
The Effect Of Ergonomic And Physical Work Environment Factors On Musculoskeletal Disorders (Msds) In Batik Craftsmen In Danau Teluk District

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Abstract

Musculoskeletal disorders (MSDs) are disorders of the muscular and skeletal systems commonly experienced by workers due to unergonomic work postures, repetitive movements, long work durations, and unsupportive physical work environments. Batik artisans are among the workers at risk of developing MSDs because batik-making activities are static, repetitive, and performed over long periods. This study aims to determine the influence of ergonomic and physical work environment factors on musculoskeletal disorders (MSDs) among batik artisans in Danau Teluk District. This study used a quantitative method with an observational analytical cross-sectional design. The study was conducted among batik artisans in Danau Teluk District, Jambi City, with a sample of 40 respondents using a total sampling technique. Data were collected through interviews, observations, temperature and lighting measurements, and assessment of work posture using the Rapid Upper Limb Assessment (RULA) method and MSD complaints using the Nordic Body Map (NBM). Data were analyzed using the Chi-Square test and logistic regression at a 95% confidence interval. The study showed that 17 respondents (42.5%) experienced high-grade MSDs. There was a relationship between work posture (p -value = 0.001), work duration (p -value = 0.000), repetitive motion (p -value = 0.000), and lighting (p -value = 0.000) and the incidence of MSDs. Meanwhile, temperature had no relationship with the incidence of MSDs (p -value = 0.131). The results of the multivariate analysis showed that work posture was the most influential factor on the incidence of MSDs with a p -value = 0.006 and $\text{Exp}(B) = 64.000$. Ergonomic and physical work environment factors influence the incidence of Musculoskeletal Disorders (MSDs) among batik artisans in Danau Teluk District. Work posture is the dominant factor influencing the incidence of MSDs in batik artisans.

Keywords: Musculoskeletal Disorders (Msds), Work Posture, Ergonomic Work Environment, Physical Work Environment, Batik Artisans.

INTRODUCTION

Musculoskeletal Disorders (MSDs) are a group of conditions that interfere with the normal functioning of the musculoskeletal system, including muscles, tendons, ligaments, nerves, cartilage, and bones (Ramayanti & Koesyanto, 2021). These disorders can affect nearly all body tissues, such as the neck, shoulders, arms, back, and legs (Lee et al., 2023). Musculoskeletal complaints refer to discomfort in the skeletal muscles experienced by individuals, ranging from mild to severe symptoms. When muscles are subjected to static loads over a prolonged period, damage to joints, ligaments, and tendons may occur (Widajati & Paskarini, 2024). Musculoskeletal complaints are also commonly referred to as MSDs (Musculoskeletal Disorders), RSI (Repetitive Strain Injuries), CTD (Cumulative Trauma Disorders), Work-related Musculoskeletal Disorders (WMSDs), and RMI (Repetitive Motion Injury) (Wardani et al., 2023).

According to the World Health Organization (WHO) in 2021, approximately 1.71 billion people worldwide suffered from musculoskeletal disorders. Among these conditions, low back pain had the highest prevalence, affecting around 568 million individuals (Tatik & Eko, 2023).

Data from Indonesia's Basic Health Research (Riskesdas) conducted by the Ministry of Health in 2018 reported that the prevalence of musculoskeletal disorders in Indonesia was 7.9%. Provincial prevalence based on diagnosis was highest in Aceh (13.3%), followed by Bengkulu (10.5%) and Bali (8.5%). Furthermore, the 2013 Riskesdas report indicated that the highest prevalence of musculoskeletal disorders by occupation was found among farmers, fishermen, and laborers, reaching 31.2% (Haq et al., 2021).

According to data from the Department of Industry and Trade of Jambi Province, the number of batik industries in Jambi City increased from 105 units in 2022 to 108 units in 2023 and further to 114 units during the 2024–2025 period. In addition, Danau Teluk District, one of the centers of Jambi batik production, has shown relatively stable growth. In 2022, there were 40 batik industries employing 258 workers. In 2023, the number of industries increased to 41 units with 255 workers. During the 2024–2025 period, there were 40 batik industries employing 255 workers.

Cases of musculoskeletal disorders among informal workers, such as batik artisans, are influenced by several factors, including ergonomic and physical work environments. Ergonomics aims to align work tasks, equipment, and working conditions with workers' capabilities in order to achieve a balance between efficiency, comfort, and safety (Yudiantyo et al., 2021). The batik-making process involves repetitive hand movements, prolonged sitting on low stools, high levels of concentration, and repeated use of tools. These conditions increase the risk of MSDs, particularly low back pain, neck pain, and muscle injuries (Safira & Kurniawan, 2022).

In addition, the physical work environment plays an important role. Exposure to high temperatures, humidity, inadequate lighting, and poor ventilation can contribute to musculoskeletal disorders (Susilowati et al., 2022). Research by Faridah and Adi (2022) showed that traditional batik artisans working in hot environments with poor ventilation experienced higher levels of back and neck pain compared to those working in studios with adequate lighting and ventilation (Faridah & Adi, 2022). Research conducted by Cindy et al. (2024) found a significant relationship between repetitive movements and musculoskeletal disorders among shoe sole manufacturers in Mojokerto (Cindy et al., 2024).

Findings from Romas and Kumala (2024) indicated that batik workers are at high risk of developing musculoskeletal disorders due to unnatural working postures, characterized by bent sitting positions, repetitive movements, prolonged work duration, and inadequate work facilities that do not support ideal posture (Romas & Kumala, 2024). Research by Yusup et al. (2025) reported that 32 workers worked less than 8 hours per day, while 80 workers worked more than 8 hours daily. This finding suggests that long working hours may increase the risk of MSD complaints (Yusup et al., 2025).

Furthermore, the waxing and dyeing stages of batik production pose a high risk of musculoskeletal disorders. These risks arise from non-ergonomic sitting postures characterized by a "C"-shaped curved back and a downward head position, resulting in strain on the neck area. Prolonged working duration combined with poor posture may lead to musculoskeletal disorders (Ginting & Prastawa, 2023).

Another study by Civic et al. (2021) found a significant relationship between physical environmental temperature and MSDs. Most dock workers involved in loading and unloading activities worked in high-risk temperatures exceeding 40°C (Civic et al., 2021). A qualitative study conducted in Ulu Gedong Village, Jambi, identified hazards related to workstation layout, where artisans worked in poorly lit rooms. Such conditions may cause eye fatigue, which can indirectly contribute to MSDs. Their primary source of illumination depended solely on natural sunlight (Prasetyo et al., 2024).

The studies above indicate that workers experience musculoskeletal disorders due to repetitive movements, poor working postures, and uncomfortable physical work environments, particularly concerning temperature and lighting conditions (Romas & Kumala, 2024).

Based on a preliminary survey conducted by the researchers involving five batik artisans in Danau Teluk District, workers reported complaints of back pain, lower back pain, and hand discomfort. The batik-making process is performed while sitting on the floor using cloth or thick cushions as seating support. The tools used include batik canting tools, pans, electric stoves, and wax (malam). This process requires monotonous working postures involving prolonged sitting, bent backs, and downward head positions, especially during hand-drawn batik production, which typically takes approximately two weeks to complete.

Meanwhile, during stamped batik production, which is performed in a standing position, artisans reported finger fatigue and numbness caused by repetitive movements and non-ergonomic postures. All batik production activities are carried out outdoors, relying primarily on natural sunlight for illumination and electric fans for temperature control.

The batik-making process begins with creating patterns or sketches using pencils on plain cloth measuring approximately 2.5 meters. The artisans then apply hot wax using a canting tool before proceeding to the dyeing and drying stages. The production time varies depending on the size of the fabric, with artisans typically requiring approximately two weeks or more to complete a 2.5-meter piece of cloth. Such prolonged periods of static sitting and standing positions may increase the risk of musculoskeletal disorders.

Based on the preceding discussion, preliminary survey findings, and previous studies, only a limited number of studies have simultaneously examined ergonomic and physical work environment factors, particularly among batik artisans. Therefore, the researchers are interested in investigating both factors concurrently to address the existing research gap. This study is entitled: "The Influence of Ergonomic and Physical Work Environment Factors on Musculoskeletal Disorders (MSDs) among Batik Artisans in Danau Teluk District."

RESEARCH METHODS

This study employed a quantitative method with an analytical observational design and a cross-sectional approach. The research was conducted at batik production houses in Danau Teluk District, Jambi City, from January 2026 until completion. The study population consisted of all batik artisans in Danau Teluk District, totaling 40 individuals. A total sampling technique was applied, whereby the entire population was included as the research sample.

The dependent variable in this study was Musculoskeletal Disorders (MSDs), while the independent variables included working posture, work duration, repetitive movements, temperature, and lighting. Data were collected through interviews, direct observation, and workplace environmental measurements using the Nordic Body Map (NBM) questionnaire, Rapid Upper Limb Assessment (RULA), a digital thermometer, and a lux meter.

The collected data were processed through several stages, including editing, coding, data entry, and data cleaning. Data analysis was conducted using univariate analysis to describe the distribution of each variable, bivariate analysis using the Chi-Square test to determine the relationship between the independent variables and the occurrence of MSDs, and multivariate analysis using logistic regression to identify the most influential factors associated with MSDs. A significance level of $p < 0.05$ was applied throughout the analysis.

RESULTS AND DISCUSSION

Table 1. Frequency Distribution of Research Variables among Batik Artisans in Danau Teluk District, Jambi City, 2026 (n = 40)

Variable	Category	Frequency (n)	Percentage (%)
Musculoskeletal Disorders (MSDs)	High	17	42.5
	Low	23	57.5
Working Posture	Moderate	26	65.0
	Low	14	35.0
Work Duration	At Risk (>8 hours)	26	65.0
	Not at Risk (≤8 hours)	14	35.0
Repetitive Movements	At Risk (>30 times/minute)	11	27.5
	Not at Risk (≤30 times/minute)	29	72.5
Workplace Temperature	At Risk (>31°C)	18	45.0
	Not at Risk (≤31°C)	22	55.0
Lighting	At Risk (<300 lux)	13	32.5
	Not at Risk (≥300 lux)	27	67.5
Total Respondents		40	100

Based on Table 1, it can be seen that most respondents experienced low-category Musculoskeletal Disorders (MSDs), accounting for 23 respondents (57.5%). The majority of respondents had a moderate working posture category, totaling 26 respondents (65.0%), and a risky work duration (>8 hours), also totaling 26 respondents (65.0%). Most respondents had a non-risk repetitive movement frequency, amounting to 29 respondents (72.5%), a non-risk workplace temperature, totaling 22 respondents (55.0%), and non-risk workplace lighting, totaling 27 respondents (67.5%).

Bivariate Analysis

Table 2. Bivariate Analysis of Variables Associated with Musculoskeletal Disorders Working Posture

Working Posture	MSDs Yes	MSDs No	Total	PR	95% CI	P-Value
Moderate >3	16 (61.5%)	10 (38.5%)	26 (100%)	8.61	1.272–58.35	0.001
Low ≤2	1 (7.1%)	13 (92.9%)	14 (100%)			

Work Duration

Work Duration	MSDs Yes	MSDs No	Total	PR	95% CI	P-Value
At Risk >8 hours	17 (65.4%)	9 (34.6%)	26 (100%)	0.34	0.204–7.73	0.000
Not at Risk ≤8 hours	0 (0%)	14 (100%)	14 (100%)			

Repetitive Movements

Repetitive Movements	MSDs Yes	MSDs No	Total	PR	95% CI	P-Value
At Risk >30/minute	10 (90.9%)	1 (9.1%)	11 (100%)	3.76	1.924–7.373	0.000
Not at Risk ≤30/minute	7 (24.1%)	22 (75.9%)	29 (100%)			

Temperature

Temperature	MSDs Yes	MSDs No	Total	PR	95% CI	P-Value
At Risk >31°C	10 (55.6%)	8 (44.4%)	18 (100%)	1.74	0.835–3.653	0.131
Not at Risk ≤31°C	7 (31.8%)	15 (68.2%)	22 (100%)			

Lighting

Lighting	MSDs Yes	MSDs No	Total	PR	95% CI	P-Value
At Risk <300 lux	0 (0%)	13 (100%)	13 (100%)	2.70	1.651–4.415	0.000
Not at Risk ≥300 lux	17 (63%)	10 (37%)	27 (100%)			

Based on the table above, respondents with a moderate working posture category showed that 61.5% experienced Musculoskeletal Disorders, while 38.5% did not experience Musculoskeletal Disorders. Meanwhile, among respondents with a low working posture category, 92.9% did not experience Musculoskeletal Disorders and 7.1% experienced Musculoskeletal Disorders. With a PR value of 8.61 (95% CI = 1.272–58.353) and a P-Value of 0.001, there was a significant relationship between working posture and the occurrence of Musculoskeletal Disorders.

Based on the table above, among the 26 respondents classified as having a risky work duration, 65.4% experienced Musculoskeletal Disorders and 34.6% did not. In contrast, no respondents in the non-risk category experienced Musculoskeletal Disorders, and all respondents in this category were free from Musculoskeletal Disorders. With a PR value of 0.346 (95% CI = 0.204–0.587) and a P-Value of 0.000, there was a significant relationship between work duration and the occurrence of Musculoskeletal Disorders.

The analysis also showed that most respondents in the risky repetitive movement category experienced Musculoskeletal Disorders, accounting for 90.9%, while only 9.1% did not experience Musculoskeletal Disorders. In the non-risk category, the majority did not experience Musculoskeletal Disorders (75.9%), compared to 24.1% who experienced them. With a PR value of 3.76 (95% CI = 1.924–7.373) and a P-Value of 0.000, there was a significant relationship between repetitive movements and the occurrence of Musculoskeletal Disorders.

For the temperature variable, 55.6% of respondents in the risk category experienced Musculoskeletal Disorders, while 44.4% did not. In contrast, among respondents in the non-risk category, 68.2% did not experience Musculoskeletal Disorders and 31.8% did. With a PR value of 1.74 (95% CI = 0.835–3.653) and a P-Value of 0.131, there was no significant relationship between temperature and the occurrence of Musculoskeletal Disorders.

Regarding lighting, respondents exposed to risky lighting conditions showed 0% experiencing Musculoskeletal Disorders, while 100% did not experience Musculoskeletal Disorders. In contrast, among respondents in the non-risk lighting category, 63% experienced Musculoskeletal Disorders compared to 37% who did not. With a PR value of 2.70 (95% CI = 1.651–4.415) and a P-Value of 0.000, there was a significant relationship between lighting and the occurrence of Musculoskeletal Disorders.

Multivariate Analysis

Table 3. Results of Multivariate Analysis of Factors Associated with Musculoskeletal Disorders among Batik Artisans in Danau Teluk District, 2026

Variable	P-Value	Exp(B)	95% CI
Working Posture	0.006	64.000	3.249–1260.649
Work Duration	0.998	2246675809.060	0.000–.
Lighting	0.998	0.000	0.000–.

The results of the multivariate analysis using logistic regression showed that working posture significantly affected the occurrence of Musculoskeletal Disorders (MSDs), with a significance value of 0.006 (<0.05). The Exp(B) value of 64.000 indicates that respondents with risky working postures were 64 times more likely to experience MSDs than respondents with non-risky working postures. Meanwhile, work duration and lighting did not significantly affect the occurrence of MSDs because their significance values were greater than 0.05.

Discussion

Overview of Musculoskeletal Disorders Incidence

Based on the study results, it was found that out of 40 respondents, 17 (42.5%) experienced Musculoskeletal Disorders (MSDs). This condition indicates that a considerable number of batik artisans in Danau Teluk District suffer from Musculoskeletal Disorders complaints. The complaints reported by respondents included pain in the back of the neck, shoulders, upper back, lower back, and arms. These complaints were caused by prolonged non-ergonomic working positions. Other factors, such as repetitive movements and long working hours, may also increase the risk of musculoskeletal system disorders. Lighting conditions may also affect workers' comfort during work activities.

Relationship Between Working Posture and Musculoskeletal Disorders

Working postures that are inconsistent with the physiological condition of the body can reduce productivity; therefore, posture improvement efforts are necessary to minimize adverse risks. Bent, downward-facing, and prolonged static sitting postures can cause muscle tension. Based on the study findings, respondents with moderate-risk working postures experienced Musculoskeletal Disorders more frequently, accounting for 61.5% or 16 respondents, compared to those with low-risk postures, where only 7.1% or 1 respondent experienced Musculoskeletal Disorders. Through the RULA questionnaire, the final assessment indicated the need for further investigation and immediate corrective action. These efforts are intended to minimize workers' complaints and prevent their condition from worsening. The Chi-Square test results showed a significant relationship between working posture and Musculoskeletal Disorders.

This finding is consistent with the study conducted by Ilmidin et al. (2024), which showed that working posture was associated with the occurrence of MSDs among workers in Indonesia. The study reviewed 21 articles and found an overall effect size of 0.418 with a p-value of $< .001$, indicating that working posture significantly influences the occurrence of MSDs. The heterogeneity value was 76.49%, indicating a high level of heterogeneity among the included studies (Ilmidin et al., 2024).

Based on field observations in Danau Teluk District, workers commonly adopted non-ergonomic postures while working, such as bending forward, sitting cross-legged, and lowering their heads. Maintaining such postures for prolonged periods may increase the risk of Musculoskeletal Disorders.

Relationship Between Work Duration and Musculoskeletal Disorders

Work duration greatly affects workers' physical and mental health. Working for long periods without adequate rest increases workload, accelerates fatigue, and raises the risk of health problems. The recommended daily work duration is ≤ 8 hours. Based on the study findings, 17 respondents (65.4%) were at risk of Musculoskeletal Disorders due to excessive work duration, while 9 respondents (34.6%) were not at risk. The Chi-Square test results indicated a significant relationship between work duration and Musculoskeletal Disorders.

These findings are supported by a study conducted by Putri et al. (2021), which reported a significant difference in muscle pain complaints based on work duration ($p = .028$) among workers at Tofu Factory X in Semarang City. Workers whose working hours exceeded standard limits reported muscle pain complaints at a rate of 72.2%, whereas only 16.7% of workers with standard working hours experienced such complaints (Putri et al., 2021).

In addition, Yusup et al. (2025) found that working more than 8 hours per day increased the risk of moderate to severe MSD complaints ($p = .014$). Among the workers studied, 32 worked less than 8 hours per day, while 80 worked more than 8 hours per day. These findings indicate that workers with long work durations are more likely to experience MSD complaints (Yusup et al., 2025). Work performed over extended periods, even when accompanied by adequate rest, may reduce physical capacity and trigger pain.

Relationship Between Repetitive Movements and Musculoskeletal Disorders

Repetitive movements are one of the dominant factors contributing to musculoskeletal disorders. Repetitive activities performed over long durations, especially in static positions or while using non-ergonomic equipment, can cause muscle tension and pain in body areas such as the neck, shoulders, and back. The study results showed that among respondents in the high-risk category, 90.9% or 10 respondents experienced Musculoskeletal Disorders, while only 9.1% or 1 respondent did not.

Similar findings were reported by Cindy et al. (2024), whose analysis revealed a significant association between working posture and Musculoskeletal Disorders ($p < .05$) and between repetitive movements and Musculoskeletal Disorders ($p = .010$). Both working posture and repetitive movements were significantly associated with Musculoskeletal Disorders (Cindy et al., 2024). The study recommended improving workplace facilities to be more ergonomic and encouraging stretching exercises before work activities.

According to Tarwaka (2015), Musculoskeletal Disorders (MSDs) are disorders affecting skeletal muscles due to excessive physical activity, particularly repetitive movements or prolonged exposure to heavy workloads (Tarwaka, 2015). In this study, the body part most involved in repetitive movements was the hand. Specific areas experiencing discomfort included the upper neck, shoulders, back, lower back, forearms, wrists, and fingers. These complaints resulted from batik-making activities, which rely heavily on hand movements as the primary support for work tasks. Consequently, these body regions were the most affected. A recommended solution for reducing pain is regular stretching to relax muscles and minimize the risk of musculoskeletal disorders.

Relationship Between Temperature and Musculoskeletal Disorders

Physiologically, each part of the human body has a different temperature. The body strives to maintain thermal stability through internal regulatory mechanisms that enable adaptation to environmental temperature changes. However, this adaptive capacity has limits. The body can generally adapt when environmental temperature changes do not exceed approximately 20% above normal conditions in hot environments and 35% below normal conditions in cold environments. In this study, 55.6% of respondents in the high-risk temperature category experienced Musculoskeletal Disorders, while 44.4% did not. With a PR value of 1.74 (95% CI = 0.835–3.653) and a P-value of 0.131, there was no significant relationship between temperature and the occurrence of Musculoskeletal Disorders.

This finding is supported by the study conducted by Siregar et al. (2025). Logistic regression analysis showed that working posture ($p = .003$) and work duration ($p = .001$) significantly influenced the occurrence of Musculoskeletal Disorders. Meanwhile, temperature ($p = .291$), age ($p = .775$), and smoking habits ($p = .485$) did not show significant effects (Siregar et al., 2025).

Relationship Between Lighting and Musculoskeletal Disorders

Lighting is also a fundamental component of an ergonomic workplace. Appropriate lighting can help reduce eye strain and fatigue, which may occur in environments with insufficient lighting or excessive glare. The study results showed that respondents exposed to risky lighting conditions had a 0% prevalence of Musculoskeletal Disorders, while 100% did not experience Musculoskeletal Disorders. In contrast, among respondents in the non-risk lighting category, 63% experienced Musculoskeletal Disorders compared to 37% who did not. With a PR value of 2.70 (95% CI = 1.651–4.415) and a P-value of 0.000, a significant relationship was identified between lighting conditions and the occurrence of Musculoskeletal Disorders.

Based on the findings of this study, batik artisans are advised to adopt ergonomic working postures, perform regular stretching exercises, and make effective use of rest periods to reduce the risk of Musculoskeletal Disorders (MSDs). Batik industry owners are encouraged to provide ergonomic work facilities, establish a balanced work-rest schedule, and deliver education regarding workplace ergonomics. The findings of this study are also expected to serve as a reference for educational institutions in the development of occupational health and safety (OHS) knowledge. Furthermore,

future researchers are recommended to investigate additional risk factors associated with MSDs and employ larger sample sizes and more comprehensive measurement methods to obtain more robust findings.

CONCLUSIONS

Based on the results of the study involving 40 batik artisans in Danau Teluk District, Jambi City, it was found that the majority of respondents experienced low-category Musculoskeletal Disorders (MSDs) (57.5%). Most respondents had moderate-risk working postures, risky work durations, risky repetitive movements, unsafe workplace temperatures, and lighting conditions that did not meet the recommended standards. The results of the bivariate analysis showed significant relationships between working posture, work duration, repetitive movements, and lighting conditions and the occurrence of Musculoskeletal Disorders (MSDs), as indicated by p -values < 0.05 . Meanwhile, workplace temperature was not significantly associated with the occurrence of Musculoskeletal Disorders (MSDs), as indicated by a p -value > 0.05 .

Based on the results of the multivariate analysis, working posture was identified as the most influential factor associated with the occurrence of Musculoskeletal Disorders (MSDs) among batik artisans in Danau Teluk District, with a p -value of 0.006 and an Exp(B) value of 64.000. These findings indicate that improving working posture is a crucial aspect of preventing and reducing the risk of Musculoskeletal Disorders among batik artisans.

Based on the study findings, batik artisans are encouraged to adopt ergonomic working postures, perform regular stretching exercises, and make effective use of rest periods to reduce the risk of Musculoskeletal Disorders (MSDs). Batik industry owners are expected to provide ergonomic work facilities, establish a balanced work-rest schedule, and offer education regarding workplace ergonomics. The findings of this study are also expected to serve as a reference for educational institutions in the development of occupational health and safety (OHS) knowledge. Furthermore, future researchers are recommended to investigate other risk factors associated with MSDs and employ larger sample sizes as well as more comprehensive measurement methods to obtain more robust and comprehensive results.

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