MUSCULOSKELETAL DISORDERS REDUCTION BY USING ANTI-FATIGUE MATS AMONG WORKERS IN A FURNITURE MANUFACTURING FACTORY IN EASTERN THAILAND

Anamai Thetkathuek[1]*, Praveena Meepradit[1], and Saksith Kulwong[1]

[1]*Department of Industrial Hygiene and Safety, Faculty of Public Health, Burapha University, Chonburi, 20131 Thailand*

[*]For correspondence; Tel. + (66)38-102740 Email: anamai@buu.ac.th

ABSTRACT: *The purpose of this study was to compare the effects of anti-fatigue mats with the perception of musculoskeletal disorder symptoms of 33 workers in the sample group, who were workers at an MDF wood furniture manufacturing factory. Data collection was conducted through a musculoskeletal-disorders questionnaire, and a risk assessment form using the EATA technique in order to assess the aspects of the workstations and the working posture while standing and working. A randomized controlled trial (RCT) was studied at MDF manufacturing furniture in Thailand. The study was randomly assigned to a control and an intervention group. Anti-fatigue mat was a method of ergonomics that was prepared and put on the floor of the working area in the intervention group, with 1-month intervals between sessions. After completion of the using anti-fatigue mat, then the study subjects were interviewed regards musculoskeletal disorders. The risk assessment result using the EATA technique of the workstation showed that the working area was solid without an appropriate mat, and the working posture required repetitive use of the same muscles without resting. The study showed that when the severity of the disorder was classified after the use of anti-fatigue mats, the severity of the disorder was reduced. The comparison results of the musculoskeletal disorder symptoms among workers before and after testing the anti-fatigue mats showed the reduction of pain found in several parts of the body. The severity of neck pain, shoulder pain, elbow pain, thigh pain, upper back pain, and lower back pain decreased compared to the pain symptoms before testing with the anti-fatigue mats. The statistical significance was at .05. Therefore, it is advisable to use anti-fatigue mats to support working areas. It should cover all working spaces where the workers are susceptible to risks, in order to reduce musculoskeletal disorder symptoms.*

Keywords: musculoskeletal disorder; furniture manufacturing factory; anti-fatigue mats; Thailand

1. INTRODUCTION

The tasks required at industrial factories, including furniture factories, are often unhealthy. For instance, workers may be requested to lift heavy or bulky items, to work with repetitive postures or to have awkward working postures [1-4]. They may also have to stand for long hours per day [5]. The standing work for extended hours can contribute to discomfort [5], so that musculoskeletal disorder symptoms can be found at the feet, legs, and lower back those results from extended hours of standing work [6-8]. The pain includes neck pain, shoulder pain, upper back pain, lower back pain, hand pain, and joint pain [2, 9, 10].

Regarding the benefits of an ergonomics assessment, it can prevent and reduce disorders derived from the discomfort and musculoskeletal pain symptoms. It can also reduce medical expenses [11]; can reduce working time loss [12], and can maintain productivity [13]. The ergonomics risk assessment can be conducted by several methods, such as an observational methodology, namely the Rapid Entire Body Assessment (REBA) method [14], and by the Ergonomic Assessment Tool for Arthritis (EATA) technique [15]. EATA is a popular technique for the risk assessment of musculoskeletal disorder symptoms, especially work-related arthritis. Currently, there aren't many studies on work-related arthritis for standing work. Previously, there were studies of the assessment of the effects of arthritis among professional computer users [16]. The future goals of risk classification for workers [17] are to manage the ergonomic challenges, such as workstation improvement and working postures.

Discomfort reduction approaches and the alleviation of musculoskeletal disorder (MSD) can be achieved by ergonomic approaches comprised of applying anthropometric data, reducing the number of repetitions, reducing the force required, and eliminating awkward positions as much as possible [18]. The majority of the time the workers in the furniture manufacturing factory are obliged to stand for an extended period. Therefore, the appropriate design for the working space is essential. Working facilities should include anti-fatigue mats, ergonomic chairs, and footrests. The working-space design can be arranged by ergonomic programs such as training, management, and exercise programs [18].

The use of anti-fatigue mats is popular in industrial factories to reduce discomfort resulting from extended hours of standing work. There was a comparative study of anti-fatigue mats resulting from fatigue caused by Hard surfaces in which volunteers were asked to stand on different types of surfaces for one-four hours in the laboratory [8,19]; and there was a study conducted on the working space for one week [20-21]. Most of the studies' results were recorded by subjective ratings after standing on anti-fatigue mats (Madeleine et al., 1998), and the discomfort found on different body parts was also recorded [19-20].

Previously, there were studies that investigated the reduction of muscle injuries among industrial factory workers by using the no-slip mats, including surface coverage by anti-fatigue mats [6]. In addition, there was a comparative study under controlled conditions in which the study group was asked to stand on four types of anti-fatigue mats for four hours. The study showed that the level of discomfort was decreased among groups that stood on three types of mats (out of four types) [5]. There was also a study indicating the benefits of the mats in the workplace in reducing the discomfort of back pain [22]. However, there hasn't been any academic evidence which has indicated that the use of anti-fatigue mats can alleviate musculoskeletal disorders found in the body parts of workers at a furniture manufacturing factory, which could be used as a guideline in eradicating the risks for

musculoskeletal disorder symptoms in the future. The objectives of this study were to compare the effects of anti-fatigue mats with the perception of musculoskeletal disorder symptoms of workers at an MDF furniture manufacturing factory in Eastern Thailand, who had to stand to work for an extended period.

2. METHODOLOGY

The methodology of this research was the cross-sectional study. The study was conducted from April to August 2015.

2.1 Study Population and the Size of the Sample

The study population in this study included 33 workers at a furniture manufacturing factory in Chachoengsao Province. The researcher received consent forms from the participants to be volunteers in this study.

2.2 Research Ethics

Regarding research ethics, all informants who had been selected to participate in this research were given information without any coercion. Consent forms were signed before participating as volunteers in this study. The study was approved by the Committee of Research in Humans at Burapha University.

2.3 Tools and Data Collection

The tools and data collection consisted of the following: 1) Questionnaires; and 2) Risk Assessment Forms on the Workstation and on Working Postures. The data collection details were as follows:

2.3.1 Questionnaires

The sample group was requested to complete the form comprised of four sections. Section One included the demographical and social aspects, comprising gender, age, educational background, marital status, smoking history, and alcohol drinking history. Section Two was the current work information, comprising working duration, working hours per day, the number of working days per week, and the resting period after work per day, respectively. Section Three was the smoking and alcohol consumption history, including the current smoking habit, the period of smoking (years), and alcohol drinking information, which included whether they were currently drinking, and the frequency (times per week) -- slightly drinking, having one drink per week, having two-three drinks per week, having more than four drinks per week. Section Four was the ergonomics risk assessment according to the perception of the workers, using the Nordic Musculoskeletal Questionnaire (NMQ). The component of the NMQ consisted of general questions inquiring about the body areas where the cause of the musculoskeletal disorder was present. Pictures of the nine body areas were displayed so that the informants could indicate the location of the disorder. The picture of the nine body areas included both hand joints, upper back, lower back, hip, thigh, knee, ankle, neck, shoulder, elbow (right elbow, left elbow or both elbows), wrists, and hands, right wrist, left wrist, right hand, and left hand, respectively.

Informants were requested to indicate the muscles and bones problems in the different parts of the body where there were problems within the past 12 months or 7 days, using the typical preventive measurement by rating the level of the body parts' pain. The answers ranged from 0 to 10 (the least to the most). The score was classified later as low range from 0-3; medium range from 4-7; high range (critical symptoms) from 8-10, respectively. There was a follow-up question for the musculoskeletal disorder concerning information about the past 12 months and the past 7 days. After 10 weeks of using the mats, the questions about the disorders were again asked. The questionnaire was adapted from the Nordic Musculoskeletal Questionnaire, which evaluated the postural stress of potters and sculptors [23]. Next, it was translated into Thai. The marking score was divided into two levels: 0 for no symptoms, and 1 for having symptoms, respectively.

2.3.2 Risk Assessment Forms on the Workstation and on Working Postures

Regarding the risk assessment form on the workstation and working postures, the risk assessment used was the Ergonomic Assessment Tool for Arthritis (EATA) [15], which assessed the aspects of the workstation (standing work) as well as the aspects of working posture (standing work) among workers who performed their tasks in the production process, as shown in the following details.

The researcher assessed the aspects of the workstation and working posture by using a video recording in the nine working departments. The video could be paused for cropping and snapshots to assess the workstation aspect (standing work). Ten items of questions were given, including the following: a solid working area without an appropriate standing mat; the sole of shoes which couldn't adequately support the weight of the body; very heavy clothes; a working area which wasn't easily accessible; work requiring continuality without resting; a workstation that was lower than the level of hip and elbow; a standing duration that was longer than ten minutes without moving or resting the feet; the front of a workstation that couldn't be adjusted; the front of workstation that was too high or too low; and the front of workstation that was out of reach, respectively.

Regarding the working posture (standing work), eight items of questions were given including the following: bending the neck or bending while standing; bending the back while standing; the hand was at the level of the knee or below the level of the knee; the hand was at the level of the head or above the level of the head; the hands were straight at all times; bending the wrist; the same muscles were used repetitively without resting; a tiny working area with a narrow place to rest the feet; the need for a space to put the feet while working; climbing ladders; bending the knee while seated; and constant walking. The marking score was divided into two levels: a "No" answer was marked 0 and a "Yes" answer was marked 1, respectively.

2.3.3 The Validity of the Research Tools

The validity of the research tools was ensured. In Section One, the researcher had submitted the developing questionnaire to the experts for them to review and verify the accuracy of the structure, contents, and language use. The team of experts consisted of two physicians specializing in occupational medicine, and one lecturer specializing in occupational hygiene and safety. After the revision by the experts, corrections were made according to the experts' suggestions. The researchers experimented with the tools to find out the problems and the limitations during the interview, and then adjusted and improved the data collection process.

2.4 Data Analysis

Statistical analysis of the data was conducted from a statistical software package for data analysis. The result of the data was presented in tables, frequency, percentage, means, standard deviation, median, minimum score, and maximum score to explain the variations.

The study compared the symptoms of musculoskeletal disorder before and after the use of anti-fatigue mats by using the Pair T-Test for statistical data analysis.

3. RESULTS AND DISCUSSION

The study on the factors of the effects of the musculoskeletal disorders among the sample group of 33 workers at the MDF wood furniture manufacturing factory in Eastern Thailand showed the following:

3.1 Demographical Information

Regarding demographical information, the number of informants in the sample group was 33. The majority of the informants were females (66.7%). Other information included the following: their average age was 40.55 (SD 9.50) years; 45.5 % completed primary school education; 15.2% used to smoke cigarettes; and 9.1% consumed alcohol drinks, as shown in Table 1.

Table 1. Subject characteristics

Subject characteristics	**Department**								N=33 (%)
	Combination N=5 (15.2%)	***Edging N=5 (15.2%)***	***Fitting N=5 (15.2%)***	***Drilling N=2 (6.1%)***	***Laminating N=5 (15.2%)***	***Wrapping N=5 (15.2%)***	***Packing N=1 (3.0%)***	***Line N=5 (15.2%)***	
Male	1(20.0)	3(60.0)	0(0.0)	1(50.0)	2(40.0)	3(60.0)	0(0.0)	1(20.0)	11(33.3)
Female	4(80.0)	2(40.0)	5 (100.0)	1(50.0)	3(60.0)	2(40.0)	1(100.0)	4(80.0)	22(66.7)
Past Smoking	1(20.0)	3(60.0)	0(0.0)	0(0.0)	1(20.0)	2(40.0)	0(0.0)	0(0.0)	7(21.2)
Current Smoking	0(0.0)	2(40.0)	0(0.0)	0(0.0)	1(20.0)	2(40.0)	0(0.0)	0(0.0)	5(15.2)
Current Drinking Frequency/Wk	0(0.0)	2(40.0)	1(20.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	3(9.1)

3.2 Working History

The majority of the workers (36.4%) had been working for 6-10 years. Other information included the following: their average working years were 9.43 (SD 6.89) years; 100% of the informants were working overtime; 38% had more than 10 hours of overtime per week; and the average overtime was 5.06 (SD 5.12) hours, as shown in Table 2.

Table 2. Work history

Work History	**Department**								
	Combination N=5 (15.2%)	***Edging N=5 (15.2%)***	***Fitting N=5 (15.2%)***	***Drilling N= 2 (6.1%)***	***Laminating N=5 (15.2%)***	***Wrapping N=5 (15.2%)***	***Packing N=1 (3.0%)***	***Line N=5 (15.2%)***	***N=33 (%)***
Work Duration (Yr) Mean)SD)	15.4 (8.73)	9.6 (6.80)	7.5 (7.35)	19.5 (9.19)	7.42 (5.54)	7.40 (3.51)	-	5.32 (2.79)	9.43 (6.89)
Md (Min,Max)	20 (5,24)	9 (1,20)	5 (0.5,18)	19.5 (13,26)	7.5 (0.58,15)	8 (3,12)	-	7 (0.58,7)	8 (0.50,26)

3.3 Workstation Aspect Assessment (Standing Work)

Regarding the results of the workstation aspect assessment (standing work) from the nine departments, the study found the following: that the surface in the working area didn't have mats to support their feet; the tasks required workers to work without resting (no pause during working hours); the standing duration with no movement or rest for the feet was longer than 10 minutes, which was equivalent to 100%, as shown in Table 3.

3.4 Working Posture Assessment (Standing Work)

The results of the working posture assessment (standing work) from the nine departments showed the following: workers had to bend while standing; there was also neck bending and wrist bending; and there was the repetitive use of the same muscles without resting, which was equivalent to 100%, as shown in Table 4.

3.5 The Musculoskeletal Effect before Using the Anti-fatigue Mats

The symptoms of musculoskeletal disorders before using the anti-fatigue mats were the following: 66.7% of workers had thigh pain symptoms; 63.6% of the workers had lower back pain symptoms; and 60.6% had neck pain symptoms, as shown in Table 5.

3.6 Musculoskeletal Disorder Symptoms Classified by the Period of the Disorder before Using the Anti-fatigue Mats

Regarding the period of musculoskeletal disorders among workers before testing, it was found that during the seven days before testing, the majority of the workers (73.7%) had developed ankle pain and feet pain symptoms, followed by knee pain, which was equivalent to 66.7%. Also, during the previous 12-month period, it was found that the majority of the workers (45.0%) had neck pain symptoms, 42.1% had upper back pain symptoms, and 40.9% had shoulder pain symptoms, as shown in Table 5.

3.7 The Musculoskeletal Effect after Using the Anti-fatigue Mats

Regarding the musculoskeletal effects after using the anti-fatigue mats, the study found the following: 54.5% of the workers had the wrist and hand pain symptom; 51.5% had the thigh pain symptoms; 45.5% had the shoulder pain symptoms; and 45.5% had the lower back pain symptoms, as shown in Table 5.

3.8 The Severity of Musculoskeletal Disorder Symptoms

Regarding the severity of musculoskeletal disorder symptoms among workers before the testing with the anti-fatigue mats, it was found that the majority of the workers (66.7%) had thigh pain and shoulder pain symptoms. Regarding the hip and thigh pain, 18.2% developed severe symptoms; 77.3% developed moderate symptoms; and 4.5% developed slight symptoms. For the shoulder pain symptoms, 22.7% developed severe symptoms; 59.1% developed moderate symptoms; and 18.2% developed slight symptoms. Regarding lower back pain (which affected 63.6% of the workers), 28.6% developed severe symptoms; 61.9% developed moderate symptoms, and 9.5% developed slight symptoms.

Table 3. Assessment of workstation aspect (standing work)

Workstation Aspect	Department								
	Combination N=5 (15.2%)	***Edging N=5 (15.2%)***	***Fitting N=5 (15.2%)***	***Drilling N= 2 (6.1%)***	***Laminating N=5 (15.2%)***	***Wrapping N=5 (15.2%)***	***Packing N=1 (3.0%)***	***Line N=5 (15.2%)***	***Total***
.1 Working Area without Appropriate Standing Base	1	1	1	1	1	1	1	1	9
2. The Sole of the Shoes which Cannot Adequately Support the Weight of the Body	0	0	0	0	0	0	0	0	0
3. Very Heavy Clothes	0	0	0	0	0	0	0	0	0
4. Working Area which Is Not Easily Accessible	0	0	0	0	0	0	0	0	0
5.Work Requiring Continuality without Resting	1	1	1	1	1	1	1	1	9
.6 Workstation Is Lower than the level of the hip and Elbow	0	0	0	0	1	0	0	0	2
.7 Standing Duration Is Longer than M 10inutes without Moving Feet or Having Rest for the Feet	1	1	1	1	1	1	1	1	9
8. The Front of the Workstation Cannot Be Adjusted	1	1	1	1	1	1	1	1	9
9. The Front of the Workstation Is Too High or Too Low	0	0	0	0	1	0	0	1	2
10. The Front of the Workstation Is Out of Reach	0	0	0	0	0	0	0	0	0
Total	4	4	4	4	6	4	4	5	

Regarding the severity of musculoskeletal disorder symptoms after testing with the anti-fatigue mats, it was found that the ankle pain and foot pain symptoms were the highest symptoms among the majority of the workers (60.6%). Specifically, 5% developed severe symptoms; 35.0% developed moderate symptoms, and 18% developed slight symptoms. As for wrist and hand pain symptoms, 5.6% developed severe symptoms; 72.2% developed moderate symptoms; and 22.2% developed slight symptoms, as shown in Table 6.

3.9 The Comparative Results of the Musculoskeletal Disorders of Occupational Workers before and after Testing with the Anti-Fatigue Mats

In order to prevent the effects of musculoskeletal disorders, the comparative results of the musculoskeletal disorders of the occupational workers before and after testing with the anti-fatigue mats have found that after using the anti-fatigue mats, the workers showed fewer pain symptoms on the neck, shoulders, elbows, upper back, lower back, thigh, feet and toe than before testing with the anti-fatigue mats. The statistical significance was .05, as shown in Table 7.

According to this study, it was found that before using the anti-fatigue mats, 66.7% of the workers had thigh pain symptoms; 63.6% had lower back pain; 57.6% had ankle and foot pain, and 45.5% had knee pain. After using the anti-fatigue mats, 51.5 % of the workers had thigh pain symptoms; 54.5 % had lower back pain; 18.2% had ankle and foot pain, and 42.2% had knee pain. Regarding the score before and after using the anti-fatigue mats, the test score of the musculoskeletal disorders found every body part was affected differently before and after the test. The statistical significance was at ($p<0.05$), except the hands and the wrists. Therefore, the use of anti-fatigue mats reduced musculoskeletal disorders, especially the lower parts of the body, which corresponded to the study indicating that the use of a carpet to support the standing area reduced lower extremity fatigue. It was also found that a longer period of standing on the carpet prevented the lower extremity fatigue [24], which corresponded to the study of the mats that showed different mats created differences in discomfort [7,8,20].

Table 4. Assessment of working posture (standing work)

Working Posture	Department								
	Combination	***Edging***	***Fitting***	***Drilling***	***Laminating***	***Wrapping***	***Packing***	***Line***	***Total***
	N=5 (15.2%)	N=5 (15.2%)	N=5 (15.2%)	N= 2 (6.1%)	N=5 (15.2%)	N=5 (15.2%)	N=1 (3.0%)	N=5 (15.2%)	N=33
.1Bending While Standing or Bending the Neck	1	0	1	1	1	1	1	1	9
.2 Bending While Standing or Bending the Back	0	0	0	0	1	0	0	0	2
.3 The Hand Is at the Level of the Knee or Below the Level of the Knee	0	0	0	0	0	0	0	0	0
.4 The Hand is at the Level of the Head or Above the Level of the Head	0	0	0	0	0	0	0	0	0
.5 The Hands Are Straight at All Times	0	0	0	0	0	0	0	0	0
.6 The Wrist Is Bent	1	1	1	1	1	1	1	1	9
.7 The Same Muscles Are Used Repetitively Without Resting	1	1	1	1	1	1	1	1	9
.8 Legs									
S 8.1uch as a Slope or Moving Standing Base	0	0	0	0	0	0	0	0	0
T 8.2iny Working Area with a narrow area to rest the feet	0	0	0	0	0	0	0	0	0
8.3The Need for Space to Put the Feet While Working	0	0	0	0	0	0	0	0	0
8.4 Climbing Ladders	0	0	0	0	0	0	0	0	0
8.5 Bending the Knee While Seated	0	0	0	0	0	0	0	0	0
8.6 Constant Walking.	0	0	0	0	0	0	0	0	0
Total	3	2	3	3	4	3	3	3	

Table 5. Symptoms of Musculoskeletal disorders before and after using anti-fatigue mats

Body Area	Time Since Onset	Before using Anti-Fatigue Mats	After using Anti-Fatigue Mats	N=33 (100%)
	M 12onths Before	***D 7ays Before***		
Neck Pain	9(45.0)	11(55.0)	14(42.0)	20)60.6(
Shoulder Pain	9(40.9)	13(59.1)	15(45.5)	(66.7)22
Elbow Pain	5(38.5)	8(61.5)	7(21.2)	(39.4)13
Wrist and Hand Pain	7(38.9)	11(61.1)	18(54.5)	18(54.5)
Upper Back Pain	8(42.1)	11(57.9)	9(27.3)	19(57.6)
Low Back Pain	7(33.3)	14(66.7)	15(45.5)	21(63.6)
Hip and Thigh	8(36.4)	14(63.6)	17(51.5)	(66.7)22
Knees	5(33.3)	10(66.7)	14(42.4)	15(45.5)
Ankles	5(26.3)	14(73.7)	6(18.2)	19(57.6)

Table 6. The percentage of workers classified according to the severity of the body areas with pain before and after using the anti-fatigue mats

Body Area	Level of Pain Severity)Pre-Test(			N=33 (100%)	Level of Pain Severity)Post-Test(			N=33 (100%)
	Little (0-3)	*Medium (4-7)*	*Severe (8-10)*		*Little (0-3)*	*Medium (4-7)*	*Severe (8-10)*	
Neck Pain	(35.0)7	(65.0)13	0(0.0)	(60.6)20	5(35.7)	9(64.3)	0(0.0)	14(42.4)
Shoulder Pain	(18.2)4	(59.1)13	(22.7)5	(66.7)22	(33.3)5	(66.7)10	(0.0)0	(45.5)15
Elbow Pain	(7.7)1	(54.6)11	(7.7)1	(39.4)13	(28.6)2	(28.4)5	(0.0)0	(21.2)7
Wrist and Hand Pain	3(16.7)	11(61.1)	4(22.2)	18(54.5)	(22.2)4	(72.2)13	(5.6)1	(54.5)18
Upper Back Pain	2(10.5)	15(78.9)	2(10.5)	19(57.6)	(33.3)3	(66.7)6	(0.0)0	(27.3)9
Low Back Pain	2(9.5)	13(61.9)	6(28.6)	21(63.6)	(26.7)4	(66.7)10	(6.7)1	(45.5)15
Hip and Thigh	1(4.5)	17(77.3)	4(18.2)	22(66.7)	(35.3)6	(58.8)10	(5.9)1	(51.5)17
Knees	0(0.0)	13(86.7)	2(13.3)	15(14.5)	(50.0)7	(50.0)7	(0.0)0	(42.4)14
Ankles	0(0.0)	14(73.7)	5(26.3)	19(57.6)	(60.0)12	(35.0)7	(5.0)1	(60.6)20

Table 7. The comparison of the musculoskeletal disorders before and after the workers were tested using the anti-fatigue mats

Symptom	Test	N	$\overline{x}$	S.D.	t	Sig.
Neck Pain	Before	33	2.57	2.57	2.321	0.027
	After	33	1.58	2.09		
Shoulder Pain	Before	33	3.58	3.07	3.782	0.001
	After	33	1.82	2.22		
Elbow Pain	Before	33	2.12	2.82	3.061	0.004
	After	33	0.85	1.80		
Wrist and Hand Pain	Before	33	2.88	3.06	1.353	0.186
	After	33	2.24	2.36		
Upper Back Pain	Before	33	3.21	3.13	3.946	0.000
	After	33	1.03	1.91		
Low Back Pain	Before	33	3.79	3.41	2.812	0.008
	After	33	2.15	2.71		
Hip and Thigh	Before	33	3.88	3.07	4.376	0.000
	After	33	1.42	1.66		
Knees	Before	33	2.70	3.16	3.440	0.002
	After	33	1.00	1.32		
Ankles and foot	Before	33	3.76	3.48	4.067	0.000
	After	33	1.36	1.34		

However, this study did not include the differences of musculoskeletal disorders and the duration that the workers stood on the anti-fatigue mats.

Therefore, the study was not able to predict the efficiency of the use of the anti-fatigue mats in terms of how many hours the mats might reduce the discomfort. If it can reduce discomfort for an only certain period of time, it is advisable to find preventive-ergonomic measures to reduce additional discomfort; for example, the study conducted by Wiggermann N and Keyserling [5] found significant differences of discomfort rating among workers who had to stand into the fourth hour at work. It also corresponded to the study conducted by Redfern [7], who found the differences of the discomfort into the third and fourth hour while standing at work. However, if the use of some anti-fatigue mat type is not efficient, the level of discomfort can increase. According to this study, 100% of the workers who performed standing work had worked for eight hours per day and their average overtime hours were 5.06 (SD 5.12) hours, which increased the level of fatigue.

The result of the workstation aspect assessment (standing work) from the nine departments showed the following: none of the departments had appropriate mats; the workers had to work continually without resting, and 100% of the workers had static posture for more than 10 minutes without moving or having rest for the feet. The result of the working posture assessment (standing work) from the nine departments showed that the workers had to bend the neck and wrists and that 100% of the workers had to use the same muscles of the same area repetitively without resting.

Therefore, the factory's management should provide the anti-fatigue mats to the workers who are categorized as the risk group at all working areas to reduce the fatigue symptom. Rest for the feet must be provided for workers who have been working for more than 10 minutes without moving the muscle. If possible, the working posture should be adjusted according to individual physical aspects, such as the height of the front work to reduce bending. Adjusting tools which can reduce wrist-twisting should be used so that the muscles can be stretched while resting to reduce the spasms of the muscle resulting from an extended period of working. Chairs must be provided for workers at the wrapping department to eliminate the squatting position.

The limitation of this study is that the assessment of musculoskeletal disorders was a self-assessment (self-reports of the Nordic questionnaire). The informants didn't have a medical checkup from a physician. Therefore, the frequency of the disorder can be higher than in reality. Also, before and after testing anti-fatigue mats, musculoskeletal disorders were not assessed by the experiment method.

4. CONCLUSIONS

The conclusion of the study found that there were differences in the musculoskeletal disorder before and after testing the anti-fatigue mats. Therefore, the use of anti-fatigue mats can reduce the musculoskeletal disorder of the arm muscles, lower extremity, and low back pain resulting from an extended period of standing work. The mats should be used to prevent the effects of fatigue among workers in the risk group who had to stand while working for an extended period of time. However, the use of the anti-fatigue mat was tested for only 10 weeks. There is no measurement to determine whether the stability deteriorates with time and prolonged standing, which should be included in further studies.

5. REFERENCES

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