjects are summarized in Table 1. The most common sites of musculoskeletal pain were, in order, the shoulder, lower back, neck, wrist, elbow, finger, knee, and ankle.

Measurement Instruments

Visual analog scale (VAS)

Pain intensity in the 1,110 subjects was evaluated

using a visual analog scale (VAS). The entire visual analog line was 10 cm long, and the endpoints of the line were labeled 'no symptoms/pain (0),' and, 'most severe symptoms/pain (10).' The patient was asked to bisect the line at a point representing the level of his or her pain on the scale (O'Sullivan and Smidt, 2006). The VAS has been shown to be a valid and reliable measure of chronic pain intensity. The intra-class correlation coefficient (ICC) for reliability of the VAS appears to be high (ICC=.97; Bijur et al, 2001).

Neck disability index (NDI)

The level of function in 175 subjects who had neck pain was evaluated using neck disability index (NDI). The NDI consists of 10 questions (pain intensity, personal care, lifting, reading, headache, concentration, work, sleep, driving, recreation) (Vernon and Miror, 1991). The questions are measured on a 6-point scale from 0 (no disability) to 5 (full disability) (Bovim et al, 1994). Vernon and Mior (1991) offered the following interpretation of NDI total scores: 0~4, no disability, 5~14, mild disability, 15~24, moderate disability, 25~34, severe disability, and >35, complete disability. The test-retest reliability of NDI was good (Pearson's $r=.89$), and internal consistency was considered good, with Cronbach's α of .88~.92 (Gay et al, 2007; Vernon and Miror, 1991).

Oswestry disability index (ODI)

Functional disability in 257 subjects who had low-back pain was evaluated using the Oswestry disability index (ODI). The ODI consists of 10 questions assessing pain intensity, personal care, lifting, walking, sitting, standing, sleeping, sex life, social life, and travel (Fairbank et al, 1980). For each item, there are

Table 1. General characteristics of subjects (N=1,110)

Characteristics	Mean±SD	Range
Age (yrs)	37.68±7.43	24~51
Height (cm)	173.53±4.34	164~183
Body weight (kg)	72.18±5.53	60~88

six statements, and the total score is five. The final score is calculated as $[\text{total score}/(5 \times \text{number of questions answered})] \times 100\%$ (Davidson, 2008). A person with a rating of 0~20% can cope with most activities of daily living, usually with no treatment required. A person with a rating of 20~40% experiences more pain and has difficulty with sitting and, particularly, with lifting and standing. With a rating of 40~60%, the patient experiences severe disabling pain that affects travel, personal care, social life, sexual activity, and sleep. With a rating of 60~100%, disabling back pain affects all aspects of a person's life, and intervention is required (Breitenseher et al, 1996; Fairbank and Pynsent, 2000). The reliability of the ODI has been reported to be good (ICC=.84) (Davidson and Keating, 2002).

Procedures

Subjects with WRMDs were evaluated by a musculoskeletal specialist before enrollment in the WCP. Assessment items were flexibility, muscle strength, muscle endurance, motor control, functional capacity, job analysis, work environment, and risk factors for WRMDs. After the assessment, subjects with serious medical and psychological problems or severe pain were referred to the medical service. Subjects eligible for WCP signed a consent form after understanding the purposes and methods of WCP. Subjects attended daily WCP for at least 1 hour per day (2 hour per day if tolerated), 5 days per week. The duration of WCP (2~12 weeks) was determined according to personal condition, physical ability, and pain intensity. The WCP was managed by a licensed physical therapist and an ergonomic trainer with a minimum of 3 years' experience in ergonomics. The WCP was a patient-specific exercise program that was constructed individually in an effort to intervene in physical aspects of the job (working posture) and the workplace environment (occupational safety, work simulation). Additionally, a trainer educated subjects in a self-exercise program for the prevention of recurrence of WRMDs. Functional capacity evaluations and improvements in physical findings were also used to determine WCP completion.

The incidence of WRMDs (number of person diagnosed with industrial accident-related WRMDs, number of case of WRMDs) and financial benefits (cost of workers' compensation insurance and lost work days related to WRMDs) per year were measured before and after the implementation of WCP. Self-reported pain was determined using a VAS, and functional disability of subjects with WRMDs was also examined using NDI and ODI.

Statistical Analysis

The incidence of WRMDs and the associated financial benefits before and after the implementation of WCP were compared. The Wilcoxon matched-pairs signed-ranks test was used to compare the NDI scores and VAS scores before and after WCP. The paired t-test was used to compare ODI scores before and after WCP. For all analysis, a significance level of $\alpha < .05$ was adopted. Statistical analysis was performed using Windows PASW, version 18.0.

Results

1. Incidence of WRMDs and Financial Benefits

A comparison of industrial accident-related WRMDs before and after WCP revealed a 51% decrease (66 vs. 32 persons) in the number of persons diagnosed with WRMDs and a 37% decrease (134 to 84 cases) in the number of WRMD cases. The cost of workers' compensation insurance was reduced by 34% (5.20 vs. 3.32 billion won) and the number of lost work days declined by 47% (7,991 vs. 3,192 days) after the implementation of WCP (Figure 1).

2. Pain Intensity and Functional Disability

Mean scores on the VAS, NDI, and ODI decreased significantly after WCP implementation. The mean VAS decreased from 6.81 to 3.39 cm, the NDI score decreased from 27.15 to 15.74, and the ODI decreased from 53.86% to 24.64% (Table 2).

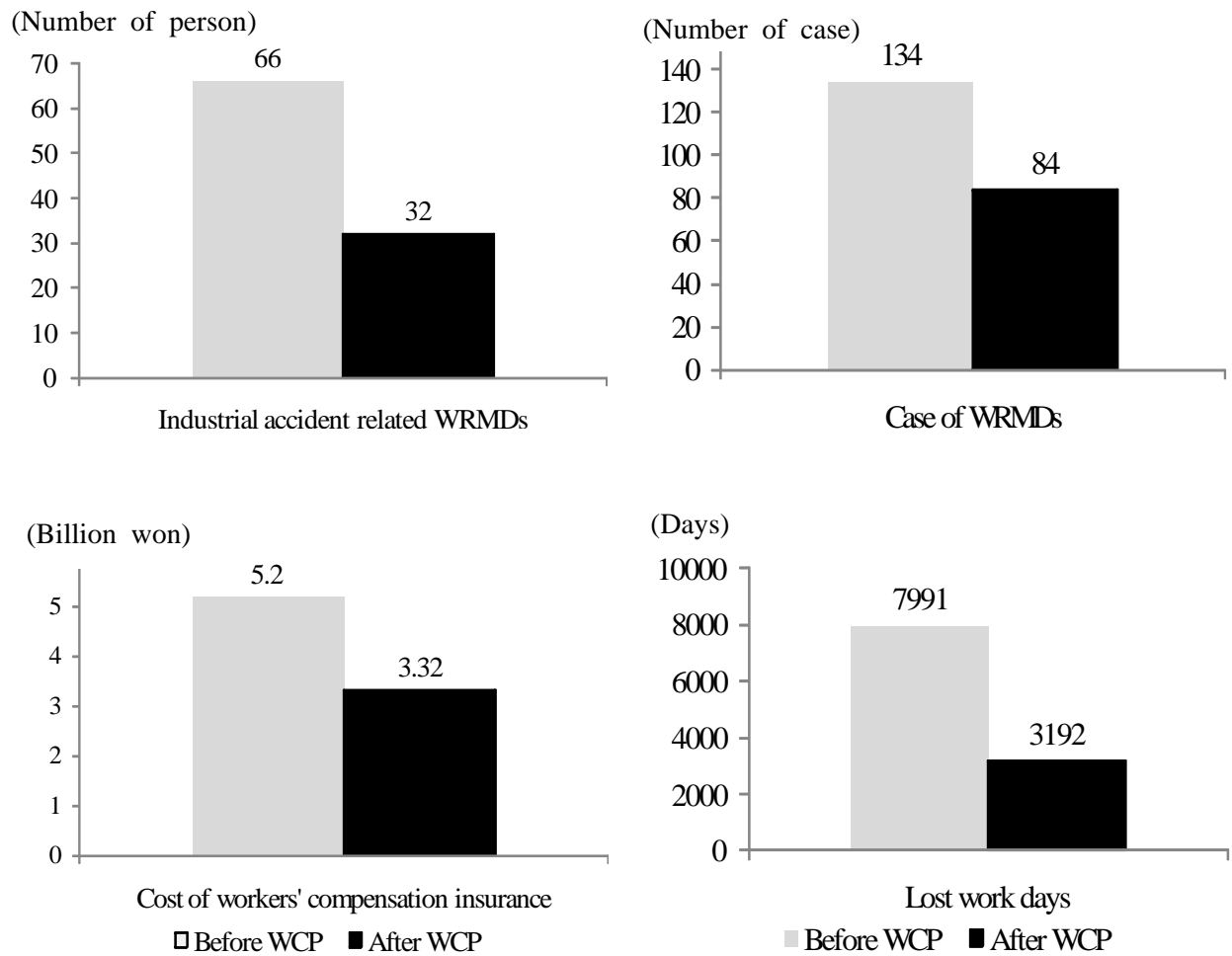


Figure 1. The number of person with industrial accident related WRMDs and the number of case of WRMDs, cost of workers' compensation insurance, and lost work days before and after the implementation of WCP.

Table 2. The pain intensity and functional disability before and after WCP

Parameter		Mean±SD	p
Visual analog scale (cm) (n ₁ =1110)	Before	6.81±1.61	.01
	After	3.39±1.84	
Neck disability index (score) (n ₂ =175)	Before	27.15±6.18	.01
	After	15.74±5.08	
Oswestry disability index (%) (n ₃ =257)	Before	53.86±9.18	.01
	After	24.64±8.77	

Discussion

This study was undertaken to investigate the effects of workplace-based WCP on the management of WRMDs in an automobile-parts manufacturing company in Korea. The number of person diagnosed with industrial accident-related WRMDs, the number of case of WRMD, the cost of workers' compensation insurance, and lost work days related to WRMDs per year were examined before and after the implementation of WCP. Additionally, self-reported pain intensity and functional disability of subjects with musculoskeletal pain were determined. The number of person diagnosed with industrial accident-related WRMDs, the number of cases of WRMDs, the cost of workers' compensation insurance, and the number of lost work days related to WRMDs per year decreased after workplace-based WCP implementation. These results suggest that workplace-based WCP can be used as an alternative management procedure that can substitute for hospital treatment in persons with industrial accident-related WRMDs and as a preventive measure for WRMDs. A reduction in the number of person diagnosed with industrial accident-related WRMDs can lead to a reduction in the cost of workers' compensation insurance.

Because the workplace-based WCP in this study was in the manufacturing plant, not in a remote area outside the company, subjects were easily able to take part in the WCP, and it was possible to work part time and participate in WCP without leaving the company. This is a major advantage of workplace-based WCP, and lost work days were reduced by 60%. The study by Bunn et al, (2006) reported that the mean number of lost days per work-related injury decreased from 35.1 to 27.6 days, mean annual compensation insurance per work-related injury decreased from \$9,327 to \$4,493, and mean annual medical costs per work-related injury decreased from \$4,848 to \$2,679 after a function-centered program. Thus, it seems that a WCP in the workplace was effective in the management and treatment of WRMDs.

The function-centered management of WRMDs has only been studied recently (Cole et al, 2009; Hart et al, 2007; Kool et al, 2005; Kool et al, 2007). Oland and Tveiten (1991) reported that 66 patients with low-back pain participated in a 4-week program of function-centered management, and 15 patients (23%) had returned to work at the 18-month follow-up. Edwards et al, (1992) reported that 30 of 54 (55%) patients who participated in a treatment program were successfully rehabilitated. Mayer et al, (1987) examined the effect of a functional program, comparing 116 patients participating in a functional restoration treatment program and 72 patients in a control group, and found that 87% of the treatment group were actively working after 2 years of follow-up, compared with only 41% of the control group. Hart et al, (2007) reported improvements in VAS and ODI scores after WCP. A function-centered program allowed industrial workers to return to work earlier and to save substantial medical costs (Mitchell and Carmen, 1990). These previous reports are consistent with the findings of this study and support the important role of WCP.

Thus, function-centered management such as WCP is recommended for use in the workplace to decrease pain in and improve the functional status of industrial workers. Management program for patients with WRMDs in advanced countries have already been converted from pain-centered management programs to function-centered work-conditioning programs, due to the limitations of pain-centered management (Franklin et al, 1994). The management paradigm of WRMDs in Korea is still largely focused on pain-centered management. Because pain-centered management focuses only on pain reduction by identifying the anatomical structure(s) in pain, it does not address the recurrence of WRMDs. In contrast, function-centered management can provide solutions for chronic and recurrent musculoskeletal disorders by finding etiological factors from movement analysis, precipitating factor identification, and work simulation.

Our study has several limitations. First, the function-centered management was not compared directly

with pain-centered management, as it was not deemed ethical to provide pain-centered management to persons with WRMDs. Second, it was almost impossible to control for confounding variables, such as working hours, daily workload, medical service, and medication of each participant. Third, the generalizability of this study is limited because only adult male subjects participated. Thus, further studies are needed that include control groups, other interventions, and more diverse subjects.

Conclusion

This study investigated the effects of WCP in managing WRMD disorders by examining the incidence of WRMDs, financial benefits related to WRMDs, self-reported pain intensity, and functional disability before and after workplace-based WCP. The number of person diagnosed with industrial accident-related WRMDs, the number of cases of WRMD, the cost of workers' compensation insurance, and lost work days related to WRMDs per year were decreased after workplace-based WCP implementation. Improvements in VAS, NDI, and ODI after WCP implementation were also observed. Thus, function-centered workplace-based WCP was effective in managing WRMDs in an automobile-parts manufacturing company.

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