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ACTIVE REST AND STRETCHING BATIK DYEING WORKERS REDUCE MUSCULOSKELETAL COMPLAINTS AND INCREASE PRODUCTIVITY

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Abstract

Pekalongan is one of the largest batik-producing areas in Indonesia. Pekuncen Wiradesa Pekalongan batik coloring workers are 20 people with 10 people in the coloring section. The work process by standing bent over repeatedly for a long time causes musculoskeletal complaints in workers. The purpose of this study was to reduce musculoskeletal complaints and increase productivity in batik dye workers. This research is a true experimental type of research with the same subject design treatment by subject design involving 10 workers. In the period I workers worked as usual while period II worked by being given stretching and active rest for 6 days. Musculoskeletal complaints were measured by a NBM questionnaire. Productivity was measured by calculating the time workers completed 200 clothes per day. Normality test of age data, BMI, working period, temperature, humidity, musculoskeletal complaints, productivity, and work pulse using Shapiro Wilk. Data analysis of musculoskeletal complaints, productivity, and work pulse used a statistical paired t-test with a value of 0.05. The results showed a significant difference $p<0.05$ in musculoskeletal complaints, the difference in period II was 11.3 or decreased by 6.43%, and was supported by a decrease in work pulse rate of 9.53%. Active rest and stretching increased productivity by 0.00117 or experienced a difference of 11.97%. It can be concluded that the application of ergonomics in the form of active rest and stretching reduces musculoskeletal complaints and increases productivity in Pekuncen Wiradesa Pekalongan batik coloring workers.

Keywords: active rest, stretching, musculoskeletal complaints, productivity, batik dye

INTRODUCTION

The development of the batik industry in Indonesia is currently experiencing rapid development. Pekalongan is one of the largest batik-producing areas in Indonesia, where Pekalongan has the characteristics of other batik such as from Jogjakarta, solo, and others. One of the areas in Pekalongan that produces batik is the Pekuncen area, Wiradesa Pekalongan District. The total number of workers in the place is 20 people consisting of 4 hand-drawn batik, 4 stamp batik, 10 batik dyes, and 2 drying workers.

The process of making batik cloth requires a series of stages from plain cloth to batik-patterned and colored cloth. The stages in making batik are the first to make a pattern with a stamp or write on the cloth, the second stage is to color the pattern on the colet method, the third stage is soaking with hard water so that the color of the pattern is brighter, the fourth stage is soaking in water for about 1 hour so that the cloth is wet and soft. easy in coloring

before dyeing batik cloth, the fifth stage of dyeing batik cloth with two stages, namely the first with chemical as the basic color, the second with dye plus salt as a color binder so that it does not fade and the last stage is drying without direct sunlight.

The analysis of eight ergonomic aspects of batik craftsmen that raises the problem is in the batik dye section. The working attitude at the time of coloring is standing and bending over and over, where the knees are semi-flexed so that the reach of the hands and waist are not too far away. When the fabric is in the tub, the shoulders and elbows will move in flexion and extension which aims to make the fabric enter the dye and the dye is evenly distributed throughout. This work posture requires the use of heavier muscles.

Ergonomics interventions that can be given to batik coloring workers in terms of tax can do a redesign of the tool or the height of the tub used to reduce the slouching attitude. Organizational aspects are given active rest and the application of stretching exercises regularly to reduce the workload. Fulfillment of nutrition can also be suggested by giving snacks in the form of fruit in addition to heavy metals. From an environmental point of view, the disposal of water and dyes is designed so as not to harm the workers. In this study, the intervention provided was stretching exercises and active rest to reduce musculoskeletal complaints and increase productivity, considering the limitations of the researchers' costs and time.

Stretching exercises performed by workers resulted in an increase in flexibility of 48.84% and an increase in productivity of 48.01%, this was done as an effort to prevent injury when (Indrawati et al., 2013). Stretching exercises can prevent injury to workers and reduce discomfort in the muscles due to work. Stretching increases muscle flexibility and increases ROM (Range Of motion) as well as accelerates the removal of waste substances such as lactic acid which will cause pain and tension. (Sari et al., 2019).

The statement that has been explained can be concluded that batik coloring workers will experience musculoskeletal complaints and decreased productivity. It is hoped that this research will give active rest and stretching to batik dyes to decrease musculoskeletal complaints and increase productivity.

METHOD

This research is an experimental study, using the same subject design (treatment by subject design). Research purposes general purpose of this study is to prove that interventions in the form of giving active rest and stretching can reduce musculoskeletal complaints and increase productivity on batik coloring workers in Pekuncen Village, Wiradesa District, Pekalongan Regency.

The research population was 20 batik coloring workers in the Pekuncen Wiradesa batik industry, Pekalongan. All workers are male with an age range of 26-50 years. Based on the inclusion and exclusion criteria, a sample of 10 people was obtained. A number of these samples then became the Period I group and also the Period II group.

Musculoskeletal complaints in subjects were measured using a Nordic Body Map questionnaire with 4 Likert scales and a working pulse. On Saturdays before work in each period, all subjects fill out the Nordic Body Map questionnaire, after 2 hours of work, the work pulse will be measured 2 times at 11.00 and 15.30 WIB. During work, the working time is calculated with the number of fabrics produced as an indicator of productivity. After working, the subject filled out the nordic body map questionnaire. Measurements were carried out every day for 6 days in each period. Work productivity is calculated based on the following formula Output (output) Productivity = Input (input) x Time (time)

RESULTS AND DISCUSSION

Based on data investigation, characteristics of research subjects are presented in the following Table 1.

Table 1
Subject Characteristics

Variable	N	Average	Standard Deviation	Range
Age (years)	10	37.3	8.1	26 – 50
Body Mass Index (kg/m^2)	10	18.5	1.04	17 – 20
Work experiences (years)	10	9.1	3.4	5 - 15

Based on Table 1, it is known that the age of the subject is still productive, the body mass index is still ideal and the work experience is sufficient.

The data of environmental conditions were tested for normality using the Shapiro-Wilk test ($p>0.05$) data with normal distribution.

Table 2
Analysis Environmental Conditions

Variable	Period I		Period II		p
	Average	Standard Deviation	Average	Standard Deviation	
Temperature (^oC)	31.83	0.75	31.83	0.75	1.00
Relative humidity (%)	76.16	3.6	80.16	7.05	0.319

A different test on environmental conditions of temperature and relative humidity with paired sample t-Test in Period I and Period II ($p>0.05$), meaning that there is no difference in temperature and humidity in Period I and Period II.

The mean of musculoskeletal complaints was tested with the Shapiro-Wilk test. data is normally distributed ($p>0.05$). Paired Samples t-Test was conducted by comparing scores of musculoskeletal complaints in the post (after work) Period I and post (after work) Period II. Paired Samples t-Test was conducted by comparing the difference in scores of musculoskeletal complaints in Period I and Period II. The test results with the Paired Samples Test are presented in Table 3.

Musculoskeletal Complaints Difference Test using Paired Samples Test after the intervention showed $p = 0.000$ there was a significant difference in Period I and Period II. A decreased score of musculoskeletal complaints by 2.1 in Period II after being given intervention for 1 week.

The average working pulse was tested with the Shapiro-Wilk test. the data is not normally distributed ($p<0.05$). Wilcoxon test was conducted by comparing pre-post Period I and Period II. Paired Samples t-Test was conducted by comparing the difference in the working pulse rate in Period I and Period II. The test results with Wilcoxon are presented in Table 4.

Table 3
Analysis of Musculoskeletal Complaints

Variable	Period I		Period II		p
	Average	Standard Deviation	Average	Standard Deviation	
Musculoskeletal complaints (Post)	43.5	2.71	40.7	2.4	0.000
Musculoskeletal complaints (difference)	13.4	2.59	11.3	2.05	0.000

Table 4
Analysis of working pulse

Variable	Period I		Period II		p
	Average	Standard Deviation	Average	Standard Deviation	
Pre – Pre	96.8	8.05	92.7	5.45	0.017
Post – Post	94.3	8.34	84.8	6.08	0.005
Difference	2.5	0.516	7.1	0.994	0.005

The working pulse condition for both pre-Period I and Period II was obtained ($p<0.05$). Therefore, to determine the difference before and after the intervention, the test used data on the difference in working pulse rates for Period I and Period II with $p<0.05$. This can be interpreted that there is a difference that indicates a decrease in the work pulse rate in the 2 period.

Productivity data was obtained from a comparison between output, namely the number of cloths per day (200 cloths), input, namely the workload received by workers during work which was determined based on the score of musculoskeletal complaints and the length of work in a day. Test with Shapiro-Wilk test data normally distributed ($p> 0.05$). Paired Samples Test was conducted by comparing productivity scores in the period I and period II. The test results with the Paired Samples Test are presented in Table 5.

Table 5
Productivity analysis

Variable	Period II		p
	Average	Standard Deviation	
Period 1	0.00977	0.000677	0.000
Period 2	0.01094	0.000717	

Productivity difference test using Paired Samples t-Test after the intervention showed $p = 0.000$ ($p <0.005$). There is an increase in productivity0.00117 in Period II after the intervention.

The mean of musculoskeletal complaints in Period I was 43.5 ± 2.07 while in Period II the average of musculoskeletal complaints was 40.7 ± 1.87. This shows a decrease of 6.43%, and the difference is significant ($p<0.05$). While the mean difference in musculoskeletal complaints after work and before work in Period I was 13.4 ± 2.59 and in Period II was 11.3 ± 2.05 and statistically also significantly different ($p <0.05$).

Nordic Body Maps is a measuring instrument in the form of a questionnaire that can provide an overview of musculoskeletal complaints in body parts. The biggest musculoskeletal complaints are located in the waist, upper back or shoulders, upper arms, and calves, this is due to the working attitude of batik dyes who tend to work with a bent attitude and repetitive movements when dipping the cloth into the tub so that it can cause musculoskeletal complaints. The shoulders decreased by 8.8%, the upper arms decreased by 11.7%, the waist decreased by 23.5% and the calves decreased by 23.5% after being given intervention in the form of active rest and stretching.

Feelings of discomfort in the subject occur due to pathophysiological mechanisms in anatomical structures including muscles, tendons, joints, and nerves. Feelings of discomfort or pain are influenced by search receptors (nociceptors) through neural pathways and a person's subjective perception. Nociceptors react to conditions associated with tissue damage, such as mechanical stress, tissue ischemia, temperature extremes, or chemical irritation. (Dewi et al., 2018).

The higher the total score for musculoskeletal complaints, the higher the level of musculoskeletal complaints experienced. Musculoskeletal complaints experienced by batik dye workers are caused by loading on the wrists, upper arms, shoulders, upper back, waist, and calves because the coloring position is in a standing position, the body is bent and both arms and hands are lowered and raised so that it affects the muscles. arms, shoulders, and waist, causing muscle fatigue.

The working attitude of batik dye workers in Period I showed an unnatural work attitude (forced attitude) in the long term and repeatedly, causing complaints on the musculoskeletal system and negative effects on health (Manuaba, 1998). Muscle fatigue is caused by static muscle work (Kroemer & Grandjean, 2000) In this study, static muscle work occurs when dipping and lifting the cloth by standing bent over.

The lack of oxygen supply to the muscles is caused by obstacles from blood circulation, this is related to the presence of static loading on the body and non-physiological work attitudes while working. These conditions can cause a buildup of lactic acid and an increase in body heat, resulting in muscle fatigue as a form of pain in the workers' muscles. Work attitudes that are not physiological are a static load on the muscles that can cause backflow of blood or blocked veins, fluid accumulation, and varicose veins, especially in the legs and feet. This condition causes muscle fatigue which can cause pain in workers.

Muscle contraction causes a change in muscle length and increased pressure on the muscle, so that blood flow to the muscle becomes blocked. If this condition occurs continuously, it can lead to ischemia in the muscles. Muscle ischemia is what causes pain (Takala, 2016; Dewi et al., 2018). Increased load on muscles allows damage to muscle cells accompanied by a buildup of calcium ions that leads to muscle cell damage (Puntillo et al., 2021).

Giving stretching in the form of active stretching exercises can reduce ischemia in muscles that experience spasms through the effect of increasing blood circulation in muscles accompanied by adequate nutrition for metabolism in muscle cells and transporting metabolic waste. (Puspadewi et al., 2018). In addition, stretching will increase muscle flexibility, provide opportunities for muscles to return to resting length conditions, break the spasm-pain-spasm cycle, increase physical fitness, and increase ROM and reduce muscle fatigue. Stretching exercises can reduce musculoskeletal complaints by 21.61% in injection cleaning workers (Ferdyastari et al., 2018). Stretching and active rest training can reduce musculoskeletal complaints by 71.98% in recording employees of Sanglah Hospital Denpasar Bali (Indrawati et al., 2013).

The working pulse is measured twice a day, at 11.00 and 15.30 WIB. These measurements are intended to determine the effect of the intervention in the form of

stretching exercises and active rest every 2 hours. The average working pulse data in pre Period I was 96.8 ± 8.05 and in pre Period II was 92.7 ± 5.45, while the average post Period I was 93.3 ± 8.34 and post Period II was 84,4±6,088 There was a difference in average points between post Period I and Period II which was 8.9 or experienced a difference of 9.53%. The results of statistical analysis obtained a value of p = 0.000 (p<0.05), this indicates that there is a significant difference between post-Period I and Period II, where the average working pulse rate in post-Period II is lower than the average working pulse rate in post-Period II Period I.

The decrease in work pulse is a decrease in the physiological load on batik dye workers, this occurs because of the provision of stretching exercises and active rest. The decrease in work pulse is also caused by a decrease in muscle tension and improvement in blood circulation so that the physiological system returns to stability (Kroemer & Grandjean, 2000). The decrease in muscle tension shows a decrease in musculoskeletal complaints because the muscles experience improvement and relaxation. The results of this study are supported by previous research by Suarjana et al. (2018) which states that there is a decrease in the work pulse of 18.14% in Tabanan dough industry workers. according to Daryono et al. (2016) with the provision of active stretching and redesign can reduce the workload by 30.3% on screen printing workers.

Thus, this study states that active rest and stretching can reduce the physiological load in the form of work pulse which can strengthen the increase in work productivity and also decrease musculoskeletal complaints in batik dyeing workers.

Work productivity in this study has constituent components, namely input (time and number of cloths, output (musculoskeletal complaints), and the amount of work time in completing 200 pieces of cloth per day as a time component. Work productivity data obtained from the average period I is 0 0.00977±0.000677, while the average work productivity in Period II was 0.01094±0.000717. The results of statistical analysis obtained p-value = 0.000 (p<0.05), this indicates that there is a significant difference between Period I and Period II, where the average work productivity score in Period II is higher than the average work productivity in Period I There is a difference in the average points between Period I and Period II which is 0.00117 or experiences a difference of 11, 97% There is an increase in the speed of workers completing 200 clothes in a day. While the increase in the number of fabrics has not been seen significantly because the amount of production has been adjusted to the demand. This increase in productivity occurs because of the provision of stretching exercises and active rest every 2 hours of work. The active rest given is reducing the number of clothes in 1 coloring session so that workers can pick up the cloth and drink faster. Workers feel more relaxed and their workload decreases which are marked by a decrease in work pulse as a decrease in physiological load after doing stretching exercises and active rest. The results of this study are supported by previous research by Ferdyastari et al. (2018) which states an increase in productivity as seen from the presence of curia breaks in injection cleaning workers.

In line with research by Rusni et al. (2017) stated that there was a significant increase in work productivity of 66.67% by providing Workplace Stretching Exercise interventions to workers in the garment industry in Mudding, Badung Regency. Dynamic stretching exercises and rest increased the productivity of screen printing workers in the Adhi fashion garment industry by 31.25% (Nooryana et al., 2019). Muscle stretching exercises can relax muscles and improve blood circulation to muscles more optimally to improve physiological responses by reducing musculoskeletal complaints and ultimately increasing productivity. according to(Pitt & Shew, 2017) an increase in productivity seen from an increase in economics, a decrease in stress, an acceleration of working time, and the use of tools, wherein this study there was an increase in the speed of time for workers to complete 200 fabrics in a day.

CONCLUSIONS

From the results of the analysis and discussion, it can be concluded that active rest and stretching reduce musculoskeletal complaints in batik coloring in the Pekuncen Wiradesa Pekalongan batik industry by 6.43% and is supported by a 9.53% decrease in work pulse. Active rest and stretching increased work productivity on batik coloring in the Pekuncen Wiradesa Pekalongan batik industry by 11.97%.

Things that can be suggested from the results of this study are to reduce musculoskeletal complaints and increase productivity in Pekuncen Wiradesa Pekalongan batik dye workers, it is recommended to do regular stretching and active rest that can be done on the sidelines of work; for other researchers who want to take the topic of research on batik workers or batik dyes, they can improve work attitudes or redesign the batik coloring bath.

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