AN ERGONOMICS INTERVENTION PROGRAM TO PREVENT WORKER INJURIES IN A METAL AUTOPARTS FACTORY

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Abstract. An ergonomics intervention program (EIP) was conducted with male employees working in the pressing and storage sections of a metal autoparts factory in Samut Prakan Province, Thailand. The objectives of this study were to assess the causes of injuries in the pressing and storage sections of that factory, and to improve working conditions by reducing worker injuries from accidents and low back muscular discomfort, using an EIP. The study design used a participatory research approach which was quasi-experimental with pretest-posttest evaluations, with a non-equivalent control group. A total of 172 male participants working in Building A were the target group for assessing causes of injury. A retrospective study of official accident information, and questionnaires for general information, health and muscular discomfort, injury frequency rate (IFR), injury severity rate (ISR), medical expenses, and EIP design. Two groups of employees volunteered for the study on muscular back discomfort. The first group of 35 persons volunteered to participate in the EIP (EIP group), and the second 17 persons from Building B did not (non-EIP group). The EIP was composed of 4 major categories: (1) engineering improvement, (2) change in personal protective equipment, (3) environmental improvement, (4) administrative intervention, training, and health education. Low back muscular discomfort was measured through questionnaires on subjective feelings of muscular discomfort, and by surface electromyography (sEMG). Muscle activities were measured by sEMG of the left and right erector spinae and multifidus muscles, and evaluated by multivariate test for dependent samples (paired observation), and multivariate test for two independent samples. After EIP, IFR decreased 65.46%, ISR decreased 41.02%, and medical expenses decreased 42.79%. The low back muscular loads of the EIP group were significantly reduced, with a 95% confidence level ($p<0.05$) while those of the non-EIPgroup were not. Subjective feelings of muscular discomfort, determined by Wilcoxon Signed Ranks test, showed that after applying the EIP to the EIP group, the mean scores for general bodily discomfort and low back muscular discomfort in the EIP group had significantly reduced, while those of the non-EIP group increased, ($p<0.05$).

INTRODUCTION

The International Labor Office (ILO) estimated that for global work accidents among workers, about 200,000 persons die annually and 120 million are injured or become ill. Fatality rates are alarmingly high in some developing countries in Asia, being several times higher than those of industrialized countries, about 30 to 43 per 100,000 workers. In many countries of Asia and the Pacific, where the number of workers injured varies depending upon national reporting procedures, accident rates were generally between 20 and 40 per 1,000 workers. For example, the accident rates of workers in Thailand, Malaysia, the Republic of Korea, Singapore, and Japan were 38, 25, 15, 10, and 4, respectively. These high accident rates may reflect a lack of adequate preventive measures in many workplaces (ILO, 1994).

In Thailand, from information based on the Workmen's Compensation Fund (WCF) (1998),

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the number of workers affected by work accidents increased from 49,874 in 1988 to 103,296 in 1991. There was also a sharp rise in the number of fatal cases, from 352 in 1988 to 665 in 1991. The annual rates for accidents per 1,000 workers for injuries and death were relatively high and stable, at 37, 39, 44, and 38, in 1988, 1989, 1990, and 1991, respectively. There was an obvious increase in ergonomics-related injury cases in the industries of Thailand. The Health Insurance Office (1998) reported in 1992 and 1997 that 6,600 and 15,406 cases of injury were caused by manual material handling, of which 1,907 and 4,389 suffered from unnatural working postures, respectively. This increase was approximately 2.3 times within a 6-year period.

The Division of Occupational Health (1998) reported that of the musculo-skeletal disorders (MSDs) of 2,595 workers studied in 300 factories of 48 provinces of Thailand, 78.5% were body pain, of which 52.4% was low back pain. MSDs were higher among female workers than males. Higher MSD rates was present in the older age groups. Working posture affected the MSDs the most.

Several studies have demonstrated the development of low back pain in the workplace in developed countries (NIOSH, 1997). To prevent low back pain, ergonomic interventions have been advocated to decrease workers' exposure to risk factors (Garg and Moore, 1992; Haag, 1992; Stobbe, 1996). Amongst the various ergonomic approaches, participatory ergonomics is increasingly popular. Participatory ergonomics consist of the workers' active involvement in implementing ergonomic knowledge and procedures in their workplace, supported by their supervisors and managers, to improve their working conditions (Nagamachi, 1995). Participatory ergonomics interventions have been associated with a decrease in the incidence of musculoskeletal symptoms (Garg and Owen, 1992; Vink and Kompier, 1997), a decrease in work absenteeism (Lanoie and Tavenas, 1996; Moore and Garg, 1998) and an improved psychosocial work environment (Laitinen *et al*, 1998). To date, participatory ergonomics has mostly been applied to the primary prevention of back pain (Garg and Owen, 1992; Lanoie and Tavenas, 1996; Moore and Garg, 1998).

The objectives of this study were to assess causes of injuries in the pressing and storage sections of a metal autoparts factory, and to improve working conditions by reducing worker injuries from accidents and low back muscular discomfort, using an EIP.

Conceptual framework

A conceptual framework was used in the EIP to prevent work accidents and low back muscular discomfort (Fig 1).

MATERIALS AND METHODS

Research design

The study design used a participatory research approach with a quasi-experimental pretest-posttest evaluation with a non-equivalent control group. The EIP was implemented from July to October 2003. The study design is shown in Fig 2.

Subjects

One hundred and seventy-two of three hundred male employees working in the pressing and storage sections in Building A of a metal autoparts factory volunteered for the study. These employees were assessed for causes of injury, injury frequency rate (IFR), injury severity rate (ISR), and medical expenses, before and after the EIP (Fig 1).

From Building A, a group of 35 persons volunteered for the study of muscular discomfort in the EIP (EIP group), while 17 persons from Building B did not (non-EIP group). The average age of the 35 employees was 26.91±5.52 years, body weight 62.37±7.36 kg, and height 169±4.92 cm. The average time working in the pressing and storage sections was 3.28±3.47 years. The control group of 17 employees had an average age, body weight, and height of 23.35±2.67 years, 61.59±6.15 kg, and 172.94±4.80 cm, respectively. Their average time working in the pressing and storage sections in Building B was 1.72±0.65 years.

Questionnaire

The questionnaire consisted of 2 sections. Section 1 had four parts: (1) general information, (2) health and muscular discomfort, (3) ac-

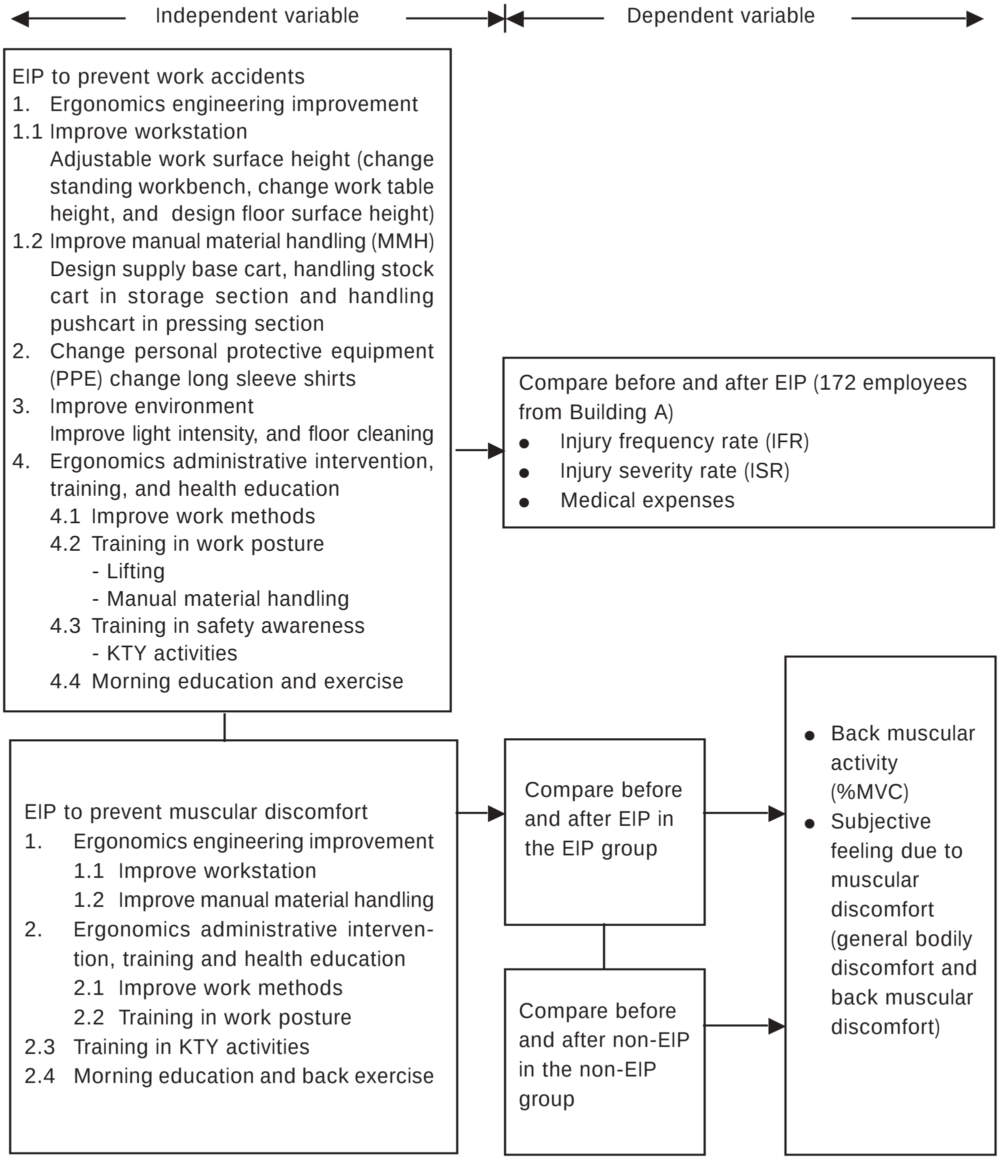

Fig 1–Conceptual framework.

cident information, and (4) postural disorder. Section 2 was about subjective feelings concerning muscular discomfort (Corlett and Bishop, 1976). A drawing of the body was divided into 13 parts and the organs were clearly indicated. The 13 parts were the neck, shoulder, upper arm, elbow, lower arm, hand, upper back, lower back, buttock, thigh, knee, leg, foot. Feelings of discomfort in the body parts were recorded according to the intensity of discomfort. The intensity scales consisted of 7 degrees, ranging from 0 to 7. The levels of discomfort scores were as follows: 0 means no discomfort, 1 to 2 slight discomfort, 3 to 4 moderate discomfort, 5 to 6 high discomfort, and 7 extreme discomfort.

IFR, ISR, and medical expenses

Accident records were collected every month from the safety official of the human resource management section of the factory. Accident records were collected twice to calculate IFR, ISR, and medical expenses; the first time

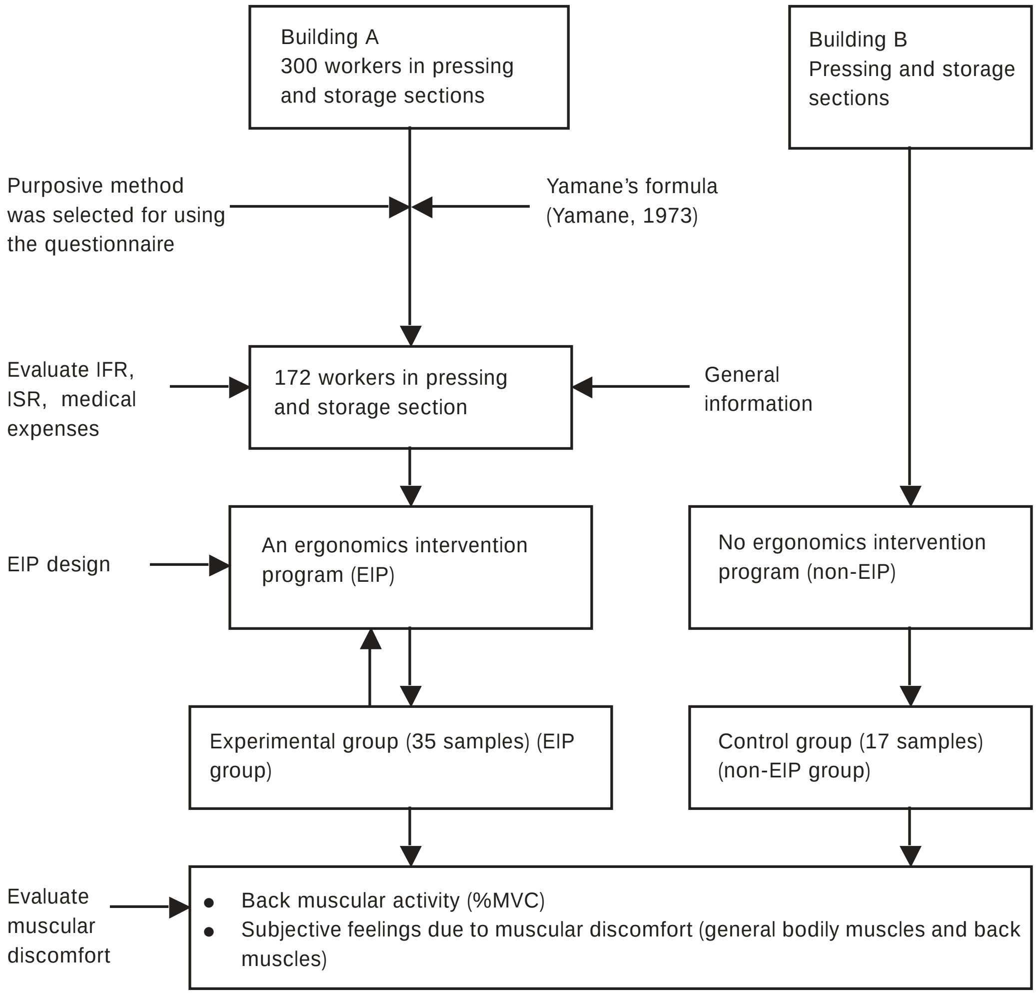

Fig 2–Study design.

was six months before the EIP (January-June, 2003), and the second was six months after the EIP (November 2003-April 2004). Means and percentages were used to calculate medical expenses. IFR, and ISR were calculated from accident statistics, as recommended by the International Labor Office (ILO, 1971), as follows:

(1) Injury frequency rate (IFR) accidents per 10^6 hours worked

$$= \frac{\text{Total number of accidents} \times 10^6}{\text{Total number of man-hours worked}}$$

(2) Injury severity rate (ISR) average number of days lost per 10^6 hours worked

$$= \frac{\text{Total number of day lost} \times 10^6}{\text{Total number of man-hours worked}}$$

Surface electromyography (sEMG)

All employees in the EIP group were asked to perform their tasks and be evaluated for muscular activity by electromyography (EMG), using a Muscle Tester ME 3000 (Mega Electronic Ltd, Finland). The method of measurement followed Cram *et al* (1998).

The back muscular load (%MVC) from the left and right of the erector spinae muscles and multifidus muscles were measured 3 times by electromyography on the same day. The first measurement began before work, at 7.30 hours The second measurement was during work, at 9.30 hours for lowering activity, and 9.35 hours for lifting activity. The third measurement was at 11.30 hours for the lowering activity, and 11.35

hours for lifting activity. The result of work measurement in the pressing and storage sections of the metal autoparts factory showed that each employee continuously lowered, lifted or transferred objects, at approximately 700 kg/hr.

In this study, the EMG measurements were performed twice: the first time was prior to conducting the EIP with the EIP group, and the second was after running the EIP for four months. Those in the non-EIP group had their muscle activities measured twice, the same as the EIP group, even though they did not receive any applied ergonomics program.

The percentage maximum voluntary contractions (% MVC) were calculated as follows (Solderberg, 1992):

$$\% \text{ MVC} = \frac{\text{Test AEMG} - \text{Resting AEMG}_1}{\text{MVC AEMG} - \text{Resting AEMG}_2} \times 100$$

where,

Test AEMG = Average EMG during the working period

Rest AEMG_1 = Average EMG during the rest period, before working

Rest AEMG_2 = Average EMG during the rest period before MVC testing (Sorensen test)

MVC AEMG = Average EMG during the MVC test (Sorensen test)

For statistical analyses, comparisons of the means of % MVC for back muscular activities, in which subjects served as their own controls, were performed in the EIP group. In the non-EIP group the multivariate test was used for dependent samples (paired observation). In order to elucidate the effect of the EIP on the EIP group, comparative statistical analyses of the EIP group and non-EIP groups were conducted by multivariate test for independent samples.

EIP

Based on the conceptual framework (Fig 1), the EIP was used to prevent working accidents and low back muscular discomfort. The EIP procedure was as follows:

Top management support. Prior to implementation of the EIP with the 35 EIP employees, meetings with top managers, the head safety officer of the Human Resource Section, and the heads of the pressing and storage sections were held to obtain full support and to sustain the program. A brief explanation of the potential EIP gave equal priority to health, well-being, production, quality, and safety.

Engineering design. The workstations and their environments, work methods, and tool and handle designs were observed at the job site during the working hours of the pressing and storage sections in Building A. The observations included the accommodation of the employees assigned to the workstations, tools and work methods, to eliminate occupational risk factors.

The anthropometry of the employees in the EIP group was studied. The 5^{th} and 95^{th} percentiles of elbow height were utilized to improve workstation and manual material handling, if necessary, for accommodating the workers' anthropometry as suggested by Sanders and Mc Cormick (1993).

Change to personal protective equipment (PPE). The PPE of the employees was examined and changed when it was necessary.

Environmental improvement. The workplace environment was improved in 2 respects, (1) light intensity, and (2) floor maintenance to reduce the slippery floor, other liquids, solids, and removing dropped objects.

Administrative intervention, training, and health education. The administrative intervention, training, and health education program primarily began with a meeting of top managers, safety officers, and the heads of the pressing and storage sections. The intervention sessions covered improving work methods, training in work posture, health education and training, and before-work warm-up exercises.

The health education and training sessions were provided in a classroom. The frequency of education and training was 7 times during the period from 19 July to 11 October 2003, and about 3 hours per session. The first five training courses were provided for workers and head workers. The last two training courses were for head workers, top managers and safety officers. Each employee in the EIP group, top managers, safety officers, and the heads of the pressing and storage sections were required to attend class at least once. In addition, the employees were free to decide to attend classes.

The education and training sessions were as follows: 1) Kiken yochi training (KYT) (Tanabae, 2000), 2) a brief lecture on the anatomy of the back with a laboratory demonstration, and 3) demonstration and practice of low back muscular exercise, as recommended by the Ministry of Public Health, which followed Selger *et al* (1998). Low back muscular exercise at home was encouraged as a self-health behavior for participants.

The KYT activity was comprised of the steps in the work to be done. First, all participants attended a short lecture, which demonstrated individual carelessness on the job, how accidents occurred, and ways to avoid accidents. The lecturer also generated employee involvement, and encouraged them to participate in safety and good-health outcomes. After the lecture, the participants were divided into small groups of 4. Each participant identified the work-related hazards found on his job site, considered together which was the most hazardous one, and then spoke loudly "zero accidents" to show their conscious intention to prevent accidents and to be safe.

The sessions for improving work methods at the workstation started in August 2003. These included arranging flexible working hours, such as night/day work rotations, and providing recreation areas near Building A. Work postures were individually observed during working hours and any unnatural work postures were corrected at the job site.

Before-work warm-up exercises were launched in September and ran through October 2003. The KYT activity and exercise were conducted every day in the morning, for about 5 to 10 minutes on Monday to Friday, and 15 minutes on Saturday.

Data collection process

Data collection was modified and developed by a job safety analysis model, techniques of accident prevention, ergonomic approach, approaches of system safety, work analysis model, and other basic information on ergonomics. There were 6 steps in data collection: (1) hazard identification, (2) problem identification and environmental aspects, (3) hazard assessment, (4) data collection before EIP, (5) ergonomic implementation, and (6) evaluation.

RESULTS

The results were divided into 5 parts, as follows:

1. Muscular discomfort status in the past 6 months. About 25% of the subjects had muscular pain or discomfort every day, 25% every week, and 25% every 2-3 months, with 40.7% of these being first aid for muscular pain during work, but continuing to work, and 37.8% stopping work. More than 70% (70.3%) of the treatment methods were self-massage, with 41.3% of employees' opinions about the cause of muscular pain was from work in the pressing section.

Twenty-one factors related to work postures and methods of moving products were found to cause risks of accidents for employees. These included awkward postures, such as bending the lower back, to lifting products from low levels (0.8187 ± SD, 0.3864), frequent reaching (0.7907 ± SD, 0.4080), always twisting the body to the side (0.7442 ± SD, 0.4376), wanting to sit in order to rest your feet (0.6919 ± SD, 0.4631), too much strength used for pushing or pulling (0.6628 ± SD,0.4741), and wanting to improve the workstation (0.6163 ± SD, 0.4877).

2. The IFR after the EIP decreased 65.46%, ISR 41.02%, and medical expenses 42.79%. The highest causes of injuries were sharp materials, unsafe personal protective equipment (unsafe gloves), and carelessness, respectively.

3. Anthropometric data and engineering design. Table 1 shows the anthropometric data (cm) of the employees in the EIP group, as values in the 5^{th}, 25^{th}, 50^{th}, 75^{th}, and 95^{th} percentiles. The 5^{th} and 95^{th} percentiles of elbow height (97.00±4.19, 111.20±4.19 cm) were utilized to improve workstation and manual material handling in the pressing and storage sections of Building A (Table 1).

Six types of equipment and workstations

Table 1
Anthropometric data of the EIP group (cm).

	Mean	SD	Percentile				
			5	25	50	75	95
Stature	169.39	4.51	161.80	166.00	169.00	172.00	176.00
Eye height	158.02	5.30	150.00	155.00	157.00	162.00	166.00
Shoulder height	139.67	5.76	133.60	137.00	139.00	144.00	147.00
Waist height	103.42	4.57	96.80	100.80	103.00	106.00	110.00
Elbow height	104.34	4.19	97.00	101.00	105.00	107.00	111.20
Knuckle height	65.41	3.32	60.80	63.80	65.00	68.00	72.00
Knee height	49.93	2.72	44.80	49.00	50.00	51.00	54.00
Ankle height	9.52	0.50	9.00	9.00	10.00	10.00	10.00

Table 2
Comparison of %MVC means for erector spinae and multifidus muscles of EIP and non-EIP groups, before application of EIP to the 35 employees in the EIP group.

Time	Position	Muscle	Group	Mean	SD	Hotelling's trace[a]	p-value
9.30 hours	Lowering	Left erector spinae	EIP	73.67	30.42		
			Non-EIP	68.52	37.10		
		Left multifidus	EIP	72.94	29.52		
			Non-EIP	57.54	26.50	0.076	0.474
		Right erector spinae	EIP	67.87	34.87		
			Non-EIP	57.04	32.63		
		Right multifidus	EIP	74.93	41.08		
			Non-EIP	63.80	41.30		
9.35 hours	Lifting	Left erector spinae	EIP	108.60	33.02		
			Non-EIP	104.27	38.88		
		Left multifidus	EIP	107.26	38.54		
			Non-EIP	121.63	40.58	0.091	0.385
		Right erector spinae	EIP	102.51	34.81		
			Non-EIP	108.03	55.11		
		Right multifidus	EIP	107.62	34.26		
			Non-EIP	105.16	41.72		
11.30 hours	Lowering	Left erector spinae	EIP	71.31	23.14		
			Non-EIP	59.23	29.77		
		Left multifidus	EIP	67.16	30.28		
			Non-EIP	46.33	22.67	0.171	0.108
		Right erector spinae	EIP	67.44	30.18		
			Non-EIP	65.63	34.60		
		Right multifidus	EIP	66.60	32.20		
			Non-EIP	55.60	31.68		
11.35 hours	Lifting	Left erector spinae	EIP	114.21	41.56		
			Non-EIP	111.49	65.99		
		Left multifidus	EIP	113.50	43.54		
			Non-EIP	108.51	46.05	0.049	0.683
		Right erector spinae	EIP	108.67	36.77		
			Non-EIP	94.77	44.01		
		Right multifidus	EIP	108.84	35.57		
			Non-EIP	98.56	47.29		

[a]Multivariate test for independent samples.

Table 3
Comparison of %MVC means for erector spinae and multifidus muscles of the EIP and non-EIP groups, after application of EIP to the 35 employees in the EIP group.

Time	Position	Muscle	Group	Mean	SD	Hotelling's trace[a]	p-value
9.30 hours	Lowering	Left erector spinae	EIP	48.71	19.68		
			Non-EIP	73.90	22.97		
		Left multifidus	EIP	50.08	19.90		
			Non-EIP	75.76	39.35	0.413	0.002
		Right erector spinae	EIP	46.11	21.91		
			Non-EIP	67.93	37.73		
		Right multifidus	EIP	48.88	21.63		
			Non-EIP	67.04	31.92		
9.35 hours	Lifting	Left erector spinae	EIP	68.21	26.75		
			Non-EIP	104.32	19.97		
		Left multifidus	EIP	71.40	26.58		
			Non-EIP	129.06	40.82	$^{b}T^2$ = 43.8338	0.000
		Right erector spinae	EIP	64.83	30.69		
			Non-EIP	112.23	42.20		
		Right multifidus	EIP	69.11	26.79		
			Non-EIP	105.64	37.96		
		Left erector spinae	EIP	50.27	23.92		
			Non-EIP	69.07	22.78		
		Left multifidus	EIP	48.64	20.94		
11.30 hours	Lowering		Non-EIP	64.88	24.62	0.299	0.014
		Right erector spinae	EIP	44.28	23.55		
			Non-EIP	65.77	24.97		
		Right multifidus	EIP	45.45	20.03		
			Non-EIP	59.26	18.39		
11.35 hours	Lifting	Left erector spinae	EIP	67.16	24.14		
			Non-EIP	109.34	38.77		
		Left multifidus	EIP	68.57	27.82		
			Non-EIP	125.63	51.30	$^{b}T^2$ = 28.8601	0.000
		Right erector spinae	EIP	66.07	26.60		
			Non-EIP	101.26	42.13		
		Right multifidus	EIP	68.16	22.92		
			Non-EIP	101.73	35.65		

[a]Multivariate test for independent samples.
[b]In case of unequal variance – covariance matrices.

in the pressing and storage sections of Building A needed to be designed or redesigned. After discussion and consideration with the top managers and supervisors of the pressing and storage sections, 6 engineering designs were built to fit the work to the employees. They were 1) changed standing work bench in the pressing section, 2) changed work table height in the pressing section, 3) designed floor surface height in the storage section, 4) designed supply base cart in the storage section, 5) changed handling stock cart in the storage section, and 6) changed handling pushcart in the pressing section.

The PPE of the employees studied consisted of changing the clothing from short-sleeved shirts to long-sleeved ones. This change was a factor in decreasing the risk of accidents from cutting injuries. The environmental improvement was composed of 2 categories: (1) light intensity was increased from 150-300 lux to 300-

400 lux, using skylights in the roofs and increasing the number of lamps. (2) floor maintenance was provided by two female house-keepers to clean up spills of oil, liquids, solids, and removing dropped objects.

4. Results of back muscular activity (% MVC) by electromyography.

The means and standard deviations for % MVC of the left and right erector spinae and multifidus muscles of the 35 employees in the EIP group, before and after application of the EIP, revealed significant changes in the low back muscular loads of the EIP group after receiving EIP. The means and standard deviations of %MVC of the left and right erector spinae and multifidus muscles of the 17 employees in the non-EIP group, measured before and after application of EIP to the EIP group, were apparent that the non-EIP employees had no significant changes in their low back muscular load.

Tables 2 and 3 show comparisons of the means and standard deviations of the %MVC between the 35 employees in the EIP group and the 17 employees in the non-EIP group. Statistical analysis showed that, before application of the EIP (Table 2), the means for the %MVC of low back muscular activity for the EIP group were not significantly different from those of the non-EIP group. However, after the application of EIP to the EIP group only, the means for low back muscular activity of the EIP group were significantly different from those of the non-EIP group ($p<0.05$) (Table 3).

5. The results of subjective feelings due to muscular discomfort, determined by the Wilcoxon Signed Ranks test, showed that after application of the EIP to the EIP group, the mean scores for general bodily discomfort and low back muscular discomfort of the EIP group had significantly reduced, while those of the non-EIP group increased, ($p<0.05$).

DISCUSSION

This study showed various working conditions and personal factors for employees working in the pressing and storage sections of a metal autoparts factory. These factors can increase the risk of developing injuries and MSD (OSHA, 2003). The more factors involved and the greater the exposure to each, the greater is the risk of developing a disorder.

For physical working conditions, repetition, force, awkward postures, and contact stress were present among the employees. According to work organization, stressful conditions were also found, for example, too much strength being used for pushing or pulling (0.6628±SD, 0.4741), improvement of areas for placing products from machines (0.6163±SD, 0.4877), and always twisting the body to the side (0.7442±SD, 0.4376).

The personal issues for the employees regarding their physical conditions were clearly shown in this study. Muscular discomfort ($p=0.059$) was a factor that influenced the physical unfitness of the employees (Prentice and Bucher, 1988). Poor personal fitness seems to be involved with several risk factors, such as 42.4% of 172 employees working overtime 3-4 days a week, with 35.5% of them working overtime every day; prolonged hours of work ($p=0.118$), causes of muscular discomfort (working in the small and large pressing sections) ($p=0.004$), and the frequency of muscular discomfort ($p=0.002$) (Poosanthanasarn and Lohachit, 2003).

In the EIP group, in which the subjects served as their own controls, the activities of left and right erector spinae and multifidus muscles showed significantly lower means of %MVC after EIP than before EIP. This evidence, therefore, demonstrates that low back muscular loads decreased after EIP application to these employees. In the non-EIP group, in which the subjects served as their own controls, the means for % MVC for the low back muscular activity of the control group, who did not receive EIP, were not significantly changed when the EIP was terminated with the EIP group. This result clearly shows that for the employees who worked in the workplace where the EIP was not applied, the low back muscular load was not reduced.

Comparison of the means for %MVC of the low back muscular activities of the EIP group with the non-EIP group, before and after application of EIP to the EIP group, (Tables 2, 3), clearly confirmed that the burden of low back muscular activity was less after the employees received the EIP. This was the same as the results for subjective feelings due to muscular discomfort after application of the EIP to the EIP group, the means scores of general bodily discomfort and low back muscular discomfort of the EIP group were significantly reduced, while those of the non-EIP group increased.

This study reveals the positive results of applying EIP to employees working in the pressing and storage sections of a metal autoparts factory. Ergonomic risk factors are synergistic elements to musculoskeletal disorder risks (Reese, 2003), and excessive exposure to these risk factors can lead to MSDs (OSHA, 2003). A participatory ergonomics intervention to reduce the risk factors for low-back disorders in concrete laborers has been shown to be an effective intervention in this occupation (Hess *et al*, 2004) as well as in other occupations (Garg and Owen, 1992; Lanoie and Tavenas, 1996; Moore and Garg, 1998) . Therefore, the application of EIP to the employees of the pressing and storage sections was an effective practice to reduce low back muscular discomfort in this factory.

In this study, the practical development of the EIP was through a better understanding, participation and appreciation of changes by the employees and administrative staff. Commitment by management provided the organizational resources and motivating force necessary to deal effectively with ergonomics-related hazards. Hence, management's support in this study was demonstrated at all organizational levels for the program to gain credibility and corporate-wide cooperation. In addition, with a human-centered design approach, for example, 6 types of engineering design for functions and tasks that could best be done by employees were provided to them, correction of work postures at the job site, health education and training, and before-work warm-up exercises with KYT constituted a sound, worthwhile project for reducing the low back muscular discomfort of the employees in this factory.

In conclusion, This study revealed the ergonomic risk factors of jobs or tasks that imposed biomechanical stress on the employees of a metal autoparts factory. These ergonomic risk factors were synergistic elements of musculoskeletal disorder hazards (Reese, 2003), and excessive exposure to these risk factors can lead to MSDs (OSHA, 2003).

By identifying and analyzing the ergonomic risk factors of the tasks in this study, and with the business and health perspectives, it is recommended that an ergonomics intervention program to prevent injuries,illnesses, or MSDs, should be provided for the employees of this factory. The IFR, ISR, and medical expenses were also decreased, and preventable injuries of the workers could be reduced (more than 10% of the national target of the Ministry of Labor and Social Welfare, Thailand). The program should include providing strong management support, active employee involvement, and providing training for employees, supervisors, managers, engineering and maintenance personnel (Hoyos and Zimolong, 1988; MacLeod, 1994; OSHA, 2003; Reese, 2003). Significant improvements, in the ergonomics of the workplace and work design, and in the competitiveness of many manufacturing companies in developed countries have already been demonstrated (Butler, 2003; Joseph, 2003; Moreau, 2003; Munck-Ulfsfalt *et al*, 2003; Smyth, 2003).

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Thus the applied ergonomics intervention program for preventing worker injuries in the sections studied should be implemented, in order to promote the health and well-being of the employees. View. Show abstract.Â An ergonomics intervention program (EIP) was conducted with male employees working in the pressing and storage sections of a metal autoparts factory in Samut Prakan Province, Thailand. The program needs to cover all levels of employee safety and health with the encouragement to report hazardous practices or behavior. Conduct pre-placement physicals. Some accidents are caused by inexperience and the inability to physically perform the position.Â Supplemental training in body mechanics can reduce strain injuries, and keep employees safe during lifting and moving. Research safety vulnerabilities. Every business is unique and doesnâ€™t necessarily have the same safety concerns. An ergonomics intervention program to prevent worker injuries in a metal autoparts factory. Southeast Asian J Trop Med Public Health 2005 Mar;36(2):512-22. Chhokar R, Engst C, Miller A, et al. The three-year economic benefits of a ceiling lift intervention aimed to reduce healthcare worker injuries. Appl Ergon 2005 Mar;36(2):223-9. Laing AC, Frazer MB, Cole DC, et al. Study of the effectiveness of a participatory ergonomics intervention in reducing worker pain severity through physical exposure pathways. Ergonomics 2005 Feb;48(2):150-70. Owen BD. Preventing injuries using an ergonomic approach