



The Effect of Anti-Fatigue Mat and Stretching on Musculoskeletal Disorders (MSDs) Complaints of Sewing Operator PT. X

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ABSTRACT

Musculoskeletal complaints are experienced by 1.71 billion people in the world, contributing to disability, pain and reducing work productivity. In Indonesia, the prevalence of MSDs is 11.9%, and the top position with 65.2% of cases was the garment sector. The garment sector generally applies a sitting posture, but at PT X all sewing operators work in a standing posture. Long-term standing poses a risk to health, muscles, skeleton and other body parts. To determine the effect of using anti-fatigue mats and stretching on MSDs complaints of sewing operators. Using a quasi-experiment by dividing the respondents into 4 groups. The total population is 156 sewing operators, and samples that meet the criteria are 112 people. Data analysis used paired T-test. There is no effect of stretching on the level of MSDs complaints (p-value = 0.745), there is no effect of using anti-fatigue mats on MSDs complaints (p-value = 0.326), and there is an effect of using anti-fatigue and stretching mats on MSDs complaints (p-value = 0.006). It is known that the combination of the use of anti-fatigue mats and stretching has an effect on MSDs complaints, the suggestion is all sewing operators can implement the program optimally and effectively every day.

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INTRODUCTION

Musculoskeletal Disorders (MSDs) are disturbances or damage to the skeletal system and muscles of the human body as a result of an imbalance in a load of activity on the ability of the muscles and skeleton which has an impact on worker productivity, both directly and indirectly (Laksana and Srisantyorini, 2020). Musculoskeletal complaints are experienced by 1.71 billion people in the world and contribute to the number of disabilities and decreased abilities (WHO, 2021).

In Indonesia, the prevalence of MSDs is 11.9%. Research in an industrial area in Jakarta regarding musculoskeletal complaints, the garment industry has the highest position with 65.2% of cases (Dwi Astuti et al., 2021). Sewing operator are susceptible to musculoskeletal disorders, especially in the neck and waist area due to a static sitting position, non-

ergonomic chairs, repetition of movements, and high work speed (Livandy and Setiadi, 2018).

In general, the garment sector applies for a sitting position, but in PT X all sewing operators work in a standing posture. The company's internal data in May 2021 obtained 32 sewing operators complaining of pain in the legs in the first place, followed by pain in the waist and shoulders. The company has an ergonomics program that includes the distribution and use of anti-fatigue mats and the implementation of stretching for all sewing operators to handle the risk of MSDs complaints.

Anti-fatigue mats are a mat made of PVC foam material with a soft and warm surface that aims to improve balance and distribute pressure evenly on both feet. In a study conducted by Prof. Dr. Redha Taiar is known that muscles on hard floors have to work harder to achieve balance and reaction speed, which causes fatigue (Taiar, 2012).

Stretching is a training to reduce musculoskeletal complaints, increase blood circulation, improve body flexibility, to improve physical function (Van Eerd et al., 2016).

Based on initial observations at PT X, there was a policy change in April 2021 where all workers are required to wear shoes. For this reason, researchers are interested in conducting experiments related to the effect of using anti-fatigue mats after the policy of using shoes is implemented. While in the stretching program, the stretching movements have been adjusted to the body parts that are at risk of experiencing muscle fatigue, including the head, shoulders, arms, back, waist and legs. However, about 33% of sewing operators do not follow the movement seriously and precisely. From this background, the researchers wanted to know the effect of using anti-fatigue mats after the policy of using shoes and stretching on MSDs complaints on sewing operators.

METHOD

The research uses a quantitative research approach with a quasi-experimental study design. This study uses an intervention on the sample in the form of using anti-fatigue mats and stretching for 5 days which aims to determine the effect of using anti-fatigue and stretching mats on MSDs complaints. The study was conducted on sewing operators at PT X from September to October 2021. The population in the study was 156 workers, and the sample was 112 workers who met the criteria as active workers, sewing operators, aged > 18 years, willing to participate in the intervention program for 5 days, and has no bone disease or abnormalities due to injury, osteoporosis, genetic disorders, and degenerative diseases.

The intervention was carried out by dividing the respondents into 4 groups, namely:

1. Group T0: as a group that was not given anti-fatigue mats and did not do stretching,
2. Group T1: the group that was not given anti-fatigue mats but did stretching.
3. Group T2: the group that was given anti-fatigue mats but did not do stretching
4. Group T3: the group that was given anti-fatigue mats and did stretching (combination).

The mats used is made from PVC foam material specially designed as an anti-fatigue mat. And stretching movements include movements in the head and neck, shoulders, arms, back body, legs covering the legs, ankles and soles of the feet, which are carried out for 3 minutes 30 seconds.

The data collection technique in this study used a Nordic Body Map (NBM) questionnaire to determine the level of musculoskeletal complaints before the intervention and after the intervention on day 5. The research instruments used were a questionnaire on Musculoskeletal Disorders (MSDs), pen, body scales, microtome, ruler, video stretching, computer, and speakers. The data analysis technique used univariate and bivariate analysis using paired T-test with SPSS version 25 software. This study has passed the ethical code of the Faculty of Public Health with the number 313/EA/KEPK-FKM/2021.

RESULTS

General Description

PT X is one of the companies engaged in garment manufacturing with the product being apparel. The company has a working period with a system of 5 working days per week and 8 working hours per day. Daily rest time is set after 4 hours of work with a duration of 30 minutes, and for daily rest time on Saturday and Sunday. The company also provides canteen, food and drinking water facilities, a parking area, and an air-conditioned workplace.

PT X has processed from receiving raw materials, checking raw materials, cutting, sewing, packing, and checking the quality of finished garments to delivery. Of all processes, the sewing process is the core process where the operator must combine all the panels that have been cut and sewn into a finished garment product. In general, garment companies in Indonesia design sewing operators with a sitting posture, but at PT X they design all sewing operators with a standing posture. Standing work posture is an attitude of physical and mental alertness where work can be done faster, stronger, and more thorough. But the impact on fatigue, the emergence of pain disorders of the spinal muscles (Primestar, 2017). PT X divides the sewing process into several teams where each team consists of 14 sewing operators with settings around 18-20 sewing machines with various specifications so that each sewing operator can operate 2 to 4 machines

Description of Respondents Characteristics

Characteristics of respondents based on age, years of service and BMI of sewing operators can be seen in the table 1.

Table 1 shows that the majority of respondents are 18-25 years old (86%), have a working period of 6-12 months (42.9%), with the majority of BMI 67.9% of respondents being in the category of underweight.

Table 1.
Characteristic of Respondents

Characteristics	n	%
Age		
18-25 years old	86	76.80
26-35 years old	22	19.60
36-46 years old	4	3.60
Years of service		
< 6 months	19	17.00
6-12 months	48	42.90
>1-2 years	14	12.50
>2 years	31	27.70
BMI		
Underweight	76	67.90
Normal	30	26.80
Overweight	6	5.40

Source: Primary data, 2021

The Effect of Anti Fatigue Mats and Stretching on the Level of Musculoskeletal Complaints before and after intervention on Sewing Operators at PT X

Measurement of the level of complaints of musculoskeletal disorders in sewing operators was carried out using a Nordic Body Map questionnaire before the

intervention to become the initial data and repeated on the 5 th day after the intervention to obtain the final data. The following is the distribution of MSDs complaints to sewing operators at PT X, which can be seen in the following table 2.

Table 2 shows that the level of musculoskeletal complaints in sewing operators has several variations in each group. In group T0 there was an increase in the frequency of moderate complaints from 29.3% to 50% and very high from none (0%) to 7.1% after the intervention. In group T1 there was 57.1% of respondents at the time of pre and post complained of low level and there was a slight decrease in frequency from high to moderate category. Meanwhile, in the T2 group, there was an increase in the frequency at the low to moderate level after intervention by 7.1%, while at the high level it was still the same in the pre and post-test. In the T3 group, there was a decrease in the level of complaints from moderate and high to low (78%) after the post-test. And complaints at a high level from 7.1% to none (0%). The results of the analysis of the effect of using anti-fatigue mats and stretching carried out in the four groups can be seen in the table 3.

Table 3 shows that the change in the level of complaints in groups T0 and T3 has a p value of less than 0.05 which indicates a difference in the level of complaints of MSDs before and after intervention. In the T1 and T2 groups, the p-values were greater than 0.05, namely 0.745 and 0.326, so there was no significant difference in MSDs complaints before and after intervention.

Table 2.
Distribution of Musculoskeletal Disorders Complaints on Sewing Operators at PT X

Criteria	Complaints of Musculoskeletal Disorders			
	Pre-Test		Post-Test	
	n	%	n	%
Group T0				
Low	11	39.3	6	21.4
Moderate	11	39.3	14	50.0
High	6	21.4	6	21.4
Very high	0	0	2	7.1
Group T1				
Low	16	57.1	16	57.1
Moderate	10	35.7	11	39.3
High	2	7.1	1	3.6
Very high	0	0	0	0
Group T2				
Low	12	42.9	10	35.7
Moderate	14	50.0	16	57.1
High	2	7.1	2	7.1
Very high	0	0	0	0
Group T3				
Low	17	60.7	22	78.6
Moderate	9	32.1	6	21.4
High	2	7.1	0	0
Very high	0	0	0	0

Source: Primary data, 2021

Table 3.
Test Results of the Effect of Anti-fatigue and Stretching Mats on the Complaint Level of MSDs on Sewing Operators at PT X

Pre-Post Complaints MSDs	Mean	SD	T	df	P Sig. (2-tailed)
Ex T0	-0.321	0.612	-2,780	27	0.010
Ex T1	0.036	0.576	0.328	27	0.745
Ex T2	-0.071	0.378	-1,000	27	0.326
Ex T3	0.250	0.441	3,000	27	0.006

DISCUSSION

Age

From the results of the study, about 78% of respondents were aged 18-25 years and were evenly distributed in all experimental groups, both groups T0, T1, T2 and T3. Where the age range according to Novita's research is included in the unrisk age (below 30 years) in the incidence or complaints of Musculoskeletal Disorders (Novita Sari et al., 2017). But that does not mean that the age range below 30 years does not have a risk of developing musculoskeletal disorders. At the age of 20-29 years a person has maximum muscle strength, but continues to decrease with age. Decreased muscle ability can occur influenced by other factors including work and environmental factors (Tarwaka, 2015).

Working Period

In the results of the study, it is known that from all respondents, about 42.9% have a working period of 6-12 months. This is due to the large number of new workers recruited at the end of 2020 and early 2021. Meanwhile, based on the experimental group, groups T0 and T4 have the most respondents with 6 -12 months of service, which is more than 53% and 78%, respectively. Meanwhile, in groups T1 and T2, respondents with more than 2 years of service were the most in the group.

There are several studies related to the tenure of musculoskeletal complaints, Helmina's research on nurses shows a relationship between working period and MSDs complaints (p = 0.014), because the longer, more frequent, and repeated every day can lead to MSDs complaints (Helmina, Diani and Hafifah, 2019). Riningrum's research on sewing operators also proves that 57% of workers with more than 4 years of service experience complaints of low back pain

As for the contradicting research, the results of working period of laundry worker less than 5 years which are categorized as unrisk working period, it is known that 18 respondents still experience MSDs complaints (Oley, Ria Avilia; Suoth, Lery F; Asrifuddin, 2018).

Body Mass Index

The results of the research respondents showed that 67.90% were included in the underweight category and 26.8% in the normal category. If classified according to the WHO Body Mass Index, the condition is underweight (<18.5 kg/m²), including abnormal weight conditions. Under conditions of abnormal weight, including underweight, overweight and obese, a person is at risk of experiencing musculoskeletal disorders such as osteoporosis, osteoarthritis, circulatory disorders, weakness, etc (Purnawijaya and Aidatmika, 2016).

BMI < 18.5 has a seven times greater risk of osteoporosis than normal or overweight people. This is due to the low

achievement of peak bone mass and high bone loss (Andini, 2019). Meanwhile, excessive BMI is at risk of increasing mechanical stress due to gravity on the musculoskeletal system. This can cause fatigue, disturbances in the joints that support the body (waist, knees) to the appearance of Osteoarthritis (OA) and Rheumatoid Arthritis (RA) as the cause of musculoskeletal disorders (Purnawijaya and Aidatmika, 2016).

The Effect of Anti Fatigue Mats and Stretching on the Level of Musculoskeletal Complaints before and after intervention on Sewing Operators at PT X

Musculoskeletal complaints are disorders experienced by a person due to significant work conditions and activities that affect the musculoskeletal system which includes nerves, tendons, and muscles (Luik, Ratu and Setyobudi, 2021). The results of research conducted in 4 groups using the Nordic Body Map (NBM) questionnaire, showed that at the time of the pretest the average respondents complained of MSDs at low (39.3% to 60.7%) and moderate (32.1% to 50%). After intervention in groups T0, T1, and T2, it was

found that there was an increase in the frequency of moderate and high levels of complaints. Meanwhile, in the T3 group, it is known that there is a decrease in frequency from high to medium and low levels.

Working posture standing for approximately 8 hours of work poses a risk. According to research, standing for 90 minutes causes discomfort in the feet, legs, and back as well as shoulder and neck stiffness (Wiggermann and Keyserling, 2013). In the working posture of standing for a long time, the calf muscles contract and pump blood back to the heart. Contracted muscles cause blood circulation to narrow and collect in the lower leg area as illustrated in figure 1, so that the heart will pump harder without realizing it, causing fatigue (Redfern and Cham, 2000).

In the T0 group, it is known that the results of the T test indicate the influence of the intervention on musculoskeletal complaints. This is supported by the results of calculating the level of Musculoskeletal complaints using the Nordic Body Map at the time after the intervention there was an increase to moderate (50%) and very high (7.1%). In the T0 group, all sewing operators worked on the floor and when stretching they just stood without doing any stretching movements.

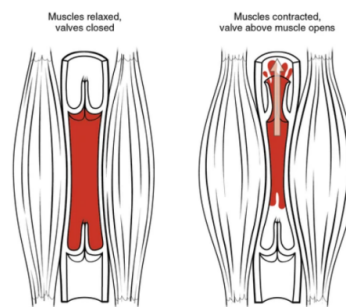


Figure 1. Muscles relax and muscles contract
Source: (First Mats, 2021)

In line with King's research, on hard floor surfaces, the most complaints of pain, discomfort, and fatigue are known to be compared to the use of a combination of shoe soles and anti-fatigue mats (King, 2002). The study by Sakthi on sewing operators standing working posture, which shows high musculoskeletal complaints in body parts, there was left leg (13.9%), right leg (10.7%), knee (left 10.3% and right 6.3%), thigh, lower back, legs, and neck. As many as 81% of respondents reported MSDs complaints about one to two times per week, while 25% felt MSDs complaints several times a day. The high prevalence of MSDs complaints can be reduced by providing anti-fatigue mats, chairs, or places to lie down during rest, stretching, and effective work rotation (Sakthi Nagaraj, Jeyapaul and Mathiyazhagan, 2019).

In the T1 group who had done stretching but did not use an anti-fatigue mats, complaints of pain in the limbs were still felt, especially the feet (foot, ankle, calf). The stretching movement has been designed for 3 minutes 30 seconds, starting from the movement of moving the neck and head, shoulders, arms and hands, body and back, legs, ankles, to the soles of the feet with each movement for 5 counts. Stretching the muscles of the limbs make a person in a condition ready to work, flexibility, relax stressed muscles, to reduce the risk of injury (Committee, 2015). This is in line with Gasibat's research that stretching cannot prevent musculoskeletal disorders. Other studies on the effect of stretching are not very significant and only reduce the risk of injury by 5% (Gasibat, Bin Simbak and Abd Aziz, 2017).

In the T2 group, which used anti-fatigue mats but did not do stretching, there was also no significant difference. The result contradicted with Aghazadeh's research on 15 respondents who stood on two different types of floors for 2 hours. In this study, the floor types were divided into hard floors and anti-fatigue mats by measuring bilateral gluteus medius co-activation and subjective pain levels using Electromyography (EMG) and Visual Analogue Scale (VAS). In the results of research, it is known that anti-fatigue mats are effective in reducing low back pain (Aghazadeh et al., 2015).

In the T3 group, which combined the use of anti-fatigue and stretching mats, there were differences in the level of MSDs complaints. Until now, research on the combination of the use of anti-fatigue and stretching mats on MSDs complaints has not been found. However, several separate studies on the impact of anti-fatigue and stretching as an effort to reduce the risk of Musculoskeletal Disorders have been carried out in recent years.

The use of anti-fatigue mats has been explored in several industries, especially for manufacturing, health, or industries that require workers to be in a standing posture. When standing the foot is an important part of the body to interact with the mat, whether standing, walking or running. The human foot is divided into 3 parts, namely the metatarsal (toes), arch, and heel. The heel is the sole of the foot that receives the greatest burden, because the heel bears the burden of $\pm 60\%$ of the body weight as shown in figure 2. A large load on the heel causes pain in the sole of the foot (Wibowo, 2017).

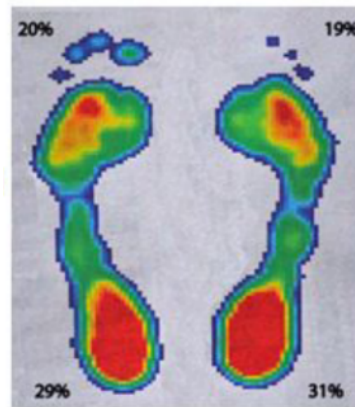


Figure 2 Distribution of the load on the soles of the feet
Source:(Wibowo, 2017)

In addition to the feet, other body parts that experience pain are the left and right calves. Complaints of pain in the calf are usually felt stiffness, cramps, pain to tension in the Achilles tendon, or the surrounding blood vessels and nerves (Lubis, 2020). Anti-fatigue mats as an ergonomic intervention to reduce the appearance of musculoskeletal complaints (Mohd Noor et al., 2013). Winberg's study of anti-fatigue mats shows that the mats design is designed to promote instability between the legs that triggers movement of the body parts, thereby increasing blood flow and preventing stress on joints and tissues (Winberg et al., 2022)

In a standing work posture, the use of a softer base or surface is recommended to create smooth muscle movement, reduce musculoskeletal tension, increase blood flow and reduce discomfort and fatigue (Aghazadeh et al., 2015). Research on anti-fatigue mats conducted by George Havenith and Lucy Dorman of Loughborough University involved 14 participants standing on hard floors and anti-fatigue mats every 90-minute session for 5 days. The study used infrared thermal imaging, body temperature sensors, and infrared photos, and filled out a questionnaire. The results showed that standing for 90 minutes caused serious discomfort in the feet, legs, and back, and found stiffness in the neck and shoulders (Wiggermann and Keyserling, 2013).

In standing posture for a long time, the use of a combination of anti-fatigue and stretching mats is an alternative ergonomic intervention where the functions of both are interrelated to discomfort, fatigue, and musculoskeletal complaints. The use of anti-fatigue mats triggers a person to keep moving so that the pressure on the feet is evenly distributed, the muscles keep pumping blood, and reduce the increase in blood volume in the lower extremities (Coenen et al., 2017). Meanwhile, stretching movements that cover movements from the neck, shoulders, back, arms to legs have the effect of changing the viscoelasticity of the tendons in the muscles which have an impact on reducing stiffness and muscle tension, reducing muscle spasm which results in increased blood flow to the muscles. In addition, with proper stretching, it will create an ideal posture to reduce the risk of musculoskeletal disorders (Gasibat, Bin Simbak and Abd Aziz, 2017)

In addition to these two interventions, several other ergonomics programs can be carried out, including physical ergonomics interventions including providing a safe and comfortable work area such as temperature regulation, lighting, noise, and machine height. Then organizational ergonomics interventions include setting working hours, overtime, production targets, rest hours, to cognitive ergonomics interventions in the form of providing standard

operating procedures or work instructions, machine automation, providing training on ergonomics principles and practices (Hoe et al., 2018).

CONCLUSION

Based on the results of the study, it can be concluded the characteristics of workers at PT X majority aged 18-25 years, about 42.90% of respondents have a working period of 6-12 months, the majority body mass index (BMI) of respondents in underweight category (<18,5). The results of the T-test showed that there was no difference between the use of anti-fatigue mats and the implementation of stretching on the level of musculoskeletal complaints separately. While the combination of the use of anti-fatigue and stretching mats affects complaints of Musculoskeletal Disorders (MSDs) on the Sewing Operators at PT X with p value = 0.006.

Suggestions from this study for companies are to monitor the feasibility and replace anti-fatigue mats regularly, add short breaks every 2 hours, while sewing operators in addition to using anti-fatigue mats can use comfortable shoes during work, and actively perform stretching movements to the fullest at the appointed time.

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