Journal of Global Research in Public Health
Vol. 10, No 2, December 2025, pp. 82-87
ISSN: 2528-066X (Print), 2599-2880 (Online)

Workplace Stretching Exercises as an Ergonomic Intervention to Reduce Musculoskeletal Disorders among Construction Workers

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ARTICLE INFO

Article history:
Received: October 7th, 2025
Revised: October 14th, 2025
Accepted: December 19th, 2025

Keywords:
Workplace Stretching Exercise
Musculoskeletal Disorder
Construction Project Workers

ABSTRACT

Musculoskeletal Disorders (MSDs) are complaints involving muscles and bones, ranging from sprains to chronic conditions that may lead to disability. Proper ergonomic implementation promotes workers' health, comfort, and productivity, while poor ergonomics can increase MSD risk. This study aimed to analyze the effect of Workplace Stretching Exercise (WSE) on MSD complaints among construction workers in Malang Regency. A quantitative approach with a quasi-experimental pretest–posttest control group design was applied. Of 94 workers, 76 were selected using simple random sampling. Data covered individual (age, tenure, BMI, habits) and work-related factors (posture, duration, workload). The dependent variable was MSD complaints before and after WSE intervention. Statistical analysis using ordinal regression revealed a significant decrease in MSD complaints after WSE. Factors significantly associated with reduced MSDs included younger age, better posture, shorter work duration, lower workload, and the WSE intervention itself ($p < 0.05$).

I. Introduction

The construction sector is considered a high-risk industry due to the complexity of its processes, ranging from planning to implementation (Saragi & Sinaga, 2021). Most occupational accidents occur during various project phases, including the construction of roads, bridges, dams, and buildings. Effective management of project duration, workforce, and financial resources is essential to minimize such risks (Ariyanto et al., 2024). Although the construction sector contributes significantly to the global economy, it remains one of the industries with the highest incidence of workplace accidents and occupational diseases (Tandazo et al., 2025). In developing countries, construction workers face a risk of exposure to hazardous work and injury that is three to six times higher than the average across all industries (Kowe et al., 2025).

Work-related musculoskeletal disorders (MSDs) represent one of the most prevalent occupational health problems worldwide, affecting millions of workers annually (Boschman et al., 2015). MSDs refer to conditions involving muscles and bones, which may develop acutely or gradually, potentially resulting in disability. Common risk factors include age, non-ergonomic working postures, prolonged working hours, repetitive movements, and unhealthy physical habits (World Health Organization, 2021). Globally, the WHO recorded 1.71 billion MSD cases, with lower back pain being the most frequent (568 million cases) (Gleadhill et al., 2021). In Indonesia, the 2018 national survey reported an MSD prevalence of 7.3%, with the highest rates in Aceh (13.26%), Bengkulu (12.11%), and Bali (10.46%). Based on occupation, the highest prevalence was among farmers (9.90%), followed by civil servants, military and police personnel, state-owned enterprise employees (7.50%), fishermen (7.40%), and laborers or drivers (6.10%) (Kementerian Kesehatan, 2018).

Previous studies on MSD complaints among Indonesian construction workers revealed variations in both the affected body regions and the severity of complaints. Research conducted by Suratno et al.

(2022) at the Manikin Dam project in Kupang City found that upper neck and lower back pain were the most frequently reported (92.2%), while the buttocks were the least affected (15.7%). Similarly, a study by Zahra et al. (2023) on workers at the SPBU X project identified lower back pain as the most common very severe complaint (18%), right calf pain as the most frequent severe complaint (60%), and mild pain most commonly in the left upper arm (20%). The left elbow recorded the highest percentage of body parts without complaints (78%).

Regulation of the Minister of Manpower No. 5 of 2018 emphasizes the importance of ergonomics in preventing musculoskeletal disorders and ensuring workplace safety. The regulation outlines standards for proper posture and positioning, ergonomic workplace and tool design based on workers' anthropometry, and workload management to ensure that lifting activities do not exceed physical capacity. These provisions aim to reduce injury risks associated with physical strain in the workplace.

A preliminary study on construction workers in Malang Regency showed that 11 out of 15 participants reported MSD-related pain, primarily in the lower back, neck, and shoulders. Most workers performed tasks for approximately six hours daily in non-ergonomic positions—such as prolonged bending, manual lifting, and repetitive movements—that contributed to poor posture. This condition was aggravated by the absence of stretching or other supportive physical activities to relieve muscle tension. The findings indicated a high risk of MSDs among construction workers in the region, underscoring the need for preventive interventions. One such approach is the Workplace Stretching Exercise(WSE) program, which can help alleviate physical discomfort from repetitive and strenuous work activities while improving workers' overall health, comfort, and productivity.

II. Methods

This study employed a quantitative approach with an explanatory level, aiming to analyze the relationship among multiple variables. The research utilized a quasi-experimental design with a pretest–posttest control group method, involving experimental and control groups to compare the effects of the implemented intervention. The study was conducted in December 2024 among operational construction project workers, totaling 117 individuals. After applying inclusion and exclusion criteria, 94 building construction workers in Malang Regency met the eligibility requirements. The sample was determined using the simple random sampling technique, resulting in a final sample size of 76 participants.

The research variables consisted of independent and dependent variables. Independent variables included individual characteristics (age, work tenure, body mass index, exercise habits, and smoking habits), work-related factors (work posture, work duration, work shifts, and workload), as well as the implementation of Workplace Stretching Exercise(WSE) in the experimental group. The dependent variable was Musculoskeletal Disorders (MSDs) complaints. Data were analyzed using the Chi-Square test to assess differences in MSD complaints before and after the WSE intervention, followed by multivariate analysis through ordinal regression to determine the influence of individual characteristics, work-related factors, and WSE implementation on MSD complaints.

This study obtained ethical approval from the Health Research Ethical Clearance Committee, Faculty of Dental Medicine, Universitas Airlangga, under reference number 1146/HRECC.FODM/XII/2024, dated 10 December 2024.

III. Results and Discussion

Identification of Individual Characteristics, Work Factors, Implementation of Workplace Stretching Exercise and Complaints of Musculoskeletal Disorders in Building Construction Project Workers in Malang Regency

Based on the frequency distribution data of job characteristics, the age variable showed that most building construction workers in Malang Regency were in the Late Adulthood category (36–45 years old), totaling 25 workers (32.9%). The work tenure variable indicated that the majority of workers had a moderate work tenure (9–17 months), with 36 workers (47.4%). The body mass index (BMI) variable showed that most workers had a normal BMI (18.5 - <25), totaling 47 workers (61.8%). The exercise habit variable revealed that most workers never exercised, with the same number of 47 workers (61.8%).

Meanwhile, the smoking habit variable was dominated by moderate smokers (11–20 cigarettes/day), totaling 32 workers (42.1%).

Based on the frequency distribution data of work factors, the work posture variable showed that most building construction workers in Malang Regency were in the moderate category, with an average score of 4–7, totaling 25 workers (32.9%). The work shift variable indicated that the majority of workers were in the morning shift, in both the experimental and control groups, with 22 workers (57.9%) in each group, totaling 44 workers (57.9%). The workload variable showed that most workers had a high workload, with an average score of 50–79, totaling 37 workers (48.7%). Meanwhile, the work duration variable indicated that the majority of workers worked more than 8 hours per day, totaling 43 workers (56.6%).

Based on the frequency distribution data of musculoskeletal disorder (MSDs) complaints, in the pretest stage, most workers were in the moderate category, with an average score of 154–307, totaling 50 workers (65.8%). In the experimental group, 28 workers (73.7%) were in the moderate category, while in the control group, there were 22 workers (57.9%). After the intervention in the posttest stage, the number of workers in the moderate category in the experimental group decreased to 20 workers (52.6%), while in the control group, it increased to 24 workers (63.2%). Overall, in the posttest stage, the majority of workers were still in the moderate category, totaling 44 workers (57.9%).

Analysis of Differences Before and After the Implementation of Workplace Stretching Exercise on Complaints of Musculoskeletal Disorders

This study used a bivariate chi-square test to analyze the differences between two paired samples in the pretest and posttest stages based on the CMDQ questionnaire. The following are the results of the difference test obtained

Table 1. Eksperimental Pretset and Eksperimental Post test

Eksperimental Pretest	Eksperimental Posttest						Total		Sig.
	Low		Moderate		High				
	f	%	*f*	%	*f*	%	n	%	
Low	1	11,1	4	18,2	0	0	5	13,2	**0,028**
Moderate	8	88,9	17	77,3	4	57,1	29	76,3	
High	0	0	1	4,5	3	42,9	4	10,5	
Total	**9**	**100,0**	**22**	**100,0**	**7**	**100,0**	**38**	**100,0**	

Based on the table above, MSDs complaints measured using the CMDQ questionnaire in the experimental group were categorized into three levels: low (13.2%), moderate (76.3%), and high (10.5%). After the WSE intervention, changes in the level of MSDs complaints were observed, with some workers shifting categories. A total of 8 workers who were previously in the moderate category moved to the low category, while others either remained in their respective categories or experienced an increase. The statistical test results showed a significance value of 0.028, indicating a significant difference before and after the intervention. Therefore, it can be concluded that the WSE intervention had an effect on reducing MSDs complaints among building construction workers in Malang Regency.

Table 2. Control Pretest and Control Post test

Control Pretest	Control Posttest						Total		Sig.
	Low		Moderate		High				
	f	%	f	%	f	%	N	%	
Low	1	14,3	13	54,2	0	0	14	36,8	**0,034**
Moderate	5	71,4	10	41,7	5	71,4	20	52,6	
High	1	14,3	1	4,2	2	28,6	4	10,5	
Total	**7**	**100,0**	**24**	**100,0**	**7**	**100,0**	**38**	**100,0**	

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Based on the CMDQ results, MSDs complaints in the control group were categorized as low (36.8%), moderate (52.6%), and high (10.5%). Posttest results showed changes in complaint levels, with a significance value of 0.034. However, since no intervention was given, these changes were likely due to natural variation or other external factors.

Influencing Factors on Musculoskeletal Disorders in Building Construction Project Workers in Malang Regency

The following is the result of the ordinal regression analysis to determine the overall influence of independent factors (individual characteristics, work factors, and the WSE intervention) on MSDs complaints among building construction workers in Malang Regency.

Table 3. Results of Ordinal Regression Analysis

Variable	Kategori	Regression Coefficient	Wald Test Statistic	Sig.
Age	17-25 Years Old	-3,682	5,796	0,016
	26-35 Years Old	-2,859	8,277	0,004
	> 46 Years Old *	-	-	-
Work Posture	Very Low	-4,884	7,631	0,006
	Low	-3,328	6,999	0,008
	Very High*	-	-	-
Work Duration	> 8 Hours	2,060	7,315	0,007
	≤ 8 Hours*	-	-	-
Workload	Low	-2,977	1,305	0,023
	Moderate	-2,867	1,173	0,015
	Very High*	-	-	-
WSE Intervention	Yes	-1,722	5,443	0,020
	No*	-	-	-

Based on the table above, the ordinal regression analysis showed that the dominant factors influencing musculoskeletal disorders (MSDs) complaints among construction project workers in Malang Regency were age, work posture, work duration, workload, and workplace stretching exercise (WSE) intervention, with a significance value of < 0.05. Workers aged 17–25 years (0.016) and 26–35 years (0.004) experienced lower MSDs complaints compared to those aged ≥ 46 years. Very low (0.006) and low (0.008) work postures were associated with lower complaints compared to very high work posture. Low (0.023) and moderate (0.015) workload levels were linked to lower complaints compared to very high workload. Working more than 8 hours per day (0.007) increased MSDs complaints compared to working ≤ 8 hours, while the WSE intervention (0.020) contributed to reducing MSDs complaints. The Nagelkerke R-Square value of 0.715 indicated that these factors collectively influenced MSDs complaints by 71.5%, while the remaining 28.5% was influenced by other factors.

IV. Conclusion

The findings indicated that the majority of construction workers in Malang Regency were aged between 36 and 45 years, had a work tenure of 9–17 months, possessed a normal Body Mass Index (BMI), and were predominantly active smokers. In terms of work-related characteristics, most workers exhibited moderate-risk postures (REBA scores 4–7), worked for more than eight hours per day, performed morning shifts, and experienced a high workload (scores 50–79).

The implementation of the Workplace Stretching Exercise (WSE) program proved to be effective in significantly reducing Musculoskeletal Disorder (MSD) complaints. Statistical analysis demonstrated that age, work posture, working hours, workload, and participation in WSE interventions had a significant

influence on MSD outcomes. Older workers were found to be more susceptible to MSDs, particularly when exposed to non-ergonomic postures, prolonged working hours, and heavy physical demands. Conversely, consistent participation in WSE sessions improved muscle flexibility and blood circulation, thereby alleviating MSD complaints and enhancing workers' overall health and productivity.

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