THE HEALTH OF WORKERS IN A METAL AUTOPARTS FACTORY IN EASTERN THAILAND

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Abstract. One hundred and seventy-two male employees working in the pressing and store sections of a metal autoparts factory in eastern Thailand participated in the study. The aim of this study was to survey the health and well-being condition of Thai workers prior to corporation initiatives in applied ergonomics with the workers of the company. A retrospective study of official accident information, and questionnaires regarding general information, health, muscular discomfort, accidents, posture disorders, and subjective feelings of fatigue or discomfort were filled out for the survey. The results of the study provided 48 categories of important information on the health and wellness of the employees in their workplace. Regression analysis revealed that, based on the working history of the employees, the small and large pressing sections of the workplace had a greater impact on the muscular discomfort of the employees (0.322) ($p = 0.001$). Based on the health information, the independent factors influencing the employee's muscular discomfort were frequency of muscular discomfort (0.240) ($p = 0.004$), no disease of muscle and bone (0.165) ($p = 0.025$), and finally, regularly taking medicine for muscular pain (0.163) ($p = 0.024$). The factors influencing accidents in the employees were working where they could be cut by sharp material or metal (0.257) ($p = 0.008$), muscular discomfort (0.169) ($p = 0.059$), and not using protective equipment (0.146) ($p = 0.076$). 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.

INTRODUCTION

In Thailand, the total number of work-related injuries increased during the period 1991 to 2001 (WCF, 2000, 2001). However, occupational injuries of Thai workers showed fluctuation in numbers. The total number of work-related injuries gradually increased during the first six years and reached a maximum of 245,816 in 1996. In the following three years, (1997, 1998, and 1999), the numbers of occupational injuries declined to 230,466, 186,582, and 172,087 cases, respectively, and then increased to 179,652 in the year 2000, and 189,752 in 2001.

In 2002, the Social Security Office (SSO) approved the payment of compensation for 191,046 employees with worked-related injuries or illness, both covered and not covered by the Workmen's Compensation Fund (WCF) (SSO, 2002). Of this number, 137,886 had less than 3 days off work, 49,031 had more than 3 days off work, 3,452 suffered loss of organs, 661 died, and 16 became invalids. Of the total of 191,046 work-related injuries and illnesses, 190,979 were covered by the WCF. The rate of employment injuries per 1,000 employees for the year 2002 was 29.20. This was a decrease from the 2001 figure of 34.20 per 1,000 employees.

In order to reduce workers' injuries and illnesses, attention to the working environment is integrated into the ordinary work tasks of various manufacturing industries in Thailand. The health and well-being of Thai workers are currently considered as important factors, along with the working environment, and increasing productivity and profitability. Many occupational health and safety activities have been launched in industries. The activity inclusion criteria are that they mainly address physical factors in the workplace and document involvement by the company. In order to achieve the vision of safe,

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injury/illness-free employees, and to facilitate continual improvement in quality and total cost for today and in the future, the use of ergonomic processes has become an important part of a comprehensive health and safety process, as well as an integral part of engineering systems (Joseph, 2003; Munck-Ulfsfalt *et al*, 2003).

During the 1990s, interest in broad ergonomic issues grew as a result of an increasing awareness of the importance of the matter for corporate core values, such as productivity, quality and an inevitable change process (Wilson,1999). The implementation of ergonomics programs varies substantially depending on the type of company, its policies and organization (Hagg, 2003). In order to incorporate applied ergonomics within a company, information on the conditions of health, injury and illness of the employees is an important factor. This study, therefore, aims at a survey of the health and well-being of Thai workers in a metal autoparts factory in eastern Thailand. The results obtained will serve as basic information for the corporate initiatives in applied ergonomics program to prevent worker injuries and to promote the health and well-being of the employees in the company.

MATERIALS AND METHODS

One hundred and seventy-two of 300 male employees who were working in the pressing and store sections of a metal autoparts factory, in the eastern part of Thailand, participated in the study. These two sections were studied because of their cumulative record of accidents, work-days off, non work-days off, and treatment costs, which were the highest in the company. This study was granted ethical approval by the Faculty Research Ethics Committee.

Data were collected by means of a retrospective study of the official accident information, and self-completed questionnaires. The retrospective study involved reviewing all monthly files of official accident information, from January through December of 2002, for cases of work-related illness or injury. The collected data included basic data for hours worked each month, all first-aid incidents (incidents that required treatment) in case numbers and accident rates, lost work-day cases (1 or more days) in numbers of days, and accident rates. The descriptions of the accidents for each patient, and medical expenses, were also recorded.

Other data were collected by means of self-completed questionnaires which had been explained prior to distribution to all volunteering employees. The questions were derived from Hoyos and Zimolong (1988), Dul and Weerdmeester (1993), and Simachokdee and Chaiyakul (1997). They consisted of 5 major aspects of general information, health, muscular discomfort, accident information, postural disorders, and a subjective feeling of muscular discomfort. General information included age, height, weight, eyesight history, education, working position, and responsibility. Health and muscular discomfort questionnaires involved health status, health behavior, medical records, accident history and muscular problems. The accident information included the extent and nature of injury, part(s) of the body injured, and the cause(s) of injury. Postural disorder information involved bending, twisting, pushing, pulling and reaching activities of the employees at their workstations.

Information on subjective feelings of muscular discomfort was elicited by the method described by Corlett and Bishop (1976) (Fig 1). A drawing of the body was divided into 13 parts with the parts clearly indicated. The 13 parts were the neck, shoulders, upper arms, elbows, lower arms, hands, upper back, lower back, buttocks, thighs, knees, legs, and feet. The 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 extremely discomfort.

The statistical analyses used were descriptive statistics and hierarchical regression analysis. All data obtained were analyzed using descriptive statistics, expressed as percentages, mean, and standard deviation. These analyses included information on working posture and moving metal products, in order to obtain fac-

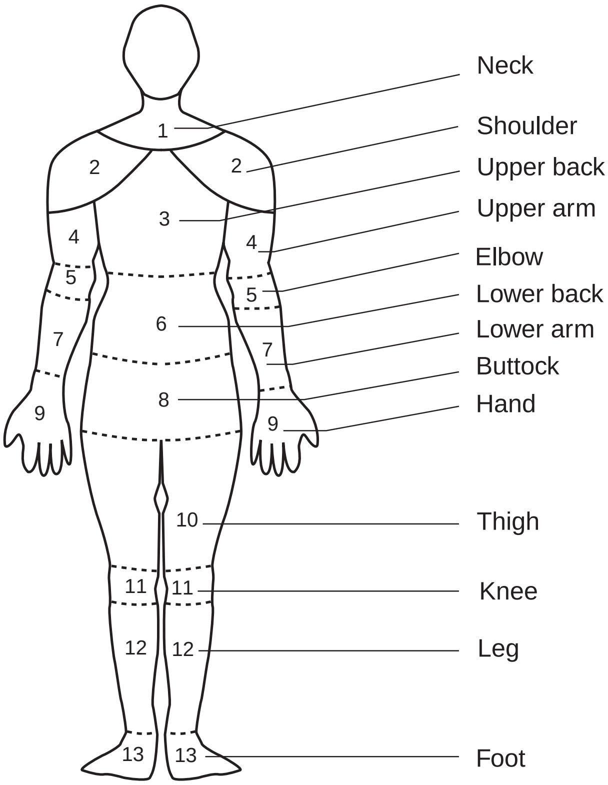

Fig 1–Diagram of the body used to describe muscular discomfort.

tors that cause the risk of accidents in employees. Hierarchical regression analysis was employed to analyze general information, work history, and health information, in order to reveal the levels of muscular discomfort. It was also used to analyze the independent variables that were obtained from the study, in order to indicate the factors that influenced the accidents of the employees.

RESULTS

Most of the male employees studied were young, with 75% between 20 and 29 years old, 22.1% between 30 and 39 years, and 2.9% between 40 and 49. They were 69.2% single, 29.1% married, and 1.8% divorced. Most of the employees were educated; 47.1% graduated from Mattayom 6 (high school), 37.2% Mattayom 3, and 1.2% with a bachelors degree. Their height profile ranged from 150 cm to 185 cm, of whom 15.7% were 165 cm high, 12.2% 170 cm, and 0.6% 150, 154, 156, 157, 159, 161, and 164 cm. Their weights ranged between 48 and 75 kg, of whom 15.2% weighed 60 kg, 12.2% 65 kg, and 1.2% 69 kg. Most of the employees had normal eyesight (81.4%); however, 6.4% had myopia, 11.0% hyperopia, and 1.2% astigmatism.

With regard to workstation, about 83.7% of the employees worked in the small and large pressing sections. The rest of them, 16.3%, worked in the store section. They commonly worked overtime 3-4 days per week (42.4%), every day, 35.5%, and 1-3 days per week, 12.8%. At the pressing section, 41.3% of the employees worked with a general pressing machine, while 17.4, 11.6, 11.6, and 7% worked with 250, 200, 500, and 1000-ton machines respectively. Eighty point eight percent of the employees had static work, while the rest (19.1%) had dynamic work.

Health analysis revealed that most of the employees consumed no regular medicine, had ever had a disease or accident of the musculature or bones, rheumatism, or ever shown neuropathy of the hands or legs. Most seldom exercised, smoked or drank liquor.

During the previous six months, the part of the employees' bodies that presented with muscular pain while working in the pressing and storage sections were the waist, thigh, and upper back, with means of 1.8895, 1.5872, and 1.4942, respectively. When the levels of muscular discomfort were specified for the 13 parts of the body, muscular discomfort was commonly found at the waist (0.5930±SD 0.4927), shoulder (0.3372±SD 0.4741), neck (0.3198±SD 0.4677), and upper back (0.2849±SD 0.4527).

Concerning the frequency of muscular pain, it occurred once every 2-3 months for 25.6%, 25.0% every day, 25.0% every week, and 5.8% every month. While working, the employees tried to reduce their discomfort by muscular movement without stopping work (40.7%), 37.8% stopped work for a while, and 21.5% took various other actions.

During the past 3 months, most of the employees had no serious accidents while they were working. However, some of them had one experience being cut by metal, slipping and falling on a slippery floor, caught in a machine, or had a foreign body in the eye. Various causes of injury were revealed, in which carelessness was the primary factor (0.4012±SD 0.4916), followed by a sharp material (0.3256±SD 0.4700), and not wearing personal protective equipment (0.2384±SD 0.4273).

According to working postures and the moving of metal products, at least 21 factors were found to cause a risk of accident for the employees (Table 1). These included awkward postures, such as bending the lower back to lift products from low levels (0.8187±SD 0.3864); frequent reaching (0.7907±SD 0.4080); frequent twisting the body to the side (0.7442±SD 0.4376); wanting to sit in order to rest their feet (0.6919±SD 0.4631); using too much strength for pushing or pulling (0.6628±SD 0.4741); and improvement of the area for placing the product from the machine (0.6163±SD 0.4877).

Table 2 presents the levels of muscular discomfort of the studied employees by regression analysis. It was found that the workstations in both the small and large pressing sections caused the greatest impact on the muscular discomfort of the employees (0.339) (p=0.001). From the health information about taking medicine regularly, frequency of muscular discomfort during the past 6 months, and the causes of muscular discomfort, the independent factors influencing the employee's muscular discomfort were frequency of muscular discomfort (0.240) (p=0.002), followed by workstations in the small and large pressing sections (0.205) (p=0.004), no disease of muscles and bone (0.165) (p=0.025), and finally, regularly taking medicine (0.163) (p= 0.024).

Table 3 shows the levels of accidents in relation to various factors found in the employees involved with workstations, work organization and management, behavior and environment.

Table 1
Risk factors for injury in working postures and moving metal products (N=172).

Description	Mean	Std deviation
1. Always bent lower back to lift products from low levels	0.8187	0.3864
2. Arm(s) often raised over shoulders	0.3023	0.4606
3. Always twisting the body to the side	0.7442	0.4376
4. Often reaching	0.7907	0.4080
5. The object lifted was slippery, had a sharp edge or no handle	0.4767	0.5009
6. The object was placed too high, thus injury occurred	0.2674	0.4439
7. The object was placed too low, thus lifting by bending	0.5464	0.4993
8. Repetitive, without changing motion	0.5058	0.5014
9. Want to sit in order to rest your feet	0.6919	0.4631
10. Too much product parts placed thus accident occurred	0.5233	0.5009
11. Improvement of area for placing product from machine	0.6163	0.4877
12. Too narrow working area, thus always twisting the body	0.3605	0.4815
13. Man-machine inappropriate	0.5523	0.4987
14. Always had accident when transferring products	0.1163	0.3215
15. Moving products by your own strength very often and over a long period of time	0.5233	0.5009
16. Moving products by your own strength for a long distance	0.2674	0.4439
17. Weight of product lifting while standing over 16 kg	0.2500	0.4343
18. Too much strength used for pushing or pulling	0.6628	0.4741
19. Difficulty in moving product by its appropriate size	0.4651	0.5002
20. Difficulty in moving products which prevent vision	0.1163	0.3215
21. Difficulty in moving products on floor not smooth or of various levels	0.4186	0.4948

Table 2
Levels of discomfort by regression analysis.

Variables[a]	B	Beta	p-value (sig)	B	Beta	p-value (sig)	B	Beta	p-value (sig)
Constant	1.983		0.000	28.867		0.425	94.746		0.016
AGE	3.028E-02	0.042	0.632	-3.072	-0.116	0.258	-3.484	-0.131	0.173
MST	3.241E-02	0.040	0.646	0.694	0.026	0.766	-0.285	-0.011	0.896
EDU	3.114E-02	0.037	0.645	1.923	0.123	0.146	1.670	0.107	0.171
HGH	-0.116	-0.151	0.089	-0.102	0.041	0.649	-9.955E-02	-0.040	0.627
WHT	-0.101	-0.140	0.089	-9.410E-02	-0.050	0.566	-9.816E-02	-0.053	0.525
EYE	0.133	0.118	0.141	-1.040	-0.071	0.373	-0.831	-0.057	0.438
WKT				12.423	0.339	0.001	9.761	0.266	0.008
YEAR				0.271	0.074	0.498	0.461	0.126	0.207
OT				-9.942E-03	-0.003	0.966	1.869E-02	0.006	0.930
WKT1				2.538E-02	0.004	0.967	7.021E-02	0.010	0.902
WKT2				-0.323	-0.011	0.907	-1.374	-0.045	0.583
HLF1							-8.646	-0.163	0.024
HLF2							-7.476	-0.165	0.25
HLF3							-1.635	-0.047	0.545
HLF4							-5.722	-0.064	0.367
HLF5							-1.288	-0.025	0.743
HLF6							-2.608	-0.118	0.100
HLF7							-2.075	-0.075	0.324
HLF8							4.069	0.121	0.099
HLF9							-2.183	-0.240	0.002
HLF10							-0.820	-0.046	0.546
HLF11							-1.552	-0.025	0.004
R2	0.055			0.013			0.351		
SEE	0.3591			13.1165			11.7365		
F	1.601, p = 0.150			2.155, p = 0.091			3.645, p = 0.000		

[a]Independent, General information: AGE=age, MST=marital status, EDU=education, HGT=height, WGT=weight, EYE=eye sight; Working history: WKT=workstation, YEAR=year(s) working, OT=overtime, WKT1=size of product involved, WKT2=transferring product(s); Health information: HLF1=regular medicine taken, HLF2=no disease of muscles and bone, HLF3=accident of muscle and bone, HLF4=rheumatism, HLF5=neuropathy, HLF6=exercise, HLF7=smoking, HLF8=drink alcohol, HLF9=frequency of muscular discomfort, HFL10=reduce muscular discomfort while working, HLF11=causes of muscular discomfort.

Among the independent variables, it was shown that being cut by a sharp edged material or metal sheet was related to accidents while working. Regression analysis revealed that the factors influencing accidents were: being cut by a sharp edged material or metal sheet (0.257)(p=0.008), muscular discomfort (0.169)(p= 0.059), and unsafe personal protective equipment (0.146) (p=0.076).

DISCUSSION

This study showed various working conditions and personal issue factors of employees working in the pressing and store sections of a metal autoparts factory. These factors can increase the risk of developing injuries and musculoskeletal disorders (MSDs)(OSHA, 2003). The more factors involved, the greater the exposure to each, the higher the chance of developing a disorder.

In the physical working conditions, repetition, force, awkward posture, and contact stress were present among the employees (Table 1). In work organization, stressful conditions were also found. Too much strength was needed for push-

Table 3
Levels of accident by regression analysis.

Independent variables	B	Beta	p-value (sig)
(Constant)	0.929		0.004
Cut by sharp edge or metal sheet	1.008	0.257	0.008
Cut while moving manufactured products	-5.679E-02	-0.009	0.914
Compression	-0.817	-0.063	0.552
Pinching	-7.402E-02	-0.008	0.944
Struck against	0.494	0.048	0.720
Fall-same-level	-0.511	-0.133	0.178
Fall-to-below	-0.729	-0.068	0.492
Foreign body in the eye	0.238	0.051	0.538
Sharp tool	0.574	0.105	0.190
Man-machine inappropriate	2.636E-02	0.003	0.973
Defective tool or equipment	-0.439	-0.065	0.440
Untidy objects	0.166	0.026	0.769
Unavoidable job	6.105E-02	0.007	0.931
Did not put on personal protective equipment	-7.942E-03	-0.001	0.988
Unsafe personal protective equipment	1.022	0.146	0.076
Carelessness	-0.531	-0.102	0.268
Lack of training	-0.477	-0.074	0.421
Prolonged hours of work	-1.283	-0.138	0.118
Lack of health behavior	6.223E-02	0.007	0.939
Muscular discomfort	1.240	0.169	0.059
Inappropriate working environment	1.134	0.125	0.208
Other	-0.929	-0.028	0.708

ing or pulling (0.6628±SD 0.4741), improvement of the area for placing product from the machine (0.6163±SD 0.4877), and frequently twisting the body to the side (0.7442±SD 0.4376) were all noted factors.

Personal issues were clearly shown in this study. Muscular discomfort (0.169) (p=0.059) (Table 3) was a factor that influenced the physical unfitness of the employees (Prentice and Bucher, 1988). Poor personal fitness seemed to be involved with several risk factors, such as 42.4% of 172 employees working overtime 3-4 days a week, and 35.5% of them working overtime every day, prolonged hours of work (0.138) (p=0.118) (Table 3), causes of muscular discomfort (working in the small and large pressing sections) (0.205) (p=0.004) (Table 2), and the frequency of muscular discomfort (0.240)(p=0.002).

In conclusion, this study revealed the ergonomic risk factors that are the aspects of a job that impose biomechanical stress on employees at a metal autoparts factory. These ergonomic risk factors are synergistic elements of musculoskeletal disorders (Reese, 2003), and excessive exposure to these risk factors can lead to MSDs (OSHA, 2003), and therefore, a variety of injuries and illnesses.

By identification and analysis of 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 and illnesses, or MSDs, should be provided for the employees of this factory. The program should include providing strong management support, active employee involvement, and provide training for employees, supervisors, managers, engineering and maintenance personnel (Hoyos and Zimolong, 1988; MacLeod, 1994; OSHA, 2003; Reese, 2003). Significant improvements, both in terms of the ergonomics of the workplace and work design, but also 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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