Jurnal Kesehatan
Vol. 19, No. 1, June 2026, pp. 66~79
p-ISSN: 1979-7621, e-ISSN: 2620-7761, DOI: 10.23917/jk.v19i1.13298

Relationship of Age, Working Period, and Work Fatigue with Musculoskeletal Disorders (MSDs) Among Weaving Workers in Textile Industry

Fery Irawan[1*], Dwi Astuti[2]

[1,2]Prodi Kesehatan Masyarakat, Fakultas Ilmu Kesehatan, Universitas Muhammadiyah Surakarta

How to Cite: Irawan, F., & Astuti, D. Relationship of Age, Working Period, and Work Fatigue with Musculoskeletal Disorders (MSDs) Among Weaving Workers in Textile Industry. Jurnal Kesehatan, 19(1), 66–79. https://doi.org/10.23917/jk.v19i1.10027

Article Information

Article History:
Submission: 21 April 2025
Revision: 3 March 2026
Reception: 3 March 2026

Keywords: *Age, MSDs, work fatigue, working period*

ABSTRACT

Introduction: Musculoskeletal Disorders (MSDs) are common symptoms experienced by textile industry workers due to repetitive work activities, static postures, and high physical workload. This study aimed to analyze the relationship between age, working period, and work fatigue with MSDs symptoms among weaving area workers in the textile industry. **Methods:** This quantitative research used a cross-sectional design with 100 respondents selected through simple random sampling. Data were collected using the Nordic Body Map questionnaire to assess MSDs symptoms and the Fatigue Assessment Scale (FAS) for work fatigue. Data were analyzed using the Fisher Exact Test at a 5% significance level. **Results:** The findings showed no significant relationship between age and MSDs symptoms (p = 0.067), while there was a significant relationship between working period (p = 0.040) and work fatigue (p = 0.009) with MSDs symptoms. The areas of the body that experience the most symptoms are the waist, right shoulder and back. **Conclusion:** The study concludes that working period and work fatigue have a significant influence on MSDs symptoms, while age does not show a significant association. Therefore, it is recommended that ergonomic interventions, job rotation, posture training, and active rest be implemented to prevent and reduce MSDs among textile industry workers.

Corresponding Authors: (*)
Prodi Kesehatan Masyarakat, Fakultas Ilmu Kesehatan, Universitas Muhammadiyah Surakarta, Jl. A. Yani Tromol Pos I, Pabelan Kartasura, Sukoharjo 57169, Indonesia
Email: feryirawan1235@gmail.com

INTRODUCTION

Industrial development in the era of globalization has had a significant impact on the world of work. On the one hand, technological advances can increase the efficiency and productivity of companies, but on the other hand, they also pose a risk to the health of the workforce, especially occupational diseases such as musculoskeletal disorders (MSDs). As a developing country, Indonesia needs a healthy, efficient and productive workforce to

support national development, but in the midst of increasingly complex work demands, protection of occupational health is becoming increasingly urgent to pay attention to (Wildasari & Nurcahyo, 2023).

Based on the 2018 International Labor Organization (ILO) report, every year there are around 2.78 million deaths caused by occupational accidents and diseases, with 86.3% of them caused by occupational diseases. In Indonesia, BPJS Ketenagakerjaan notes that the number of cases of occupational diseases (PAK) continues to increase from year to year, with around 32% of them being musculoskeletal symptoms, mainly due to work activities that involve lifting weights and non-ergonomic postures (Ridlo & Fasya, 2023).

Furthermore, the World Health Organization (WHO) reports that around 59% of workers in the industrial sector experience MSDs symptoms every year. In fact, MSDs are also the cause of work absenteeism in various sectors at around 15%, with annual prevalence in Western countries ranging from 36.2% to 57.9%, while in Asian countries, the figure is higher, ranging from 36.8% to 69.7% (Alfiani et al., 2023).

Various studies in India, Ethiopia, and a cross-country systematic review show a very high prevalence of MSDs among weavers, particularly in the shoulders, lower back, upper back, and neck, with 12-month prevalence in some locations reaching >80% for back and shoulder pain among handloom weavers, and a combined prevalence of approximately 72% in low- and middle-income countries. Consistent occupational factors that emerged were prolonged static sitting in front of the loom, uncomfortable posture, chairs without backrests, repetitive movements, working hours >8 hours/day, high workload, lack of rest, and lack of knowledge about ergonomics (Geto et al., 2025; Haftu et al., 2023; Siddiqui et al., 2021). A similar pattern is also seen among garment and batik workers in Indonesia, with the dominant complaints being lower back, neck, shoulder, and upper extremity pain due to awkward postures and repetitive manual work. In Laweyan, Surakarta, the context that has been studied, mainly batik and stamped batik, shows a high risk of MSDs due to stooped postures, long working hours, and workstation designs that are not ergonomic (Das et al., 2023; Gebrye et al., 2025; Pratiwi & Nuriati, 2022; Pristianto et al., 2025).

Various studies on weavers in countries such as Ethiopia and India show a high prevalence of MSDs related to prolonged sitting, repetitive hand movements, static work postures, and continuous physical workloads. These findings indicate that weaving work carries high ergonomic risks. Similar working conditions are also found in the textile industry in Laweyan District, Surakarta, where the weaving process is dominated by repetitive activities and long working hours. However, specific data on the prevalence and patterns of MSD complaints among textile industry weavers in this region are still limited, so there is no measurable picture available as in studies in other countries. This limitation provides an opportunity for further research to examine the relationship between age, length of service, and work fatigue with MSDs among textile industry weavers in Laweyan (Haftu et al., 2023b; Siddiqui et al., 2021).

Various evidence shows that age, working period, and work fatigue play an important role in the occurrence of MSDs. Among weavers in India and Ethiopia, complaints of MSDs increase with age and length of employment; workers with more than 10 years of experience have a risk of MSDs that is up to five times higher than those with less than 5 years of employment, presumably due to cumulative exposure, age-related degenerative changes, and reduced tissue repair capacity (Haftu et al., 2023a; Siddiqui et al., 2021). A meta-analysis of weavers in low- and middle-income countries also identified age >40 years and work experience >10 years as recurring factors associated with MSDs (Geto et al., 2025). A study of weavers in Indonesia found that age, daily working hours,

length of service, working posture, workload, and working hours were significantly associated with both work fatigue and MSD complaints, confirming that physical fatigue due to excessive work and non-ergonomic posture accelerates the onset of musculoskeletal pain (Pah et al., 2025).

Various work studies show that people over the age of 35 have a higher risk of MSDs than younger people. Among manufacturing workers in Beijing, being over the age of 35 significantly increased the prevalence of MSDs, along with long working hours, static sitting postures, repetitive movements, and uncomfortable positions (Ding et al., 2023). A textile study in India reported that most workers had 8–10 years of experience and concluded that longer work experience was associated with more severe MSDs incidents and pain, along with long working hours and continuous standing/sitting work (Saha et al., 2023). Ergonomic models explain that prolonged physical fatigue reduces muscle strength and endurance, worsens posture, and increases mechanical stress on joints/spine, thereby triggering or exacerbating MSDs (Ma et al., 2022). Therefore, these three factors are considered important determinants in understanding the risk of MSDs among textile industry weaving workers.

LITERATURE REVIEW

MSDs caused by cumulative trauma are a common health problem and occupational disorder globally. These problems stem from a variety of stressors, including repetitive movements, poor posture, overexertion, and localized mechanical stress (Marzban et al., 2024). In 2019, Global Burden of Disease noted that approximately 1.71 billion people worldwide experience these disorders, including low back pain, neck pain, osteoarthritis, and other similar conditions (Cieza et al., 2020).

In Indonesia, the prevalence of MSDs is also quite high. According to the Central Bureau of Statistics (2019), as many as 40.5% of diseases are the result of work. Based on a study involving 9,482 workers in 12 districts/cities in Indonesia, it is known that MSDs are experienced by 16% of total employees. In Indonesia, the RISKESDAS results show that the prevalence of MSDs symptoms reached 7.9%, and even in some provinces, such as Aceh and Bengkulu, the figure exceeded 10% (Ariyanto et al., 2024).

Some of the risk factors for MSDs commonly found in the workplace include age, working period, and fatigue. As we age, muscle ability and elasticity of body tissues will decrease, thus increasing susceptibility to injury. Previous research shows that workers over 35 years old have a 26 times greater risk of experiencing MSDs symptoms compared to workers under 35 years old (Rustam, 2024).

In addition to age, working period also plays a role in increasing the risk of MSDs. According to the theory of working period by Tarwaka (2004), the longer a person works, the greater the risk of experiencing MSDs. This is especially true in jobs with static sitting positions, which can cause strain on muscles, fascia, and ligaments in the thoracic area (Alfiani et al., 2023). Meanwhile, fatigue is a condition that is often not realized, but can reduce performance, increase the risk of injury, and accelerate the onset of MSDs symptoms (Hosseini et al., 2021).

METHODS

This study employed a quantitative analytic observational design with a cross-sectional approach to examine the relationship between age, working period, work fatigue, and MSDs symptoms at a single point in time.

This research was conducted at one of the leading textile companies located in the Laweyan area, Surakarta, from March to April 2025. The focus of this research was on the Weaving Department, which is the heart of fabric production at the company.

Working conditions in the weaving department are physically demanding, requiring workers to operate hundreds of weaving machines in a high-noise, high-temperature environment. Work activities involve prolonged standing and repetitive movements when joining threads, which ergonomically pose a risk of MSDs.

Age and working period are crucial variables at this location due to the diversity of employee profiles, ranging from new workers to senior workers who have been exposed to physical strain for decades. In addition, the noisy and hot work environment and the demand to always be alert to thread damage trigger the emergence of Work Fatigue. This fatigue is not just drowsiness, but a condition of decreased physical stamina in workers, which if left unchecked can exacerbate MSDs or disorders of the muscles and joints.

The population in this study consisted of all 490 workers in the weaving department. The sample size was determined using the Lemeshow formula with finite population correction, namely:

$$n = \frac{Z^2 \times P \times (1 - P) \times N}{d^2 \times (N - 1) + Z^2 \times P \times (1 - P)}$$

with the explanation:
n = minimum sample size
N = population size (490 workers)
Z = Z score at a 95% confidence level (1.96)
P = estimated population proportion (0.5)
d = margin of error (0.1)

Based on these calculations, the value n = 80.44 was obtained, which was rounded to 80 respondents as the minimum sample size. However, to increase the representativeness and strength of the analysis, this study involved 100 respondents selected using simple random sampling techniques among workers in the weaving section of the textile industry.

The independent variables in this study include age, working period, and work fatigue, while the dependent variable is MSDs symptoms. The instruments used were Fatigue Assessment Scale (FAS) questionnaire to measure work fatigue. The Fatigue Assessment Scale (FAS) is a standardized questionnaire used to assess the subjective fatigue experienced by workers, encompassing both physical and mental aspects. This instrument consists of 10 items designed to evaluate the intensity of fatigue and its impact on motivation and daily functioning. Work fatigue was measured using the Fatigue Assessment Scale (FAS), which consists of 10 items covering physical and mental fatigue dimensions (Lestari et al., 2022). Each item is rated on a five-point Likert scale ranging from 1 (never) to 5 (always). Items 4 and 10 are reverse-scored before calculating the total score. The total FAS score ranges from 10 to 50, obtained by summing all item scores (Tokumasu et al., 2024). Based on established cut-off values, a total score ≥22 indicates the presence of significant fatigue, while a score <22 indicates no fatigue (Hussain et al., 2022).

Musculoskeletal pain was assessed using the Nordic Body Map (NBM) questionnaire, an ergonomic instrument commonly used to detect musculoskeletal symptoms among workers. The NBM consists of a body map that identifies the location and level of discomfort in various muscle regions (Ammarwati, 2022). The Nordic Body Map (NBM) questionnaire was used to obtain detailed information on body regions experiencing pain or discomfort during work. Although based on self-report, this instrument has been standardized and validated for assessing musculoskeletal symptoms

(Dewi, 2020). The Nordic Body Map (NBM) questionnaire assesses 28 body regions on the right and left sides, from the neck to the lower limbs, to identify areas experiencing pain or discomfort. The total score reflects the overall level of musculoskeletal symptoms (Beatrix & Wijayanto, 2023). Although the original scoring system classifies symptoms into several risk levels, this study applied a simplified cut-off point, where a total score ≤28 was categorized as no symptoms and >28 as symptomatic (Ammarwati, 2022). Thus, there are 2 categorizations in this research MSDs symptoms, namely asymptomatic and symptomatic. As explained in Yung et al (2020) study, self-reported data may include responses from both asymptomatic and symptomatic workers, and individuals experiencing musculoskeletal symptoms may tend to report higher levels of exposure compared to those without symptoms.

Data collection was carried out through distributing questionnaires to respondents who met the inclusion criteria. After the data was collected, data processing was carried out consisting of editing, coding, scoring, entry, and tabulating. Data analysis was carried out univariately to describe the characteristics of respondents and bivariate with the Fisher Exact Test using IBM SPSS Statistics version 20 to identify the relationship between variables, with a significance level of 95% ($p < 0.05$).

Before this research was conducted, an ethical test was submitted to the Health Research Ethics Committee of the Faculty of Health Sciences, Universitas Muhammadiyah Surakarta with number 1024/KEPK-FIK/IV/2025. After ethical testing, data were collected from respondents by providing research consent sheets, followed by observation and filling out questionnaires by respondents. Primary data were then processed in accordance with predetermined univariate tests and bivariate tests, and interpretation of the results obtained.

RESULTS AND DISCUSSION

This research was conducted in one of the textile industries in Laweyan District, Surakarta City, which is engaged in the production and distribution of fabrics on a national to international scale. The company has an integrated production system that includes various processes ranging from yarn preparation, weaving, to fabric quality inspection. In supporting occupational safety and health (OHS), the company has tried to apply the principles of industrial hygiene and OHS management system which aims to minimize the risk of occupational accidents and health problems in its workforce.

The weaving area is one of the main work units in the production process, tasked with processing yarn into fabric through the crossing of warp and weft yarns. The process involves a series of stages such as warping, sizing, and recing, which are performed with repetitive movements and static postures. After that, the yarn is fed into the loom to be processed into fabric. This process is also supported by a cooling system in the form of water spraying so that the yarn does not break easily. After weaving, the fabric is checked for quality through the shiage process (quality inspection), then classified, folded through the kolding process (fabric fireplace), and mended (cutting of untidy threads and bleaching). High physical activity, static work positions, and repetitive movements performed continuously have the potential to cause MSDs in workers in this area. These risks are exacerbated by ergonomic hazards, such as lifting heavy loads, performing fast or repetitive movements, and the use of less ergonomically designed work machines and equipment that force workers to adopt unnatural or inappropriate postures (International Labour Organization, 2018).

This section presents the general characteristics of respondents involved in the study. The highest number of respondents was in the female gender category as many as

96 respondents (96%) while the number of respondents in the male gender category was 4 respondents (4%). The statistical tests that have been conducted produced data for univariate analysis as shown in Table 1.

Table 1. Distribution of Age, Working Period, Work Fatigue, and MSDs Symptom

Variable	Categories	Frequency	Percentage %
Age	≤ 35 Years	15	15
	> 35 Years	85	85
Working Period	≤ 10 Years	22	22
	> 10 Years	78	78
Work Fatigue	No Fatigue	15	15
	Fatigue	85	85
MSDs Symptom	Asymptomatic	7	7
	Symptomatic	93	93

The majority of respondents were over 35 years old, accounting for 85 individuals (85%), while those aged 35 years or younger totaled 15 individuals (15%). Most respondents also had a work period of more than 10 years, with 78 individuals (78%), compared to 22 individuals (22%) who had worked for 10 years or less. Additionally, the majority of respondents reported experiencing fatigue (85 individuals or 85%), while only 15 individuals (15%) did not report fatigue. In terms of MSDs symptoms, 93 respondents (93%) were categorized as symptomatic, while only 7 respondents (7%) were asymptomatic (Table 1).

Relationship between Age and Musculoskeletal Disorders (MSDs) in Weaving Workers of the Textile Industry

Age is one of the individual factors often associated with the risk of MSDs in workers. In this context, age refers to the chronological age of individuals that can affect their physical condition and health, including susceptibility to MSDs. Several studies have shown that increasing age may be associated with an increased risk of MSDs due to physiological changes that occur with age, such as decreased muscle strength and tissue elasticity (Gebrye et al., 2025).

The results of statistical tests in Table 2, that have been carried out with the Fisher Exact Test with a confidence level of 95% or α = 0.05 obtained a value (p-value 0.067), then Ha is rejected and Ho is accepted, which means that there is no relationship between age and symptoms of MSDs in textile industry weaving workers. The age category ≤ 35 years with no symptoms is 3% and there are MSDs symptoms as much as 12%. While the age category > 35 years with no symptoms as much as 4% and there are symptoms of MSDs as much as 81%.

Table 2. Bivariate Analysis Results

Variables	Categories	MSDs Symptoms				Total		*P-value*
		Asymptomatic		Symptomatic				
		n	%	n	%	N	%	
Age	≤ 35 Years	3	3	12	12	15	15	0,067
	> 35 Years	4	4	81	81	85	85	
Working Period	≤ 10 Years	4	4	18	18	22	22	0,040
	> 10 Years	3	3	75	75	78	78	
Work Fatigue	No Fatigue	4	4	11	11	15	15	0,009
	Fatigue	3	3	82	82	85	85	

The findings of this study are supported by previous research, which indicates that age is not significantly correlated with musculoskeletal symptoms (p = 0.05) (Ruka et al., 2024). The results of this study are also reinforced by research conducted based on age, the results of bivariate analysis in this study prove that there is no relationship between age and MSDs (p = 0.958) (Balaputra et al., 2020).

The results of this study contradict research conducted by Shobur et al (2019), that the results of the relationship analysis obtained the value of the age variable on MSDs is 0.012 (p <0.05) which indicates there is a relationship between age and MSDs symptoms. The possible relationship between age and MSD symptoms among weaving workers may be due to degenerative musculoskeletal processes that occur with age, such as decreased muscle elasticity, reduced bone density, and decreased tissue recovery capacity, making older workers more susceptible to pain and disorders resulting from long-term exposure to repetitive movements and static postures.

According to Tarwaka (2004), these findings are also supported by other theories that explain that age is a risk factor that can cause MSDs. In general, aged 35-65 years humans begin to feel symptoms in skeletal muscles. Usually, the first symptoms appear around the age of 35, and these symptoms tend to increase with age. This is due to the decline in muscle health and strength that often occurs in middle age, which increases the risk of developing problems with the muscles (Hakim et al., 2017). If there is no relevant relationship between age and MSDs symptoms, this could be due to the high number of elderly people who are still productive in the study area, either due to economic factors or personal desires. In addition, the condition is also influenced by physical strength that has been trained since a young age (Fahmiawati et al., 2021).

Relationship between Working Period and Musculoskeletal Disorders (MSDs) in Weaving Workers of Textile Industry

The working period is the time during which an employee, in accordance with internal regulations and employment contracts, must perform his or her job duties. It includes not only the main working time but also additional work, regulated rest periods, and other types of working time expenditure (Karavashkina et al., 2024)

The results of statistical tests that have been carried out with the Fisher Exact Test with a confidence level of 95% or α = 0.05 obtained a value (p-value 0.040), then Ha is accepted and Ho is rejected, which means that there is a relationship between working period and symptoms of MSDs in textile industry weaving workers. This shows that the longer the working period, the more at risk the weaving workers experience MSDs symptoms. The category of working period ≤ 10 years with no symptoms is 4% and there are MSDs symptoms as much as 18%. While the category of work period > 10 years with no symptoms was 3% and there were MSDs symptoms as much as 75%.

This result is in line with research conducted by (Djawa et al., 2023), that workers with a work period of more than 10 years have almost 4 times greater risk of experiencing MSDs than those with a shorter work period. Although the lower limit of the CI is close to 1, the p value still shows statistical significance.

Another study conducted on ulos weaving workers in South Siantar District also found that working period has a significant relationship with MSDs symptoms, with a p value of 0.020. This study suggests that workers with more than 10 years of working period need to manage work time to maintain health and reduce workload to prevent MSDs symptoms (Muliati, 2020).

The results of this study are also reinforced by a study conducted in Chencha District, Gamo Zone, Ethiopia which showed that a work period of more than ten years had

a 5.05 times greater chance of experiencing occupational MSDs compared to those with less than five years of work experience (AOR = 5.05; 95% CI: 1.23-20.77). A possible explanation is that more experienced weavers often work for extended durations and are more frequently exposed to risk factors that can lead to occupational MSDs. Moreover, aspects like the natural aging process, degenerative changes associated with age, reduced capacity for tissue repair, cartilage thinning, and the buildup of stress on various body structures due to workload also play a role in the development of work-related MSDs (Haftu et al., 2023b). Working period is one of the risk factors that have a major influence on the possibility of a worker experiencing MSDs symptoms, especially in types of work that require high physical exertion (Bahri et al., 2022)

The results of this study are not in line with the research proposed by Darlis and Elyanovianti (2023), with the results of the statistical test p value = 0.060 (p>0.05) indicating that there is no relationship between working period with symptoms of MSDs.

From the results presented above, it can be inferred that there is a significant association between the working period and the incidence of MSDs symptoms among weaving workers in the textile industry. An extended working period tends to increase the likelihood of workers experiencing MSD-related symptoms. This indicates that the duration of exposure to ergonomic risk factors, such as static work positions, repetitive movements, and high physical workloads over a long period of time, contributes to an increased risk of MSDs.

Therefore, it is recommended that companies make preventive efforts through job rotation to reduce the duration of exposure to workloads, provide regular ergonomic training, improve ergonomic work design, provide active breaks such as light stretching during working hours, and conduct routine occupational health checks, especially for workers with more than 10 years of working period. These measures are expected to reduce the prevalence of MSDs symptoms and improve worker welfare and productivity.

Relationship between Work Fatigue and Musculoskeletal Disorders (MSDs) in Weaving Workers of Textile Industry

Work fatigue is a condition in which workers experience a decrease in physical and mental capacity due to excessive workload or unergonomic working conditions. This fatigue can be triggered by several factors, such as high job demands, lack of control at work, and inadequate support from coworkers or superiors. Work fatigue can affect worker productivity and health, and increase the risk of other health problems such as MSDs (Das & Singh, 2025; Susoko & Zetli, 2023).

The results of the statistical analysis using the Fisher Exact Test at a 95% confidence level or $\alpha = 0.05$ yielded a p-value of 0.009. This indicates that the alternative hypothesis (Ha) is accepted while the null hypothesis (Ho) is rejected, signifying a significant relationship between work fatigue and MSDs symptoms among weaving workers in the textile industry. This shows that the more workers feel fatigue, the more at risk weaving workers experience MSDs symptoms. The category of no fatigue that has no symptoms is 4% and there are MSDs symptoms as much as 11%. While the category of fatigue with no symptoms was 3% and there were MSDs symptoms as much as 82%.

These results are reinforced by research conducted by Ruliati et al (2023) on Semau Island, Kupang Regency, which demonstrated a significant association between work fatigue, workload, and work posture with MSDs symptoms among traditional weaving workers. The study reported a p-value of less than 0.05, indicating a statistically significant relationship.

The findings in this study are also supported by the results of a study by Dwiseli et al (2023), which showed a significant relationship between work fatigue and MSDs symptoms, with a p value of 0.000. Based on these results, it is recommended that workers be given adequate rest time to restore energy and reduce the risk of MSDs.

Initial signs of MSDs may involve discomfort, numbness, tingling sensations, inflammation, joint stiffness, trembling, disrupted sleep, and a burning feeling. One condition that is also often experienced is fatigue, which can be a triggering factor for MSDs if it continues without proper treatment. (Faridah and Junaidi, 2022).

According to Saini et al (2022), MSDs are a major global problem, with increasing prevalence due to poor health, weight gain, fatigue, stress, and various lifestyle factors. From this statement it can be concluded that work fatigue also contributes to the incidence of MSDs.

Overview of MSDs Symptoms in Respondents

MSDs symptoms are disorders felt in the skeletal muscles, with severity varying from mild to severe. If this condition persists for a long period of time, it can cause permanent damage to muscles, joints, and ligaments, and have an impact on reducing work productivity and efficiency (Wardani et al., 2023).

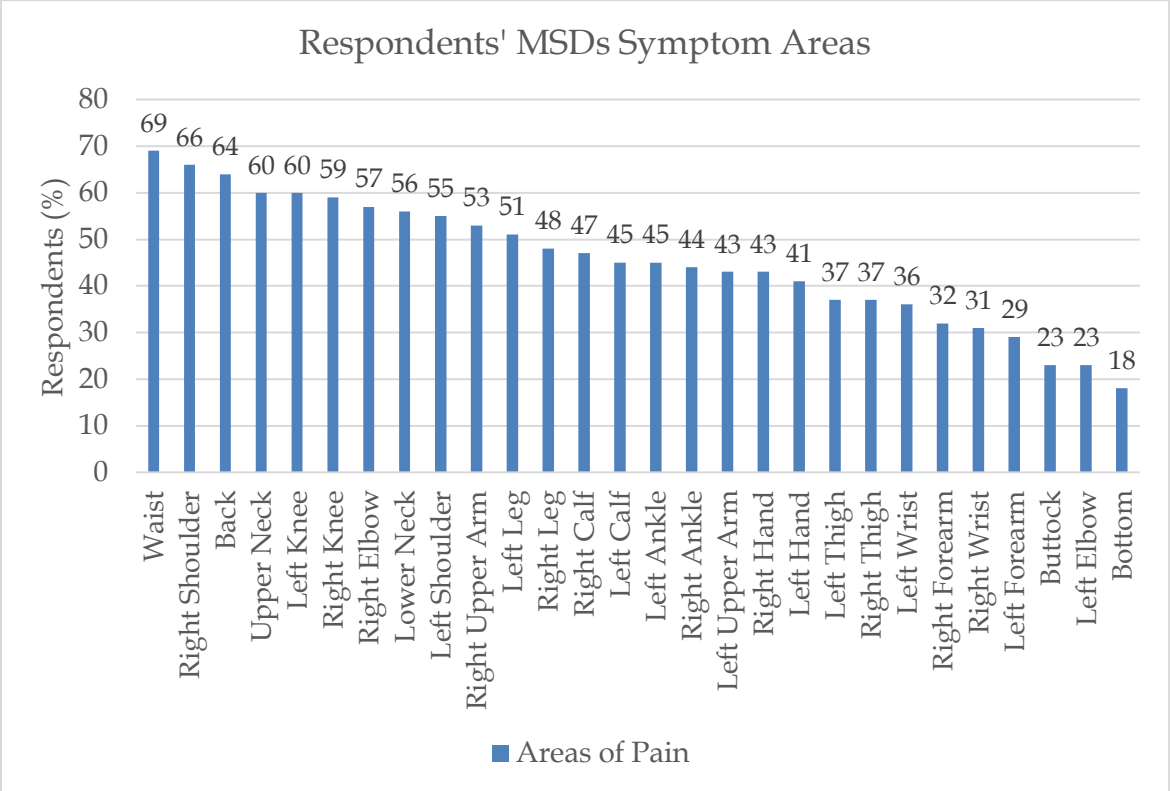

Figure 1. Respondents' MSDs Symptom Areas

Based on Figure 1, it can be seen that the top 3 areas that most often experience musculoskeletal symptoms are the waist, right shoulder, and back. Details of pain intensity show that 69% of respondents felt symptoms at the waist, 66% of respondents felt symptoms at the right shoulder, and 64% of respondents felt symptoms at the back.

In existing textile companies, weavers or workers often encounter issues such as prolonged sitting positions, repetitive motions, and poorly designed tools that lack

ergonomic support, which can lead to fatigue and MSDs. MSDs as a disease in which this disease has an indication of attacking the muscles, tendons, joint bones, ligaments, spinal nerves and cartilage. Indications of this disease are caused by events or work carried out on an ongoing basis or indications that arise as a result of events or work that has a chronic nature or can be said, some of the factors that become the main triggers that have a relationship with the risk of MSDs in the workplace are posture, load, frequency and time (Santi Pridayanti et al., 2023).

One recommendation to address musculoskeletal symptoms in workers in the textile industry, especially weavers, is to implement a comprehensive ergonomics program. This program includes education on correct work posture, adjusting equipment design to be more ergonomic, and managing workload and frequency to prevent excessive repetitive movements. Structured ergonomics training and counseling on the importance of maintaining posture while working has proven effective in reducing symptoms of pain in the waist, shoulder and back areas, and contributing to improving work productivity (Entianopa et al., 2024). In addition, interventions through dynamic stretching exercises and active rest performed regularly have also proven effective in significantly reducing musculoskeletal symptoms. These activities help reduce muscle tension caused by static work positions and monotonous movements (Febrianti et al., 2024; Nooryana et al., 2020). This approach is ideally combined with manual therapy, neuromuscular techniques, and the use of infrared light to provide comprehensive treatment of musculoskeletal symptoms as well as long-term prevention. Infrared therapy plays a role in helping to relax soft tissues, as the heat generated can facilitate muscle relaxation, increase muscle flexibility and range of motion (ROM), and reduce pain (Pristianto et al., 2024). Therefore, adjustments to work environment conditions and ongoing ergonomics training are key factors in reducing the risk of MSDs in the textile industry.

CONCLUSION

This study analyzes the relationship between age, working period, and work fatigue to MSDs symptoms in weaving workers. The results showed that age was not significantly associated with MSDs symptoms while working period and work fatigue had a significant relationship. Workers with a working period of >10 years and who experience fatigue experience more symptoms, especially in the waist, right shoulder, and back.

These symptoms can be triggered by non-ergonomic work postures, prolonged sitting, and repetitive movements. Therefore, it is recommended to improve ergonomics, job rotation, muscle stretching training, as well as providing rest time and routine health checks.

ACKNOWLEDGEMENT

Thanks to the Public Health Study Program, Faculty of Health Sciences, Universitas Muhammadiyah Surakarta and the owner of the textile industry for the time and support that has been given so that this research can be carried out well.

REFERENCES

Alfiani, R. R., Listyandini, R., & Fathimah, A. (2023). Faktor-Faktor yang Berhubungan dengan Keluhan Musculoskeletal Disorders (MSDs) pada Penjahit di Pasar Anyar Bogor Tahun 2022. *PROMOTOR: Jurnal Mahasiswa Kesehatan Masyarakat*, *6*(3), 204–212. https://doi.org/10.32832/pro.v6i3.246

Ammarwati, Q. (2022). *Faktor-Faktor Yang Berhubungan Dengan Keluhan Musculoskeletal Disorders (MSDs) Pengguna Komputer Pada Pegawai Kantor Dinas Ketahanan Pangan Kota Tangerang Tahun 2022*. UIN Syarif Hidayatullah Jakarta-FIKES.

Ariyanto, J., Aulia Rahman, N., Zen, A., Latifah, N., & History, A. (2024). Analisis Postur Kerja Menggunakan REBA Dan Faktor Penyebab Keluhan MSDs Pekerja PT X Broiler. *Jurnal Promotif Preventif*, *7*(3), 537–544. http://journal.unpacti.ac.id/index.php/JPP

Bahri, S., Kania Rahsa Puji, L., Widya Dharma Husada Tangerang, Stik., Pejajaran No, J., Barat, P., & Tangerang selatan, K. (2022). Hubungan Sikap Kerja, Masa Kerja, dan Durasi Kerja dengan Keluhan Musculoskeletal Disorders (MSDs) pada Pekerja Manual Handling Pekerja di Gudang X. Tangerang Selatan. In *Frame of Health Journal* (Vol. 1).

Balaputra, I., Al-Qodiri, S. B., Manggar, J., & Gebang, A. (2020). *Hubungan Pengetahuan dan Masa Kerja dengan Gangguan Musculoskeletal pada Perawat di Rumah Sakit*.

Beatrix, M. E., & Wijayanto, A. W. (2023). Posture Analysis Using the Rapid Entire Body Assessment (REBA) & Nordic Body Map (NBM) Methods to Reduce the Risk of Musculoskeletal Disorders (MSDs) in Automotive Company. *International Journal of Advances in Scientific Research and Engineering*, *09*(02), 29–35. https://doi.org/10.31695/ijasre.2023.9.2.4

Cieza, A., Causey, K., Kamenov, K., Hanson, S. W., Chatterji, S., & Vos, T. (2020). Global estimates of the need for rehabilitation based on the Global Burden of Disease study 2019: a systematic analysis for the Global Burden of Disease Study 2019. *The Lancet*, *396*(10267), 2006–2017. https://doi.org/10.1016/S0140-6736(20)32340-0

Darlis, I., & Elyanovianti. (2023). Hubungan Antara Masa dan Lama Kerja Dengan Keluhan Nyeri Otot Skeletal (Musculoskeletal Disorders). *Jurnal Keolahragaan Juara*, *3*, 45–51. https://doi.org/10.37304/juara.v3i1.9435

Das, D., & Singh, A. K. (2025). Interactions between work-related factors, perceived fatigue and musculoskeletal disorders among handicraft artisans: structural equation model analysis. *Ergonomics*, *68*(1), 95–111. https://doi.org/10.1080/00140139.2023.2300952

Das, Krishna Moorthy, M., & Shanmugaraja, K. (2023). Analysis of Musculoskeletal Disorder Risk in Cotton Garment Industry Workers. *Journal of Natural Fibers*, *20*(1), 2162182. https://doi.org/10.1080/15440478.2022.2162182

Dewi, N. F. (2020). Identifikasi Risiko Ergonomi dengan Metode Nordic Body Map terhadap Perawat Poli RS X. *Jurnal Sosial Humaniora Terapan*, *2*(2), 15.

Ding, X., Guan, Z., Liu, N., Bi, M., Ji, F., Wang, H., Zhang, X., Liu, B., Niu, D., Lan, T., Xie, T., Li, J., & Yan, T. (2023). Prevalence and risk factors of work-related musculoskeletal disorders among emerging manufacturing workers in Beijing, China. *Frontiers in Medicine*, *10*, 1289046. https://doi.org/10.3389/fmed.2023.1289046

Djawa, A. N., Muntasir, M., & Landi, S. (2023). Analysis of Musculoskeletal Disorders Complaints among Ikat Weaving Craftsmen in Langa Bajawa, Ngada, East Nusa Tenggara in 2022. *Journal of Health Promotion and Behavior*, *8*(3), 216–225. https://doi.org/10.26911/thejhpb.2023.08.03.06

Dwiseli, F., Rahmadani, Y., Syafitri, M. N., & Hairudin, K. (2023). Hubungan Kelelahan Kerja dengan Keluhan Musculoskeletal Disorders pada Pengemudi Bus Terminal Regional Daya. *Jurnal Kesehatan Akper Kesdam II Sriwijaya Palembang*, *12*(3).

Entianopa, E., Marisdayana, R., & Octavia, D. (2024). Edukasi Postur Kerja Secara Ergonomi untuk Meredakan Keluhan Nyeri Gangguan Muskuloskeletal (MSDS) pada Pekerja

Batik Tulis. *Jurnal Kreativitas Pengabdian Kepada Masyarakat (PKM)*, *7*(10), 4661–4672. https://doi.org/10.33024/jkpm.v7i10.17424

Fahmiawati, A. N., Fatimah, A., & Listyandini, R. (2021). Faktor-faktor yang Berhubungan dengan Keluhan Musculoskeletal Disorders (MSDs) pada Petani Padi Desa Neglasari, Kecamatan Purabaya, Kabupaten Sukabumi Tahun 2019. In *PROMOTOR Jurnal Mahasiswa Kesehatan Masyarakat* (Vol. 4, Number 5). http://ejournal.uika-bogor.ac.id/index.php/PROMOTOR

Faridah, F., & Junaidi, A. S. (2022). Faktor yang Mempengaruhi Keluhan Musculoskeletal Disorders (MSDs) Pada Pembatik Seberang Kota Jambi. *Quality : Jurnal Kesehatan*, *16*(2), 109–116. https://doi.org/10.36082/qjk.v16i2.831

Febrianti, P. A., Arismawati, P., & Wahyuni, A. E. (2024). Analisis Postur Kerja Terhadap Keluhan Musculoskeletal Disorders (MSDs) Menggunakan Metode Rapid Upper Limb Assessment (RULA) pada Pekerja Pencantingan di Tatsaka Batik Banyuwangi. *Religion Education Social Laa Roiba Journal*, *6*, 5175. https://doi.org/10.47476/reslaj.v6i11.3924

Gebrye, T., Mbada, C., Apeagyei, P., & Fatoye, F. (2025). Prevalence of musculoskeletal disorders among garment workers: a systematic review and meta-analysis. *BMJ Open*, *15*(1), e085123. https://doi.org/10.1136/bmjopen-2024-085123

Geto, A. K., Daba, C., Desye, B., Berihun, G., & Berhanu, L. (2025). Prevalence of work-related musculoskeletal disorder and its associated factors among weavers in low- and middle-income countries: a systematic review and meta-analysis. *BMJ Open*, *15*(8), e093124. https://doi.org/10.1136/bmjopen-2024-093124

Haftu, D., Kerebih, H., & Terfe, A. (2023a). Prevalence of work-related musculoskeletal disorders and its associated factors among traditional cloth weavers in Chencha district, Gamo zone, Ethiopia, an ergonomic study. *PLOS ONE*, *18*(11), e0293542. https://doi.org/10.1371/journal.pone.0293542

Haftu, D., Kerebih, H., & Terfe, A. (2023b). Prevalence of work-related musculoskeletal disorders and its associated factors among traditional cloth weavers in Chencha district, Gamo zone, Ethiopia, an ergonomic study. *PLoS ONE*, *18*(11 NOVEMBER). https://doi.org/10.1371/journal.pone.0293542

Hakim, N. R., Tarwaka, & Asyfiradayati, R. (2017). *Hubungan Risiko Manual Handling dan Karakteristik Individu dengan Keluhan Musculoskeletal pada Petani Pembudidaya Ikan Lele Bangun Mina Sejahtera Kec. Sawit, Kab. Boyolali*. Universitas Muhammadiyah Surakarta.

Hosseini, E., Daneshmandi, H., Bashiri, A., & Sharifian, R. (2021). Work-related musculoskeletal symptoms among Iranian nurses and their relationship with fatigue: a cross-sectional study. *BMC Musculoskeletal Disorders*, *22*(1). https://doi.org/10.1186/s12891-021-04510-3

Hussain, N., Samuelsson, C. M., Drummond, A., & Persson, C. U. (2022). Prevalence of Fatigue at One-Year Follow-up from The Gothenburg Recovery and Rehabilitation after COVID-19 and Intensive Care Unit Study. *Scientific Reports*, *12*(1). https://doi.org/10.1038/s41598-022-14787-6

International Labour Organization. (2018). *Improving the Safety and Health of Young Workers*.

Karavashkina, R. I., Guro-Frolova, Y. R., & Fedotova, E. M. (2024). Factors for increasing the efficiency of using working time for knowledge workers in water transport. *Russian Journal of Water Transport*, (78), 141–147. https://doi.org/10.37890/jwt.vi78.459

Lestari, I. D., Chirzun, A., & Nurhasanah, N. (2022). Analisis Kelelahan Kerja Menggunakan Fatigue Assessment Scale pada PT. Indonesia Power Priok POMU. In *Jurnal Metris* (Vol. 23). http://ejournal.atmajaya.ac.id/index.php/metris

Ma, L., Chablat, D., Bennis, F., & Zhang, W. (2022). A new simple dynamic muscle fatigue model and its validation. *International Journal of Industrial Ergonomics*, *39*(1), 211–220. https://doi.org/10.1016/j.ergon.2008.04.004

Marzban, H., Rezaei, E., Shahmahmoudi, F., Zangiabadi, Z., Sahebi, A., & Makki, F. (2024). Musculoskeletal disorders among bank workers: a systematic review and meta-analysis. *BMC Musculoskeletal Disorders*, *25*(1), 951. https://doi.org/10.1186/s12891-024-08077-7

Muliati, M. (2020). *Faktor yang Berhubungan Dengan Muskuloskeletal Disorders (MSDs) Pada Pekerja Tenun Ulos di Kecamatan Siantar Selatan Kota Pematangsiantar Tahun 2016*. (10), 132–145.

Nooryana, S., Adiatmika, I. P. G., & Purnawati, S. (2020). Latihan Peregangan Dinamis Dan Istirahat Aktif Menurunkan Keluhan Muskuloskeletal Pada Pekerja Di Industri Garmen. *Jurnal Ergonomi Indonesia (The Indonesian Journal of Ergonomic)*, *6*(1), 61. https://doi.org/10.24843/jei.2020.v06.i01.p08

Pah, Y., Putu Ruliati, L., Sahdan, M., Matani Raya, J., Klp Lima, K., Kupang, K., & Tenggara Timur, N. (2025). Analisis Faktor Ergonomi dengan Kelelahan Kerja dan Keluhan Musculoskeletal Disorders pada Pekerja Tenun Ikat di Desa Numponi Kabupaten Malaka. *Vitamin : Jurnal Ilmu Kesehatan Umum*, *3*(2), 157–164. https://doi.org/10.61132/vitamin.v3i2.1270

Pratiwi, I., & Nuriati, H. W. (2022). Ergonomic risk evaluation to minimize musculoskeletal disorders of workers at batik cap industry. *Jurnal Sistem Dan Manajemen Industri*, *6*(2), 176–186. https://doi.org/10.30656/jsmi.v6i2.5043

Pristianto, A., Kusumaningrum, T. A. I., Dewangga, M. W., Ilmuddin, F. W., Amanda, M. S., Triasari, A., Siddiq, M. N., Samiyem, S., & Nabila, K. N. (2024). Pendampingan Kesehatan Fisik bagi Pembatik sebagai Upaya Mengurangi Risiko dan Keluhan Work-related Musculoskeletal Disorder (WMSD) di Kampung Batik Laweyan. *Warta LPM*, 322–331. https://doi.org/10.23917/warta.v27i2.5171

Pristianto, A., Naufal, A. F., Dewangga, M. W., Setiyaningsih, R., Aranti, W. A., Triasari, A., Amanda, M. S., Lathifani, N. R., Billa, A. S., Samiyem, & Siddiq, M. N. (2025). Age and ergonomic position as determinants of musculoskeletal disorders among Batik workers: A cross-sectional study. *Physical Therapy Journal of Indonesia*, *6*(1), 64–69. https://doi.org/10.51559/ptji.v6i1.282

Ridlo, A. J., & Fasya, A. H. Z. (2023). Gambaran Keluhan Musculoskeletal Disorder (MSDs) pada Pekerja PDKB PT. PLN (Persero) UP3 Surabaya Selatan. *SEHAT RAKYAT (Jurnal Kesehatan Masyarakat)*, *2*(2), 258–266. https://doi.org/10.54259/sehatrakyat.v2i2.1665

Ruka, F. S., Banjari, M. R. A. Al, Thariq, T. C. A., & Hardini, K. F. (2024). Hubungan Usia dan Pekerjaan dengan Keluhan Muskuloskeletal pada Ibu Rumah Tangga di Desa Bedali. *SEHATMAS: Jurnal Ilmiah Kesehatan Masyarakat*, *3*(3), 542–548. https://doi.org/10.55123/sehatmas.v3i3.3945

Ruliati, L. P., Setyobudi, A., Talahatu, A. H., & Takaeb, A. E. L. (2023). Ergonomic Risk Analysis on Traditional Weaving Workers on Semau Island Kupang Regency. *JURNAL INFO KESEHATAN*, *21*(2), 257–264. https://doi.org/10.31965/infokes.Vol21.Iss2.1044

Rustam, I. A. (2024). *Faktor Risiko Keluhan Musculoskeletal Disorders (MSDs) pada Buruh Jasa Angkut Perwakilan Sinar Jaya di Desa Lamunre Tengah Kecamatan Belopa Utara Kabupaten Luwu Tahun 2024*. UIN Alauddin Makassar.

Saha, R., Chakraborty, R., Ghosh, P., Ghosh, J., & Haldar, P. (2023). Work-Related Musculoskeletal Disorder an Increasing Concern in Garment Industry. *Journal of Advanced Zoology*, *44*(S6), 1684–1689. https://doi.org/10.17762/jaz.v44is6.2591

Saini, S. K., Bedwa, M., &. A. (2022). Review Paper on Musculoskeletal Disorders. *International Journal for Research in Applied Science and Engineering Technology*, *10*(6), 536–539. https://doi.org/10.22214/ijraset.2022.43809

Santi Pridayanti, P., Wayan Rusni, N., & Nia Calista Santoso, P. (2023). Identifikasi Risiko Ergonomi pada Pekerja Tenun di Kecamatan Dawan Kabupaten Klungkung. *Aesculapius Medical Journal |*, *3*(2).

Shobur, S., Maksuk, M., & Sari, F. I. (2019). Faktor Risiko Keluhan Musculoskeletal Disorders (MSDs) Pada Pekerja Tenun Ikat di Kelurahan Tuan Kentang Kota Palembang. *Jurnal Medikes (Media Informasi Kesehatan)*, *6*(2), 113–122. https://doi.org/10.36743/medikes.v6i2.188

Siddiqui, L. A., Banerjee, A., Chokhandre, P., & Unisa, S. (2021). Prevalence and predictors of musculoskeletal disorders (MSDs) among weavers of Varanasi, India: A cross-sectional study. *Clinical Epidemiology and Global Health*, *12*, 100918. https://doi.org/10.1016/j.cegh.2021.100918

Susoko, Y. J. P., & Zetli, S. (2023). Pengaruh Kelelahan Kerja terhadap Keluhan Musculoskeletal Disorders (MSDs) pada Pekerja Wanita di PT Amtek Plastic Batam. *Computer and Science Industrial Engineering (COMASIE)*, *9*(7). https://doi.org/10.33884/comasiejournal.v9i7.7875

Tokumasu, K., Matsuki, N., Fujikawa, H., Sakamoto, Y., & Otsuka, F. (2024). Reliability and Validity of the Japanese Version of the Fatigue Assessment Scale. *Internal Medicine*. https://doi.org/10.2169/internalmedicine.4101-24

Wardani, R., Meirino, M., Lestari, D. D., & Giawa, D. (2023). *Upaya Pencegahan Gangguan Musculoskeletal Disorders (MSDs) Pada Karyawan dan Karyawati Front Office Department di Klinik Recons Fit Palembang*. *1*(2). https://doi.org/10.24853/jaras.1.2.116-124

Wildasari, T., & Nurcahyo, R. E. (2023). *Hubungan Antara Postur Kerja, Umur, Masa Kerja Dengan Keluhan Musculoskeletal Disorders (MSDs) Pada Pekerja di CV. Sada Wahyu Kabupaten Bantul Yogyakarta*. https://doi.org/10.69883/jlkm.v2i1.24

Yung, M., Dale, A. M., Buckner-Petty, S., Roquelaure, Y., Descatha, A., & Evanoff, B. A. (2020). Musculoskeletal Symptoms Associated with Workplace Physical Exposures Estimated by A Job Exposure Matrix and By Self-Report. *American Journal of Industrial Medicine*, *63*(1), 51–59. https://doi.org/10.1002/ajim.23064