

Determinants of Musculoskeletal Disorders (MSDs) in Construction Workers in Medan Tuntungan District

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ABSTRACT

Construction workers are prone to Musculoskeletal Disorders (MSDs) due to the high physical demands of their work and their working environment. MSDs have a negative impact on workers' health and productivity. This study aims to analyze the partial and simultaneous effects of work posture, workload, and working environment temperature on MSD complaints among construction workers in Medan Tuntungan District. The study was conducted on 40 construction workers in Medan Tuntungan District. Data were collected through measurements of work posture (using QEC), workload (using CVL), environmental temperature (using Heat Index), and MSD complaints. Data analysis used multivariate analysis with multiple linear regression tests. The residual data were normally distributed (Sig. = 0.200 > 0.05). Simultaneously, work posture, workload, and temperature significantly influenced MSD complaints (Sig. = 0.000 < 0.05). Partially, work posture significantly influenced MSD complaints (Sig. = 0.030 < 0.05), and workload (Sig. = 0.025 < 0.05). However, environmental temperature did not significantly influence MSD complaints (Sig. = 0.205 > 0.05). The combined contribution of the three variables to MSD complaints is 41.6%. Work posture and workload are significant determinants of MSD complaints among construction workers in Medan Tuntungan District. Therefore, efforts to prevent MSDs should focus on improving work posture and managing workload.

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INTRODUCTION

Musculoskeletal Disorders (MSDs) are injuries that arise due to incompatibility between the work environment and a person's work methods (1). These disorders are characterized by the gradual but persistent onset of pain, which lasts for a long time and can range in intensity from mild to severe (2).

Other studies, such as Amalia's research, explain that in the industrial world, Musculoskeletal Disorders (MSDs) are one of the most significant health problems. Research by Kibret, then research conducted by Kibret et al. (2018), identified Musculoskeletal Disorders (MSDs) as the most dominant occupational health disorder, accounting for 42% to 58% of work-related cases in 2019 (3). Risk factors such as repetitive work, long periods of standing, and manual lifting can trigger this disorder (4).

According to the International Labor Organization (ILO), an estimated 2.3 million workers worldwide experience workplace accidents each year (5). This figure shows an upward trend, with an average of more than 6,000 additional cases per year since 2020. Regarding MSDs, UK data from 2019 recorded 481,000

cases, with complaints in the neck area being the highest (212,000 cases or 44%), the back 176,000 (37%), and the lower limbs 93,000 (19%) with a prevalence of 1,421 per 100,000 workers. As a result, workers lost 8.9 million working days due to these incidents (6). According to data from the Global Burden of Disease (GBD) analysis for 2021, there are approximately 1.71 million people worldwide who suffer from musculoskeletal disorders and live in countries with the highest prevalence rates, which affects 441 million people, 427 million people in the Western Pacific Region, and 369 million people in Southeast Asia. In Indonesia, 2018 data shows that 713,783 people suffer from Musculoskeletal Disorders (MSDs), with a national prevalence of 7.30%. Globally (7). The WHO confirms that MSDs, especially lower back pain, are one of the main contributors to disability in the world (8).

A study of 9,482 workers in 12 districts/cities in Indonesia revealed that the most common health complaint was musculoskeletal disorders (16%). Other complaints included cardiovascular disorders (8%), neurological disorders (5%), respiratory disorders (3%), and ENT disorders (1.5%). The informal sector, particularly traditional construction workers, was recorded as the industry with the largest contribution to musculoskeletal complaints (9).

Construction projects involve many workers, materials, tools, and diverse locations that are potentially hazardous. Their uniqueness lies in their varying scope and location, as well as their varying duration. Musculoskeletal complaints can worsen if workers perform activities with non-ergonomic postures or awkward positions (10). Common activities for construction workers in the workplace include lifting, carrying, and other construction activities. However, inadequate working conditions and practices contribute to injuries and accidents that cause pain and illness among workers (11). Construction workers in Indonesia, especially those in the informal sector or commonly known as construction laborers, still rely heavily on manual labor for lifting and carrying building materials and other construction work.

The occurrence of Musculoskeletal Disorders (MSDs) can be influenced by several factors. Previous studies have found a relationship between posture and the occurrence of Musculoskeletal Disorders (MSDs) (12). Another study stated that occupational factors, including workload, work posture, length of service, working hours, working climate, and repetitive movements during work, can affect Musculoskeletal Disorders (MSDs) complaints. Environmental factors also need to be considered. In accordance with Indonesian Minister of Health Regulation No. 70 of 2016 concerning Standards and Requirements for Industrial Work Environment Health, the permissible work environment temperature for workloads is

After conducting an initial survey using the Nordic Body Map questionnaire, 100% of the 10 construction workers surveyed experienced Musculoskeletal Disorders (MSDs) with 2 people classified as low risk, 7 people classified as moderate risk, and 1 person classified as high risk. Complaints included discomfort in the neck, shoulders, back, waist, arms, and legs. After conducting observations, there were awkward working postures, such as when lifting materials, workers bent over, bent down too much when laying bricks, and others. The workload felt by construction workers can affect Musculoskeletal Disorders (MSDs) complaints, which can be seen from dynamic physical activities and activities of lifting and carrying heavy materials. Additionally, environmental factors also need to be considered, as the ambient temperature at the research site reached 34.5°C, which exceeds the threshold for industrial climate temperature. Based on these findings, the author was interested in examining the determinants of Musculoskeletal Disorders (MSDs) among construction workers in the Medan Tuntungan subdistrict.

METHOD

This study used a quantitative approach with a cross-sectional design, in which measurements of independent variables (work posture, workload, and environmental temperature) and dependent variables (Musculoskeletal Disorders/MSDs complaints) were conducted simultaneously. The research sample consisted of 40 informal construction workers in Medan Tuntungan District, Medan City, specifically in Ladang Bambu and Tuntungan II villages, who were selected using non-random sampling techniques with the Rule of Thumb method (number of variables multiplied by 10). Primary data were obtained directly through questionnaires and field measurements using standard instruments, namely Quick Exposure Check (QEC) to assess work posture risks, Cardiovascular Load (CVL) to measure workload, thermometers based on the NWS Heat Index to record environmental temperature, and Nordic Body Map (NBM) to detect MSD complaints. Measuring instruments such as pulse oximeters and thermometers were calibrated by licensed medical personnel. Secondary data was obtained from literature, scientific journals, and reliable online sources.

Data collection was conducted through field surveys, literature studies, and internet research from February to April 2025. Data analysis was performed statistically using SPSS, including normality tests to evaluate residual distribution and multivariate analysis (multiple linear regression) to assess the simultaneous effect of independent variables on dependent variables.

RESULTS

1. Description of Research Location

This study was conducted in Medan Tuntungan District, Medan City, North Sumatra, specifically in Ladang Bambu and Tuntungan II subdistricts. This area was chosen because it is a rapidly developing suburban area in the southwestern part of Medan City (3°27'–3°47' N and 98°35'–98°44' E) with various construction activities, ranging from simple housing projects to large-scale public facility development. The working environment conditions in the construction sector in Medan Tuntungan have distinctive characteristics, namely a tropical climate with high air temperature and humidity as well as direct sunlight exposure in open areas, which can increase the risk of heat strain. These factors have the potential to increase fatigue and the vulnerability of traditional construction workers to Musculoskeletal Disorders (MSDs). In addition, the topographical variations in this region can also affect the types of work and work postures adopted by workers, making it a relevant location for research.

2. Research Data Description

Table 1. Research Data Distribution

Variable	(n)	Mean	Median	SD	Min	Max
Age	40	37,25	37,50	11,119	17	63
Msd	40	54,98	57,00	13,482	30	73
Posture (QEC) (%)	40	68,675	70,250	4,8184	58,0	75,0
Load (CVL)	40	50,2435	59,9650	13,583	26,67	64,77
Temperature (Heat Indeks)	40	117,70	117,50	9,169	100	132

Based on Table 1 above, it is known that the average age of workers is 37.25 years, with the youngest being 17 years old and the oldest being 63 years old. The average Msds shows 54.98 with a minimum value of 30 and a maximum value of 73. The average work posture shows 68.675 with a minimum value of 58.0 and a maximum value of 75.0. The average workload is 50.2435, with a minimum value of 26.67 and a maximum value of 64.77. The average temperature is 117.70, with a minimum value of 100 and a maximum value of 132.

3. Research Analysis Results

The results of this analysis aim to identify the determining factors of MSD complaints and the extent of their influence. This study was conducted on construction workers in Medan Tuntungan District with a total of 40 respondents who became the sample in this study. Data analysis used normality tests to see the normal distribution of data and linear regression tests to see the effect of work posture, workload, and temperature on MSD complaints.

a. Normality Test

Table 2. Normality Test

Normality	Kolmogorov - Smirnov		
	Statistic	df	Sig.
	0,105	40	0,200

Based on Table 2 above, the significance value in the multiple regression equation is 0.200, which is greater than 0.05. Therefore, it can be concluded that the normality assumption is fulfilled, indicating that the residual data is normally distributed.

b. Simultaneous Test (F Test)

Table 3. Simultaneous Test Results

Variabel	Sum Of Squares	df	Mean Square	F	Sig.
Regression	4918,79	3	1639,597	23,198	0,000
Residual	2170,18	36	60,283		
Total	7088,975	39			

Berdasarkan tabel diatas nilai signifikansi yang didapat sebesar $0,000 < 0,05$ maka dapat disimpulkan bahwa variabel postur kerja, beban kerja, suhu berpengaruh signifikan secara bersama-sama (simultan) terhadap keluhan MSDs.

c. Uji Regresi Linear

Tabel 4. Linear Regression Test

Model	Unstandardized Coefficient		Standardized Coefficient	t	Sig.
	B	St.d Error	Beta		
(Constant)	0,795	0,275		2,894	0,006
Posture (QEC) (%)	0,156	0,069	0,351	2,265	0,030
Load CVL	0,222	0,95	0,344	2,336	0,025
Temperature F	0,144	0,111	0,178	1,292	0,205

Based on the table above, the working posture obtained a significance value of $0.030 < 0.05$, indicating that working posture has a significant effect on MSD complaints. The workload obtained a significance value of $0.025 < 0.05$, indicating that workload has a significant effect on MSD complaints. The temperature variable had a significance value of $0.205 > 0.05$, indicating that temperature does not significantly affect MSD complaints.

The analysis also shows that the most influential variable in the study is work posture with a value (B) = 0.351, meaning that work posture has an influence of 35.1%. This was followed by workload with a value of (B) = 0.3444, meaning that workload has an influence of 34.4%. Next was temperature with a value of (B) = 0.178, meaning that temperature has an influence of 17.8%, but statistically, after controlling for variables, temperature has no influence.

d. Determination Coefficient Test (R2)

Table 5. Determination Coefficient Test (R2)

R	R Square	Adjusted R Square	Std.Error of the Estimate
0,645	0,416	0,367	0,349

The coefficient of determination aims to see how much influence the independent variable has on the dependent variable. The results of the coefficient of determination test in this study can be seen in the following table.

DISCUSSION

1. The Effect of Work Posture on MSD Complaints in Construction Workers

The results showed that work posture was the most dominant variable, accounting for 35.1% of the variance, with an average work posture score of 68.675, a minimum score of 58.0, and a maximum score of 75.0, indicating variations in the level of work posture risk among respondents. Based on statistical test results, a significance value of $0.030 (p < 0.05)$ was obtained, which means that there is a significant effect between work posture and Musculoskeletal Disorders (MSDs) complaints. This finding reinforces that non-ergonomic work posture can be a major risk factor in causing MSD complaints, especially in parts of the body such as the neck, back, shoulders, and arms. Poor work posture, such as bending over for too long, twisting the body excessively, or prolonged static positions, can increase the mechanical load on the musculoskeletal system and cause micro-injuries that accumulate over time.

Ergonomic theory explains that in a work system, it is very important to adjust the physical abilities and limitations of humans to the demands of the job. If the work posture applied is not in accordance with ergonomic principles—for example, a body position that is too bent, sitting for too long, or repetitive movements—then there will be a mismatch between the worker and the job. This mismatch can cause increased muscle strain, physical fatigue, and in the long term, potentially lead to injuries to the musculoskeletal system, such as muscle and joint pain or spinal disorders. Construction workers are a group that is highly susceptible to Musculoskeletal Disorders (MSDs) due to high physical workloads, repetitive activities, the use of heavy equipment, and non-ergonomic work postures. Problems often faced by construction workers, such as lifting excessive loads, working in bent or squatting positions for long periods of time, and the lack of ergonomic work aids, can trigger muscle and bone disorders slowly but continuously. This is in line with equivalent research in a study of painters in Surabaya, which found that poor work posture when lifting and carrying materials manually increased the frequency of MSD complaints (13). In addition, an epidemiological study in a mechanical renovation project showed a significant relationship between manual physical workload and fatigue in construction workers, which was then correlated with musculoskeletal symptoms.

Work posture is one of the main risk factors for Musculoskeletal Disorders (MSDs). Non-ergonomic postures, such as bending over for too long, lifting heavy loads with poor body positioning, or working in

uncomfortable static positions, can cause excessive strain on muscles, joints, and bones. If left unaddressed, this can lead to muscle fatigue, soft tissue injuries, and even long-term disorders of the musculoskeletal system. Therefore, it is important to evaluate and improve work posture, including through ergonomics training, providing appropriate work aids, and rearranging work positions to align with ergonomic principles. These efforts can not only prevent MSDs but also enhance worker comfort and productivity.

2. The Effect of Workload on MSD Complaints Among Construction Worker

The results show that workload has an influence of 34.4% with an average value of 50.2435, with a minimum value of 26.67 and a maximum value of 64.77. This indicates that there is variation in the level of workload felt by respondents. In addition, statistical tests show a significance value of $p = 0.025 (< 0.05)$, which indicates that there is a significant effect between workload and musculoskeletal disorders (MSDs). Physiologically, excessive workload can cause the body's muscles to work excessively. Activities involving repetitive movements, heavy lifting, and long working hours cause muscle fatigue, pressure on the joints, and disruption of blood flow to muscle tissue. These conditions will gradually cause MSD symptoms such as lower back, neck, shoulder, and hand pain.

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In line with the research conducted by Dihartawan et al. (2024), they also found an indirect relationship between high workload and fatigue, which leads to musculoskeletal disorders (14). Additionally, a study in Karawang by Sudiono & Milalestari (2024) found that workload is one of the significant factors contributing to MSD complaints among manufacturing workers ($p = 0.000$) (11). This is also supported by a cross-country study in China by Lee et al. (2023), which noted a prevalence of WMSDs of 57.9% among construction workers and showed that fatigue after heavy physical work was associated with an increase in MSD symptoms (15).

The significant influence of workload on Musculoskeletal Disorders (MSDs) complaints indicates that addressing excessive workload is crucial in preventing musculoskeletal disorders among workers, particularly in the construction sector. Heavy and continuous physical workloads can cause muscle fatigue, decreased joint function, and biomechanical stress, leading to chronic pain and injury. Therefore, ergonomics-based interventions are necessary, such as reorganizing work tasks to be more proportional, using tools to reduce heavy manual physical activity, and implementing work schedules that allow for adequate rest periods. In addition, education and training on proper work posture are very important to increase workers' awareness of safe working practices. Management must also involve comprehensive risk management, including the identification of excessive workloads through observation and ergonomic assessment. With these efforts, it is hoped that MSD complaints can be minimized, and work productivity and worker welfare can be improved in a sustainable manner.

3. The Effect of Temperature on MSD Complaints Among Construction Workers

Based on the results of the study, the average temperature was 117.70, with a minimum of 100 and a maximum of 132. Although this temperature range is considered quite high in a physical work environment, statistical analysis shows that the significance value is $0.205 (> 0.05)$, which means that temperature does not have a significant effect on Musculoskeletal Disorders (MSDs) complaints, but temperature has an effect of 17.8% even though it does not have a significant effect. Scientifically, environmental temperature can indeed affect work comfort and fatigue levels, but its direct effect on musculoskeletal disorders is not always significant, especially if other factors such as work posture, workload, work duration, and ergonomics are more dominant.

At temperatures that are still within the body's physiological tolerance threshold, workers may only experience temporary discomfort that does not cause muscle and skeletal disorders. In Islam, Allah SWT created humans with an extraordinary ability to adapt to various environmental conditions. Although high temperatures can cause discomfort, the body has mechanisms to regulate its internal temperature. However, this does not negate the importance of maintaining comfort and health at work. Islam encourages us to always seek ease and avoid hardship (yusrun wa laa 'usr). Therefore, even though temperature does not directly cause MSDs, efforts to provide a comfortable environment, such as adequate ventilation systems or the use of personal protective equipment (PPE), are still in line with Islamic teachings that prioritize benefit and avoid harm to humanity. Although temperatures in construction work environments tend to be high due to outdoor activities and direct exposure to sunlight, this study shows that temperature does not have a significant effect

on Musculoskeletal Disorders (MSDs) complaints (p-value significance of 0.205 (> 0.05). Scientifically, this indicates that although extreme temperatures can cause fatigue, dehydration, and thermal stress, their direct effects on musculoskeletal disorders such as muscle pain, joint pain, or hard tissue injuries are still relatively weak compared to primary factors such as workload and posture. Within the physiological tolerance temperature range (e.g., WBGT below the critical threshold), workers' bodies are relatively capable of adapting through temperature regulation mechanisms, so the biomechanical stress causing MSDs is more often triggered by heavy physical loads and non-ergonomic work postures than by temperature itself.

In addition, systematic reviews and meta-analyses show that although construction workers experience severe heat stress with increased core body temperature (< 38 °C), it is the level of dehydration and muscle performance that affects overall fatigue, rather than directly causing musculoskeletal complaints. Therefore, although temperature management remains important for productivity, safety, and general health aspects, the main focus of MSD prevention efforts should be on managing physical load, ergonomic posture, and task rotation and rest, rather than environmental temperature alone (16).

CONCLUSION

Based on the analysis results, complaints of Musculoskeletal Disorders (MSDs) among construction workers in Medan Tuntungan Subdistrict are mainly influenced by work posture and workload. Work posture has the greatest influence at 35.1% with a significance value of 0.030, while workload has an influence of 34.4% with a significance value of 0.025. Both of these variables were proven to have a significant effect on MSD complaints. Meanwhile, environmental temperature did not show a significant effect ($p = 0.205$), although in terms of coefficient value it still had a contribution of 11.7%.

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