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Original Article

Effects of Self Stretching on Pain and Musculoskeletal Symptom of Bus Drivers

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Abstract. [Purpose] The aim of this study was to evaluate the musculoskeletal symptoms, pain and risk of postures as well as the effects of stretching exercise on the work-related symptoms and pain of bus drivers. [Subjects and Methods] Eighty-one drivers were randomly recruited from a bus corporation for this study. Information about pain levels, painful regions, and general characteristics of subjects was obtained using the symptom research form (KOSHA Code H-30-2003). The level of pain was assessed on a scale of numeric rating scale (NRS) which is divided by 10. Ergonomic posture assessment was conducted using the rapid upper limb assessment (RULA). Self-stretching exercise was performed for 4 weeks by the bus drivers who suffered from neck and shoulder pain. [Results] Musculoskeletal symptoms were present in the order of shoulder, neck, lower back and lower extremities. Compared with other jobs, the final score, and the action level of bus drivers were very high, showing 57.6% of action levels 3 and 4. A statistically significant decrease of pain was shown after the self-stretching intervention. There was also a significant decrease of musculoskeletal symptoms in the neck and shoulders after the self-stretching exercise. [Conclusion] Performing stretching for musculoskeletal symptoms had a positive influence on the symptoms and reduced pain.

Key words: Stretching, MSDs, Bus driver

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INTRODUCTION

Industrialization has changed industrial structure and production methods. In addition the migration of the population between regions has greatly influenced the development of public transportation. Consequently, the number of people working in the transportation industry has been on the rise. According to the National Statistical Office of Korea, 95,488 people were engaged in bus driving in 2011, and 77.8% of them drove intra-city buses, 14.6% drove the intercity buses, 4.2% drove the express buses and 3.4% drove buses in farming and fishing communities[1)].

Bus drivers are exposed to physical and chemical risk factors such as vibration and exhaust emissions. Furthermore, they are heavily stressed by having to continuously concentrate on road conditions and by staying alert for unexpected incidents[2)].

The fatigue caused by driving should be focused on, because 25% of fatal accidents result from fatigue, and 30% of drivers driving business vehicles complain of chronic fatigue symptoms. In addition, it has been reported that the attention decreases with increasing driving time, resulting in higher risk of traffic accidents[3)]. It has also been reported that more than half of accidents on expressways are caused by fatigue accumulation[4)]. The fitness of drivers has an important effect on not only the driver's safety but also on passenger safety, and it has been reported that most traffic accidents are caused by drivers in many previous studies. Thus, the health management of bus drivers is a very important issue for the prevention of traffic accidents[5)].

In recent years, musculoskeletal disorders (MSDSs) have been increasing. In previous studies, MSDS was studied in manufacturing businesses such as the car, ship and heavy industries due to characteristics such as collective occurrence, incidence of industrial accidents, and economic damage. Recently, the study of MSDS has expanded to hospitals, transportation businesses and nonmetallic mineral manufacturing[6)]. Most previous studies of MSDSs focused on factors related to lower back pain. It is reported that 81.9% of bus drivers have experiences lower back pain, and that it is closely related to the working conditions and the whole-body vibration received from the vehicle and road[7)]. Moreover, it has also been reported that some factors such as the increased age of workers, working time and psychological stress are highly related to lower back pain[8)].

Regular stretching exercise can reduce and prevent the symptoms of MSDS. Stretching is known to be an effective and simple exercise which increases flexibility[9)]. Stretching exercise is reported to be effective at not only improving neuromuscular coordination and flexibility, but also at reducing pain and muscle weakness[10)]. Stretching exercise may improve physical activity by encouraging correct pos-

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ture of body and increasing muscle endurance[11].

Compared to other countries, there is a lack of information on bus drivers' health, especially physical and psychological fitness, in Korea[12], and there has been no ergonomic assessment of posture and body parts related to MSDSs in bus drivers. In addition, changes in symptoms of pain and the musculoskeletal system in bus drivers have not been studied. Thus, this study was conducted in order to investigate not only musculoskeletal symptoms, pain and risk of postures, but also the effects of stretching exercise on the work-related symptoms and pain of bus drivers.

SUBJECTS AND METHODS

Subjects

Eighty-one drivers were randomly recruited from a bus corporation for this study. Pain level, painful region, and the general characteristics of subjects were obtained using the symptom research form (KOSHA Code H-30-2003). Driving posture and characteristics of subjects were recorded two times using a video camera during driving (Table 1). This study was conducted after sufficient explanation about its purpose and method had been given to the subjects, who provided their written informed consent prior to participation in the study, in accordance with the ethical principles of the Declaration of Helsinki.

Methods

A general questionnaire was used in this study in order to investigate the general characteristics and the work-related characteristics of the bus drivers. A musculoskeletal symptom research form was used to assess individual characteristics and pain was also assessed in this study. Subjects were informed of the contents and purpose of the questionnaire and instructed to complete it by themselves. The examiner interviewed the subjects and confirmed the questionnaire answers. The level of pain was measured on a 10-cm numerical rating scale. A score of 0 meant 'no pain' and 10 meant 'severe pain'. The musculoskeletal symptom research form and pain assessments were conducted before and after the intervention.

The general assessment questionnaire included items on physical strain and general characteristics such as age, gender, height, weight, working time and break time. Musculoskeletal symptoms were defined as: symptom criteria 1, a symptom lasting for one week or occurring more than once a month within a year; symptom criteria 2, a level of pain greater than moderate in addition to symptom criteria 1; and symptom criteria 3, a level of pain greater than severe in addition to 'symptom criteria 1'.

The questionnaire about musculoskeletal symptoms assessed body parts such as the neck, hand/wrist, upper limb/elbow and shoulder regions. If a symptom was present in any of these body parts, it was decided that there was a musculoskeletal symptom in the upper extremities. Thirty drivers who reported symptoms in the neck and shoulders were recruited for the experimental group which performed the intervention.

Ergonomic posture assessment was conducted using the rapid upper limb assessment (RULA). Posture score was marked using the RULA coding system. The assessment was divided into four action levels based on the sum of the score of all items. The action level was classified as level 1 to 4, according to the desired improvement. Action levels 3 and 4 were defined as levels that required immediate improvement, and action level 2 as needing long-term improvement in the ergonomic assessment of the work of the bus drivers. Overloaded posture and the most frequent posture were selected in the ergonomic assessment based on two recordings of the bus drivers' work.

In the experimental group, bus drivers who suffered from neck and shoulder pain according to their responses to the musculoskeletal symptom research form performed self-stretching exercises for 4 weeks. Subjects in the experimental group were provided with documents demonstrating the method of the self-stretching exercise and a self-check list. In addition, physical therapists educated subjects on the stretching method and related precautions. Physical therapists visited the subjects in the experimental group once a week and continuously educated them about stretching.

Self-stretching exercise was performed in two ways. In one exercise the levator scapulae, upper trapezius muscle and sternocleidomastoid muscle were stretched[13], and in the other the subjects performed a self-stretching exercise described by Kim and Lee consisting of seven movements[14]. Each stretching movement was performed three times per set, three times a week for four weeks, and the subjects were instructed to maintain maximum stretch for more than 25 seconds and then relax in order to obtain the benefits of stretching.

Descriptive statistics and frequency analysis were used to analyze the distribution of individual posture scores and each item of the questionnaire. The paired t-test and cross-over analysis were also used to investigate the effects of the intervention. SPSS WIN (version 20.0) was used for the statistical analysis with a significance level of 0.05.

RESULTS

Most of the bus drivers were male and liked to play sports, but they did not have enough time or a place to relieve fatigue or stress in their break times (Table 1). Their physical strain was severe. The physical load caused by long hours of driving and irregular rest was found to be high, because the sum of the 'slight hardness' and 'severe hardness' items accounted for 28.8% of the total.

The bus drivers often complained of pain which resulted from increased muscle tone of the upper extremities, because the upper extremities are not fixed when driving a bus (Table 2). Musculoskeletal symptoms were reported in the order of the shoulder, neck, lower back and lower extremities. Moreover, an assistive device which could reduce the muscle tone of the upper extremities was not used.

Because of the work-related characteristics, abduction and adduction of the shoulder joint repeatedly occurred, and excessive flexion and extension of the wrist joint also repeatedly occurred when moving the steering wheel. Bus drivers didn't use any assistive devices which could support

Table 1. General characteristics and work-related characteristics of the bus drivers (N=80)

		Mean±SD	Frequency (%)
Age (yr)		49.39±8.19	
Height (cm)		170.81±4.89	
Weight (kg)		70.63±7.95	
Work career (yr)		10.17±7.82	
Work time of 1 day (hour)		13.29±2.30	
Rest time of 1 day (hour)		3.33±0.81	
Marriage (married / unmarried)			77 (96.3%) / 3 (3.8%)
Physical load	No hardness		8 (10.0%)
	Slight hardness		49 (61.3%)
	Hardness		18 (22.5%)

Table 2. Musculoskeletal symptoms of the bus drivers (N=80)

Musculoskeletal symptoms	Frequency (%)
Neck	27 (33.8)
Shoulder	34 (42.4)
Arm / Elbow	5 (6.2)
Hand / Wrist / Finger	5 (6.2)
Lumbar	27 (33.7)
Leg / Foot	15 (18.8)

Table 3. Ergonomic posture assessment of the bus drivers (N=80)

		Mean±SD	Frequency (%)
Posture score A		3.78±0.73	
Final wrist & arm score		4.77±0.74	
Posture score B		3.16±1.04	
Final neck, trunk & leg score		4.16±1.03	
Final score		4.95±1.26	
Action level	2		34 (42.5%)
	3		31 (38.8%)
	4		15 (18.8%)

Table 4. The changes in pain and musculoskeletal symptoms after self-stretching (N=30)

		Pre-test	Post-test
Numeric rating scale (score) *		6.17±1.51	3.21±1.87
Musculoskeletal symptoms (Frequency, %)	Neck*	27 (33.8%)	20 (25%)
	Shoulder*	34 (42.4%)	28 (35%)
	Arm / Elbow	5 (6.2%)	5 (6.2%)
	Hand / Wrist / Finger	5 (6.2%)	2 (2.5%)
	Lumbar	27 (33.7%)	24 (30%)
	Leg / Foot	15 (18.8%)	16 (20%)

*, significant difference, $p<0.05$

the neck and the neck was maintained in flexion because the drivers needed to keep looking forward during driving. There was a lack of education about the proper driving posture and self-stretching methods. Also the steering wheel and driver's seat were not designed to be suitable for the driver's body. Compared with other jobs, the final scores and action levels of the bus drivers were very high, action levels 3 and 4 accounting for 57.6% of the total (Table 3).

A statistically significant decrease of pain was found after the bus drivers had completed the self-stretching intervention ($p<0.05$) (Table 4). There was also a significant decrease in musculoskeletal symptoms in the neck and shoulders after the self-stretching exercise ($p<0.05$).

DISCUSSION

The ILO first described musculoskeletal disease as a work-related disease in 1960. In Korea, musculoskeletal disease became a health issue in the late 1980. Work-related musculoskeletal disease was included in the law for the prevention of musculoskeletal disease, legislated and revised under Article 24 of the Occupation Safety and Health Acts in Dec 2002, which came into effect in July 2003[15].

Ergonomic evaluation of working postures and the environment of workers for the prevention of musculoskeletal disease in Korea first began to be studied mainly in manufacturing sectors such as the car, shipping, and heavy industries, and prevention policies and programs for managing musculoskeletal patients were introduced. Although musculoskeletal disease was mostly identified in manufacturing industry, the seriousness of musculoskeletal disease in non-manufacturing sectors including the service industry has only been recognized recently[16].

Traffic accidents can be caused by decreased concentration and by delay in judgment due to the musculoskeletal disease of a driver[17]. The main reasons for musculoskeletal disease are overwork, wrong working posture, repetitive tasks, misallocation of resting and working times, lack of education about correct working posture, job stress etc[18].

The working environment of bus drivers can be improved by adopting regular resting times and providing places where bus drivers can recover from fatigue. In addition, a driver's seat with a neck support which can fix the cervical vertebrae should be provided to improve bus drivers' musculoskeletal symptoms, and armrests to reduce muscle tension around the shoulder joints.

Easily adjustable steering wheels should be provided for the ergonomical improvement of bad posture and for the prevention of excessive movement of the shoulder and wrist joints. Unnecessary movement of the upper extremities while driving should be prevented by changing the size of the steering wheel to match on the physical features of a driver. The positions of outside mirrors should be properly controlled and a backup camera should also be equipped to remove the need for excessive cervical extension and rotation.

The driver's seat should be adjusted to maintain the trunk joint angle in the range of 90° to 110° in order to improve the overall driving posture, and drivers should be educated to avoid greater than 90° of hip extension and greater than

60° of knee flexion to prevent excessive trunk joint extension while driving. Furthermore, a continuous management program by physical therapists is needed to teach exercise methods and postures that can relieve upper limb fatigue while driving.

As well as the improvements mentioned above, therapeutic intervention is also important. The advantage of stretching is that it can be conducted regardless of time, place, physical conditions, and special skills. In addition, continuous stretching can reduce musculoskeletal disease symptoms through flexibility improvement by decreasing muscle tension and pain[19, 20]. Research on the effects of stretching on musculoskeletal pain has reported that the pain score decreased from 5.52 before the intervention to 4.80 after stretching was performed for 4 weeks[21]. In addition, Kim study on the effect of stretching on VDT workers' upper extremity pain also reported a decrease in upper limb pain after the performance of stretching[22].

Neck and shoulder musculoskeletal subjective symptoms and pain were decreased by 4 weeks of stretching in this study. Post-intervention, there was a statistically significant decrease of 25% in subjective symptoms in the neck, and of 28% in the shoulder. The pain level of the most painful part of the neck and shoulders also significantly decreased. These findings are in agreement with Kim's study that reported a significant decrease in the pain level of workers at an automobile workspace[23], and Lee's study that reported a significant decrease in shoulder pain after stretching had been performed[24]. In other words, stretching is able to decrease the pain of occupational musculoskeletal disease.

In conclusion, performing stretching to treat musculoskeletal disease had a positive effect on subjective symptoms and reduced pain. Stretching treatments for musculoskeletal disease can prevent the lowering of concentration and impairment of judgment. Furthermore, the physical management of drivers can reduce their work load and the risk of traffic accident.

This study had some limitations. First, the results are difficult to generalize because of the small number of subjects. Since stretching was performed only by subjects following the instructions of physical therapists, the treatment was not continuously managed. In addition, we are not sure whether or not subjects performed stretching regularly, because exercise compliance was only evaluated with a self-administered check list. Besides, the correlation between musculoskeletal subjective symptoms and the incidence of traffic accidents was not investigated in this study. Based on the results of this study, research into self-intervention methods for the prevention and cure of workers' musculoskeletal disease should be continued.

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