



ANALYSIS OF RISK FACTORS FOR MUSCULOSKELETAL DISORDERS AMONG STREET SWEEPER WORKERS IN MATARAM CITY

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Abstract

Street sweepers perform heavy, continuous work, potentially leading to musculoskeletal disorders. They are not aware of the center of gravity, early signs and symptoms of disorders, and appropriate treatment when experiencing disorders, which can reduce work productivity. This study aimed to analyze determinant factors associated with musculoskeletal disorders among street sweeper workers. This study employed a quantitative design with a cross-sectional approach. The study population consisted of all street sweeper workers in Mataram City, totaling 195 respondents, selected using a total sampling technique. Musculoskeletal disorders were assessed using the Nordic Body Map (NBM) questionnaire. A total of 63.6% of respondents experienced musculoskeletal disorders. Musculoskeletal disorders were associated with smoking habits ($p = 0.0001$), length of employment ($p = 0.057$), and repetitive work movements ($p = 0.0001$), whereas body mass index, working duration, working posture, workload, and psychosocial factors were not significantly associated ($p > 0.05$). Multivariate analysis indicated that smoking habits ($p = 0.0001$; Exp(B) = 4.643), length of employment ($p = 0.004$; Exp(B) = 0.935), and repetitive work movements ($p = 0.0001$; Exp(B) = 0.895) were significantly associated with musculoskeletal disorders. Smoking habits being the most dominant factor associated with musculoskeletal disorder.

Keywords: *Musculoskeletal Disorders; Risk Factors; Street Sweepers; Work Ergonomics.*

1. Introduction

Street cleaning workers play an important role in maintaining urban environmental cleanliness. One category of street cleaning workers is street sweepers, whose primary task is to collect waste on roads to keep the environment clean. The work patterns and types of physical activities performed by street sweepers may have varying impacts on their physical health, including the risk of developing musculoskeletal disorders (MSDs) due to heavy workloads and non-ergonomic working postures. Lifting or carrying heavy loads over prolonged periods also contributes significantly to the development of MSDs. Heavy loads can place stress on the spine and joints, often resulting in lower back pain and other injuries (Kurusi et al., 2020).

Musculoskeletal complaints such as lower back pain, neck pain, and joint pain are very common among street sweepers. A cross-sectional study in Nepal reported that approximately 36% of sanitation workers experienced musculoskeletal disorders in the previous 12 months, with the highest prevalence (38.8%) observed among street sweepers (Khatri et al., 2025). Another survey conducted in Ethiopia among street sweepers found that the prevalence of MSDs reached 73% (Alie et al., 2023).

A high body mass index (BMI) (overweight/obesity) increases the mechanical load on joints and the spine, thereby significantly elevating the risk of musculoskeletal pain (Viester et al., 2013). In addition to BMI,

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smoking has also been associated with the occurrence of MSDs (Dai et al., 2021). This association may be explained by disturbances in the sympathetic nervous system and the hypothalamic-pituitary-adrenal axis, which play a role in endogenous pain regulation, as well as the effects of smoking on reducing the body's adaptive mechanisms to stress and pain (Dai et al., 2021).

Prolonged working duration among outdoor workers such as street sweepers, combined with heavy physical workloads, is known to increase the risk of musculoskeletal disorders. These workers often perform tasks for long hours in bent postures or engage in repetitive, non-ergonomic movements, leading to cumulative mechanical stress on muscles and joints and triggering complaints of lower back, knee, and shoulder pain (Van Kampen et al., 2020). Non-ergonomic working postures are strongly associated with a high prevalence of musculoskeletal disorders. Prolonged bending, repeated heavy lifting, and the use of non-ergonomic work equipment can result in muscle strain and chronic pain (Palilingan et al., 2020). Heavy and prolonged physical workloads such as lifting heavy loads, repetitive bending, and sweeping long distances are also known to increase the prevalence of musculoskeletal disorders among workers (Singh & Chokhandre, 2015).

Several studies have demonstrated that longer working duration is associated with increased musculoskeletal complaints among workers such as street sweepers. Similar findings were reported in Mumbai, India, where analysis confirmed that older age and longer length of service were significant risk factors for MSDs, particularly affecting the lower back and shoulders (Singh & Chokhandre, 2015). Street sweeping work requires repetitive sweeping movements with intensive physical demands and static working postures, often involving prolonged bending (Alie et al., 2023; Nugraheni et al., 2019). Nugraheni et al. (2019) reported that this type of work is highly repetitive and carries a high risk of musculoskeletal disorders due to non-ergonomic postures, static muscle contractions, and repetitive activities. Research has also shown that psychosocial workload in the work environment such as high job stress, mental workload, and limited social support can trigger or exacerbate musculoskeletal complaints (Ng et al., 2019).

In Indonesia, occupational health problems among street sweepers have become a serious concern. A study conducted in Wenang District, Manado City, identified an association between working posture and age with musculoskeletal complaints among street sweeping workers (Imbar et al., 2019). Another study in Balikpapan identified various occupational safety and health risks faced by street sweepers, including the risk of hearing loss and musculoskeletal disorders (Zainul et al., 2019). Although several studies have been conducted in a number of Indonesian cities such as Manado and Balikpapan, to date there has been no comprehensive study specifically examining the risk factors for musculoskeletal disorders among street sweeping workers in Mataram City.

Previous studies on street sweepers in Indonesia have generally focused only on limited factors such as work posture, age, or work duration, while comprehensive research examining individual, ergonomic, occupational, and psychosocial factors simultaneously remains limited, especially in Mataram City with its distinct geographical and work characteristics. Therefore, this study aimed to analyze the risk factors associated with musculoskeletal disorders among street sweepers in Mataram City, including body mass index, smoking habits, work duration, work posture, workload, years of employment, repetitive movements, and psychosocial factors, as well as to identify the most dominant risk factor contributing to musculoskeletal disorders.

2. Method

This study used an analytic observational design with a cross-sectional approach to analyze risk factors associated with musculoskeletal disorders (MSDs) among street sweepers in Mataram City. The study was conducted in Mataram City from May to July 2025 among 195 street sweepers selected from a population of 325 workers under the Department of Environmental Services of Mataram City. The inclusion criteria were street sweepers who had worked for at least one year, were willing to participate by signing informed consent, and were able to communicate verbally well. Respondents who were pregnant, had active work-related injuries, or suffered from musculoskeletal diseases were excluded from the study. Data were collected through interviews and direct observation using validated instruments, including the Nordic Musculoskeletal Questionnaire (NMQ) to assess MSD complaints, Rapid Entire Body Assessment (REBA) to evaluate work posture, Borg Rating of Perceived Exertion (RPE) scale to measure workload, and Effort-Reward Imbalance (ERI) questionnaire to assess psychosocial factors. Additional variables measured were body mass index (BMI), smoking habits, working duration, years of

employment, and repetitive work movements. The ERI questionnaire has been reported as a valid and reliable instrument for assessing occupational psychosocial stress. Data analysis was performed using SPSS version 26. Univariate analysis was used to describe respondent characteristics, while bivariate analysis was conducted using the Chi-square test for categorical variables and the Mann-Whitney test for non-normally distributed numerical variables. Multivariate logistic regression analysis was subsequently performed to identify the dominant factors associated with musculoskeletal disorders. I conducted this study from September to December 2025.

3. Result and Discussion

Result

In this study, a total of 195 respondents completed the research instruments. The characteristics of the respondents are presented in Table 1.

Table 1. Characteristics of the Respondents

Variable	Frequency (n)	Percentage (%)
Age		
17-25 years	5	2,6
26-35 years	47	24,1
36-45 years	63	32,3
46-55 years	58	29,7
56-65 years	22	11,3
Sex		
Male	88	45,1
Female	107	54,9
Education Level		
No formal education	23	11,8
Elementary school or equivalent	38	19,5
Elementary school or equivalent	41	21,0
Senior high school or equivalent	93	47,7
Bachelor's degree or more	0	0
Marital Status		
Unmarried	11	5,6
Married	184	94,4
Total		195

Based on Table 1, the characteristics of the respondents indicate that the largest age group was 36–45 years, comprising 63 respondents (32.3%). In terms of sex, female respondents outnumbered male respondents, with 107 individuals (54.9%). Regarding educational level, the majority of respondents had completed senior high school or its equivalent, totaling 93 respondents (47.7%). Meanwhile, based on marital status, most respondents were married, with 184 respondents (94.4%).

Based on the table 2, the study results indicate that for the musculoskeletal disorder variable, the majority of respondents experienced complaints, totaling 124 respondents (63.6%). Regarding body mass index, most respondents were in the non-overweight/non-obese category, with 128 respondents (65.6%). In terms of smoking habits, the majority of respondents had never smoked, accounting for 123 respondents (63.1%). For the working posture variable, nearly all respondents were classified as having a moderate risk level, with 187 respondents (95.9%), indicating a predominance of working postures associated with a moderate ergonomic risk. Furthermore, the most common workload category was light workload, reported by 118 respondents (60.5%). In the psychosocial aspect, most respondents reported that the perceived rewards exceeded the efforts, with 118 respondents (60.5%).

Table 2. Results of Univariate Analysis of Variables with Categorical Measurement Scales

Variable	Frequency (n)	Percentage (%)
Musculoskeletal Disorders		
No complaints	71	36,4
Complaints present	124	63,6
Body Mass Index		
Non-overweight / Non-obese	128	65,6
Overweight / Obese	67	34,4
Smoking Status		
Never smoked	123	63,1
Smoker	72	36,9
Working Posture		
Moderate risk	187	95,9
High risk	8	4,1
Workload		
Light	118	60,5
Moderate	77	39,5
Psychosocial Factors		
Rewards perceived to exceed effort	118	60,5
High imbalance	77	39,5

Based on the descriptive statistics table 3, the respondents' working duration had a mean value of 5.47, with both the median and mode at 5, indicating that the respondents' working duration tended to be relatively uniform. Length of employment had a mean value of 13.90 years with a fairly large standard deviation (10.72), indicating considerable variation in length of employment among respondents. Meanwhile, repetitive work movements showed a mean value of 66.71, suggesting that most respondents performed work activities with a relatively high intensity of repetitive movements.

Based on the results of the bivariate analysis presented in Table 4, among the various factors examined, only smoking habits showed a significant association with the occurrence of musculoskeletal disorders. Respondents who smoked had a 1.76-fold higher risk of experiencing musculoskeletal disorders compared to non-smokers ($p = 0.0001$; $PR = 1.764$; 95% CI: 1.447-2.152). Meanwhile, body mass index, working posture, workload, and psychosocial factors did not show a significant association with musculoskeletal disorders, as indicated by p -values greater than 0.05 and PR values close to 1. These findings suggest that smoking is the main risk factor for musculoskeletal disorders among the study respondents, while the other factors have not been proven to play a significant role.

Table 3. Results of Univariate Analysis of Variables with Ratio Measurement Scales

Variable	Min	Maks	Mean	Median	Mode	SD
Working Duration (hours)	2	8	5,469	5.000	5	1,1438
Length of Employment (years)	1	45	13,90	13.00	20	10,720
Repetitive Work Movements (minutes)	40	90	66,71	68.00	60	10,720

Table 4. Bivariate Analysis of Musculoskeletal Disorders with Independent Variables Measured on a Categorical Scale

Variable	Musculoskeletal Disorders				Total	<i>p-value</i>	PR 95% CI
	Complaints		No Complaints				
	n	%	n	%			
Body Mass Index							
Not Overweight/Obese	83	64.8	45	35.2	128	0,729	0,944 (0.750 - 1.187)
Overweight/ Obese	41	61.2	26	38.8	67		
Total	124	63.6	71	36.4	195		
Smoking Habit							
Never Smoked	61	49.6	62	50.4	123	0,0001	1,764 (1.447 – 2.152)
Smoker	63	87.5	9	12.5	72		
Total	124	63.6	71	36.4	195		
Working Posture							
Moderate Risk	119	63.6	68	36.4	187	1,000	0,982 (0.568 – 1.698)
High Risk	5	62.5	3	37.5	8		
Total	124	63.6	71	36.4	195		
Workload							
Light	77	65.3	41	34.7	118	0,656	0,935 (0.749 – 1.168)
Moderate	47	61.0	30	39.0	77		
Total	124	63.6	71	36.4	195		
Psychosocial Factors							
Perceived reward greater than effort	74	62.7	44	37.3	118	0,870	1.035 (0.835 – 1.284)
High imbalance	50	64.9	27	35.1	77		
Total	124	63.6	71	36.4	195		

Based on the results of the bivariate analysis (Table 5), working duration and length of employment did not show a significant association with the occurrence of musculoskeletal disorders, as indicated by p-values of 0.981 and 0.057, respectively, with 95% confidence intervals crossing 1. In contrast, repetitive work movements showed a statistically significant association ($p = 0.0001$), with a negative B coefficient and a 95% confidence interval entirely below 1, indicating that increased intensity of repetitive work movements was associated with a reduced risk of musculoskeletal disorders among the study respondents.

Table 5. Bivariate Analysis of Musculoskeletal Disorders with Independent Variables Measured on a Numerical Scale

Independent Variable	B	<i>p-value</i>	Exp(B)	Confidence Interval 95%	
				Lower Bound	Upper Bound
Working Duration	0,003	0,981	1,003	0,777	1,295
Length of Employment	-0,035	0,057	0,966	0,931	1,001
Repetitive Work Movements	-0,121	0,0001	0,886	0,852	0,921

Table 6. Final Results of Multivariate Modeling Using Multiple Logistic Regression Analysis

Independent Variable	B	sig.	Exp (B)	95% CI
Smoking Habit	1,535	0,0001	4,643	(1,963 - 10,985)
Length of Employment	-0,068	0,004	0,935	(0,893 - 0,978)
Repetitive Work Movements	-0,111	0,0001	0,895	(0,859 - 0,933)
Constant	6,511	0,000	672,730	

Based on the final results of the multivariate multiple logistic regression analysis (Table 6), smoking habits, length of employment, and repetitive work movements were found to be significantly associated with the occurrence of musculoskeletal disorders, while the other five variables showed no association and were not identified as confounding factors. Respondents who smoked had a 4.6-fold higher risk of experiencing musculoskeletal disorders compared to non-smokers after controlling for other variables ($\text{Exp(B)} = 4.643$). Each additional year of employment was associated with a 0.9-fold reduction in the risk of musculoskeletal disorders ($\text{Exp(B)} = 0.935$), while each one-unit increase in repetitive work movements was associated with a 0.8-fold reduction in risk ($\text{Exp(B)} = 0.895$). Based on the prevalence ratio values, smoking was the most dominant factor influencing the occurrence of musculoskeletal disorders among the study respondents.

Discussion

Association Between Body Mass Index and Musculoskeletal Disorders

The results of this study among street sweepers in Mataram City showed no significant association between body mass index (BMI) and musculoskeletal disorders (MSDs). A study by Rika and Dwiyantri (2023) among container crane operators also reported that although most respondents were overweight, there was no statistically significant association between BMI and musculoskeletal complaints ($p = 0.585$). These findings indicate that factors other than BMI play a more dominant role in triggering musculoskeletal complaints, such as static working positions, prolonged working duration, and non-ergonomic working postures.

In the context of street sweepers, job characteristics require highly repetitive physical activities, including long-distance walking, bending, arm swinging, and prolonged standing. These ergonomic factors have been shown to contribute substantially to the development of musculoskeletal disorders. A study among hospital nurses demonstrated that awkward working postures, bending and twisting activities, and prolonged standing were the main predictors of musculoskeletal complaints, even after accounting for BMI (Stanchev & Vangelova, 2022).

Furthermore, large cohort-based studies have shown that the association between obesity and musculoskeletal disorders is more evident when linked to metabolic obesity phenotypes (metabolically unhealthy obesity), rather than BMI alone (Karimi et al., 2022). This suggests that BMI, as a simple anthropometric indicator, has limitations in explaining the risk of MSDs, particularly among workers with high levels of physical activity such as street sweepers.

Association Between Smoking Habits and Musculoskeletal Disorders

The results of this study indicate that there is an association between smoking habits and musculoskeletal disorders among street sweepers in Mataram City. This finding is consistent with the concept that individual factors, particularly unhealthy lifestyle behaviors such as smoking, may act as additional risk factors for musculoskeletal complaints among workers who perform heavy and repetitive physical activities (Indah Rabbihim et al., 2023).

Street sweepers are an informal worker group with a high physical workload, including sweeping activities in a bent posture, repetitive movements of the upper extremities, and long working hours. These conditions require muscles to work both statically and dynamically for prolonged periods, thereby increasing the risk of musculoskeletal disorders. Smoking habits may exacerbate this condition, as nicotine and other harmful substances in cigarettes adversely affect the musculoskeletal system (Rizkia et al., 2024).

Physiologically, smoking can reduce lung capacity and decrease oxygen supply to body tissues. This reduction in oxygen levels leads to suboptimal muscle metabolism, accelerating muscle fatigue and slowing tissue recovery after strenuous work activities. Consequently, smokers are more susceptible to muscle pain and musculoskeletal disorders compared to non-smokers (Kemenkes, 2022; Rizkia et al., 2024).

A study among factory workers by Rizkia et al. (2024) showed that smoking habits were significantly associated with musculoskeletal disorder complaints ($p\text{-value} = 0.037$). This indicates that workers who smoke are at higher risk of experiencing musculoskeletal complaints than non-smokers, particularly in jobs that require high physical strength and intensive manual handling activities.

Furthermore, smoking habits can increase lactic acid accumulation in muscles due to insufficient oxygen supply, leading to persistent pain and soreness in the musculoskeletal system. This condition becomes more severe when workers are required to perform continuous heavy physical activities without adequate recovery time, as experienced by street sweepers (Rizkia et al., 2024).

Association Between Working Duration and Musculoskeletal Disorders

The results of this study indicate that working duration is not significantly associated with the occurrence of musculoskeletal disorders among street sweepers in Mataram City. Theoretically, working duration is often considered a risk factor for musculoskeletal disorders because prolonged exposure to workload may lead to muscle fatigue and the accumulation of biomechanical stress. However, findings from a literature review in the agricultural sector indicate that the occupational factors most consistently and strongly associated with musculoskeletal disorders are working posture and work area, whereas working duration does not always show a significant association when working posture is relatively uniform and workload does not vary extremely (Maulana et al., 2021).

Several other studies have reported an association between working duration and musculoskeletal complaints, such as among batik workers and office workers, where longer working hours were associated with an increased prevalence of low back pain or shoulder pain (Ramadhiani et al., 2017; Sutami et al., 2021). Nevertheless, the job characteristics in these sectors differ from those of street sweepers, particularly in terms of prolonged static postures and workload concentrated on specific muscle groups, making the results not directly comparable to the conditions of street sweepers in Mataram City.

Furthermore, systematic reviews have suggested that working duration often acts as a supporting factor rather than a primary factor in the development of musculoskeletal disorders. Working duration increases risk mainly when accompanied by non-ergonomic working postures, heavy workloads, and insufficient rest periods (Aprianto et al., 2021). When workers have short rest breaks during work or relatively constant workloads, the impact of working duration on musculoskeletal disorders becomes insignificant.

Result and discussion contain scientific research findings and discussions. Write down the scientific findings obtained from the results of the research conducted but must be supported by adequate data. The scientific findings agreed here are not the data obtained from the research result. What scientific findings were obtained? Why did it happen? Why are trend variables like that? All these questions must be discussed, not just descriptive, if necessary, supported by adequate scientific basis phenomena. In addition, it must also be discussed contrary to the results of other researchers who are almost the same as the topic. The results of research and findings must be able to answer the research hypothesis in the introduction.

Association Between Working Posture and Musculoskeletal Disorders

The statistical analysis in this study showed that working posture, as measured using the Rapid Entire Body Assessment (REBA) method, was not significantly associated with the occurrence of musculoskeletal disorders among street sweepers in Mataram City. This finding indicates that although most workers had REBA scores in the moderate-risk category, this condition did not directly contribute to the development of musculoskeletal complaints.

Theoretically, REBA is an ergonomic assessment method that evaluates the risk of musculoskeletal disorders based on body posture, movement, load, and work activities. This method is widely used to identify jobs with non-ergonomic postures that may potentially cause musculoskeletal disorders. However, the results of this study are consistent with several other studies that also found no significant association between working posture and musculoskeletal disorders, particularly in jobs characterized by relatively dynamic activities and high movement variability.

A study by Tewal et al. (2025) among cleaning service workers, which also used the REBA method, showed no significant association between working posture and musculoskeletal disorders ($p = 0.903$), despite respondents performing repetitive physical activities over long periods. These results support the findings of the present study, considering that the job characteristics of street sweepers are similar to those of cleaning service workers, involving light-to-moderate physical activities performed repetitively with varied body positions.

Furthermore, a study by Wachid et al. (2024) emphasized that high-risk working postures based on REBA are not always directly proportional to the level of musculoskeletal complaints, especially when other more dominant factors such as workload, working duration, and work tool design are present. This reinforces the notion that musculoskeletal disorders are multifactorial in nature and cannot be explained by a single ergonomic variable alone.

Association Between Workload and Musculoskeletal Disorders

The results of this study indicate that there is no significant association between workload, as measured using the Borg Scale of Perceived Exertion (Borg RPE), and the occurrence of musculoskeletal disorders among street sweepers in Mataram City. This finding suggests that the level of perceived work-related fatigue experienced by workers does not directly correlate with the development of musculoskeletal complaints in this occupational group.

Theoretically, the Borg RPE is a subjective instrument used to assess an individual's perception of physical work intensity based on perceived effort and fatigue. However, such perceptions do not always reflect chronic biomechanical exposure, which is a primary cause of musculoskeletal disorders. This is consistent with a systematic review by Gregg et al. (2024), which stated that work-related musculoskeletal disorders are more strongly influenced by specific biomechanical factors such as working posture, repetitive movements, exposure duration, and static load, rather than perceived workload alone.

In the context of street sweepers, work activities tend to be routine, repetitive, and performed at a relatively constant intensity on a daily basis. These conditions allow for physiological adaptation, meaning that even when workers perceive their workload as moderate or heavy according to the Borg RPE, such perceptions are not always accompanied by an increase in musculoskeletal complaints. Similar adaptations were described in a study by Arman et al. (2022) among forestry workers, where high perceived workload was not a sole predictor of musculoskeletal disorders but interacted with chronic fatigue, mental factors, and individual characteristics.

Furthermore, differences between the findings of this study and other studies that reported an association between workload and musculoskeletal disorders may be attributed to variations in workload measurement methods. Some studies employed objective indicators such as Cardiovascular Load (CVL) or the NASA Task Load Index (NASA-TLX), which assess physical and mental workload more comprehensively. For example, a study among manufacturing industry operators demonstrated an association between high workload and musculoskeletal disorders due to tasks involving heavy lifting, time pressure, and variable high physical demands (Achmad Rizal Alqurta & Sajiyo, 2023). These conditions differ from street sweeping work, which is relatively homogeneous in terms of physical demands.

Association Between Length of Employment and Musculoskeletal Disorders

The results of this study indicate that length of employment is significantly associated with the occurrence of musculoskeletal disorders among street sweepers in Mataram City. This finding suggests that the longer an individual works as a street sweeper, the greater the risk of experiencing musculoskeletal complaints.

Theoretically, length of employment is closely related to the accumulation of exposure to ergonomic risk factors over a prolonged period. Musculoskeletal disorders do not occur acutely but rather result from repeated and long-term exposure to physical workload, repetitive movements, non-ergonomic working postures, and long working duration. Continuous exposure over many years can cause microtrauma to muscles, tendons, ligaments, and joints, which ultimately leads to musculoskeletal complaints (Fadhillah et al., 2024).

The findings of this study are consistent with research by Fadhillah et al. (2024) among oil palm harvesters, which reported a significant association between length of employment and musculoskeletal disorder complaints ($p = 0.001$) with a moderate positive correlation. The study explained that workers with longer employment duration have a higher risk of musculoskeletal disorders due to daily exposure to heavy physical work and repetitive movements.

Similar findings were also reported by Inayah et al. (2024) among workshop workers, showing a significant association between length of employment and the level of musculoskeletal complaints ($p = 0.001$). The study emphasized that workers with longer employment duration tend to experience increased musculoskeletal complaints due to continuous exposure to physical work activities without adequate muscle recovery.

In the context of street sweepers in Mataram City, longer length of employment means prolonged exposure to sweeping activities, pushing waste, long-distance walking, and maintaining certain working postures over many years. These activities are performed repeatedly on a daily basis and often without ergonomic aids, thereby increasing the accumulation of static and dynamic loads on the musculoskeletal

system. This condition accelerates muscle fatigue and tissue degeneration, ultimately leading to musculoskeletal disorder complaints.

Association Between Repetitive Work Movements and Musculoskeletal Disorders

The results of this study indicate that there is a significant association between repetitive work movements and the occurrence of musculoskeletal disorders among street sweepers in Mataram City. Physiologically, repetitive work movements cause muscles to undergo repeated static and dynamic contractions without sufficient recovery time. This condition leads to the accumulation of lactic acid, reduced tissue oxygenation, and impaired muscle metabolism. When sustained over a long period, these conditions may develop into chronic musculoskeletal disorders, particularly affecting the upper extremities, shoulders, back, and lower back, which are the body parts predominantly used in street sweeping activities (Bonfiglioli et al., 2022).

Street sweeping activities generally involve repetitive sweeping motions with relatively similar patterns, performed for several hours each day. These movements primarily engage the wrists, forearms, shoulders, and lower back muscles. Continuous exposure to repetitive movements without adequate posture variation or rest periods increases the risk of muscle pain, joint stiffness, and musculoskeletal discomfort. This reinforces the finding that repetitive movements are a major risk factor for musculoskeletal disorders among informal sector workers and those engaged in manual labor (Bonfiglioli et al., 2022).

The findings of this study are supported by research by Munairah et al. (2025), which demonstrated a significant association between repetitive activities and musculoskeletal disorders among laundry workers. The study found that workers who performed repetitive movements ≥ 10 times per minute had a higher risk of musculoskeletal complaints compared to workers with more varied activities. Monotonous and repetitive work activities were shown to cumulatively increase stress on muscles and joints.

Additional empirical evidence comes from studies among waste sorters, whose job characteristics are similar to those of street sweepers, involving manual activities with repetitive movements and long working durations. These studies showed that repetitive activities were significantly associated with musculoskeletal complaints, indicating that workers in the sanitation and environmental sectors face high ergonomic risks due to prolonged and monotonous repetitive work movements (Faisal et al., 2022).

Association Between Psychosocial Factors and Musculoskeletal Disorders

The results of this study indicate that psychosocial factors are not significantly associated with the occurrence of musculoskeletal disorders among street sweepers in Mataram City. This finding suggests that although psychosocial factors are often reported to contribute to musculoskeletal disorders across various occupational sectors, their influence does not appear to be dominant in the context of street sweeping work.

Theoretically, musculoskeletal disorders are multifactorial conditions involving interactions between physical, individual, and psychosocial factors. Psychosocial factors such as work-related stress, mental workload, job demands, role conflict, and lack of social support may influence pain perception and muscle tension through neuroendocrine mechanisms and prolonged muscle tension. However, empirical evidence indicates that the contribution of psychosocial factors to musculoskeletal disorders is not always consistent across different types of occupations and is highly dependent on the dominant characteristics of job demands (Afsharian et al., 2023).

These findings are consistent with several studies reporting that the association between psychosocial factors and musculoskeletal disorders is not always significant, particularly among groups of workers engaged in heavy manual labor. Bezzina et al. (2023), in a longitudinal systematic review, noted that although many studies identified associations between psychosocial factors and musculoskeletal disorders, some studies found no significant relationship, especially when physical variables were more dominant or when cross-sectional study designs were used.

Furthermore, the absence of an association in this study may be attributed to workers' psychological adaptation to working conditions. Street sweepers generally have long employment durations with relatively stable routines, resulting in lower psychosocial demands such as role conflict, role ambiguity, or mental pressure. This condition may reduce the impact of psychosocial stress on the development of musculoskeletal complaints, as stress perception is strongly influenced by work experience and individual coping ability (Harahap & Widanarko, 2021).

Most Dominant Factors Associated with Musculoskeletal Disorders Among Street Sweepers in Mataram City

The results of the multivariate analysis indicate that smoking habits, length of employment, and repetitive work movements are factors that significantly influence the occurrence of musculoskeletal disorders (MSDs) among street sweepers in Mataram City. The Exp(B) values of each variable represent the magnitude of the likelihood of developing musculoskeletal disorders after controlling for other variables in the model.

Smoking habits were identified as the most dominant factor in this study, with an Exp(B) value of 4.643. This means that workers who smoke have approximately a 4.6-fold higher risk of experiencing musculoskeletal disorders compared to non-smoking workers. Physiologically, nicotine in cigarettes causes vasoconstriction, reducing the supply of oxygen and nutrients to muscle tissues. This condition accelerates muscle fatigue, inhibits tissue recovery processes, and increases the risk of pain and musculoskeletal complaints.

These findings are consistent with a study by Rizkia et al. (2024), which demonstrated a significant association between smoking habits and MSD complaints among factory workers ($p < 0.05$). Another study by Hanif et al. (2020) also reported that higher levels of smoking habits were associated with more severe MSD complaints among manual material handling workers. Thus, smoking habits not only affect general health but also contribute substantially to musculoskeletal disorders among informal sector workers.

The length of employment variable had an Exp(B) value of 0.935, indicating that each additional year of employment reduced the likelihood of musculoskeletal disorders by 6.5%. This finding suggests that workers with longer employment duration tend to have a lower risk of developing MSDs compared to those with shorter employment duration.

This phenomenon can be explained by work adaptation processes, whereby workers with longer experience develop better skills, working techniques, and bodily adjustment strategies to cope with physical job demands. This result is consistent with findings by Fadhillah et al. (2024), which stated that length of employment is associated with MSD complaints, although the direction of the association may vary depending on workers' adaptive capacity and working conditions. Therefore, in this study, length of employment acts as a protective factor against musculoskeletal disorders.

Repetitive work movements had an Exp(B) value of 0.895, meaning that an increase in the intensity of repetitive work movements was associated with a 10.5% reduction in the likelihood of musculoskeletal disorders. This result indicates that although repetitive movements were statistically significant, their association was protective in nature.

This may be due to street sweepers' habituation to performing the same movement patterns daily, resulting in neuromuscular adaptation. In addition, relatively light and rhythmic movements may reduce static muscle load compared to tasks involving rigid and non-varied postures. These findings differ from some previous studies reporting that repetitive movements increase the risk of MSDs, such as the study by Santoso et al. (2022) among weaving workers. This difference suggests that the impact of repetitive movements is strongly influenced by job type, movement intensity, as well as the duration and workload involved.

Overall, the results of the multivariate analysis demonstrate that smoking habits are the most dominant risk factor for musculoskeletal disorders among street sweepers in Mataram City. Meanwhile, length of employment and repetitive work movements act as protective factors, which are likely related to work adaptation processes and the characteristics of workers' physical activities.

4. Conclusion

Based on the results of the study, it can be concluded that musculoskeletal disorders among street sweepers in Mataram City are influenced by individual factors and specific job characteristics. Most respondents were of productive working age with relatively homogeneous working conditions, and the analysis showed that smoking habits, length of employment, and repetitive work movements were significantly associated with the occurrence of musculoskeletal disorders, with smoking being the most dominant factor. In contrast, body mass index, working duration, working posture, physical workload,

and psychosocial factors were not found to be associated with musculoskeletal disorders in this group of workers.

5. Acknowledgments

The author sincerely thanks the supervisors for their guidance and valuable input throughout the completion of this thesis. Appreciation is also extended to the Faculty of Health Sciences and Technology, Jenderal Achmad Yani University, for academic support and facilities, as well as to the authorities and street sweeper workers in Mataram City who participated in this study. The author also acknowledges the support and encouragement from family, colleagues, and friends during the research process.

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