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Assessment of Ergonomic Risk Factor and Musculoskeletal Discomfort among Construction Workers in Terengganu

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ABSTRACT

Ergonomic risk factors (ERFs) at construction sites are frequently associated with the development of musculoskeletal disorders (MSDs), particularly due to awkward postures, repetitive tasks, exposure to extreme heat, excessive noise, and vibration. This study investigates the prevalence of MSDs among construction workers in Kuala Terengganu and explores the relationship between ERFs and the occurrence of musculoskeletal discomfort. A total of 44 workers participated in this cross-sectional study. Data were collected through the validated Nordic Musculoskeletal Questionnaire (NMQ), field observations based on the Guidelines on Ergonomic Risk Assessment at the Workplace, and systematic site assessment. The results indicated that the shoulders, lower back, upper back, and wrists/hands were the most frequently reported areas of discomfort over the past 12 months. These symptoms were closely associated with prolonged awkward postures, repetitive movements, and exposure to extreme heat. The findings underscore the need for targeted ergonomic interventions at construction sites. This study offers valuable insights for industry stakeholders in formulating proactive MSD prevention strategies to improve occupational health and safety in the construction sector.

1. Introduction

The construction industry remains one of the most hazardous sectors in Malaysia, characterized by physically demanding tasks and harsh working environments. According to the Department of Occupational Safety and Health (DOSH) [1], the construction sector recorded 73 fatalities and 2,297 non-fatal injuries in 2021, ranking it third among them risky industries after manufacturing and services. Despite growing awareness of occupational safety, work-related health issues particularly musculoskeletal discomfort (MSDs) continues to receive insufficient attention in the local context. Musculoskeletal discomfort refers to persistent pain or strain affecting muscles, joints, ligaments, and tendons, which can impair physical function, productivity, and long-term occupational

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engagement. World Health Organization [2] recognizes this condition as a widespread occupational health burden, particularly in sectors involving manual labor. In construction, this discomfort is closely linked to frequent lifting, prolonged bending, overhead tasks, awkward working postures, repetitive motions, vibration exposure, and extreme temperatures [3,4]. These risk factors not only compromise physical health but also increase fatigue, reduce job efficiency, elevate absenteeism rates, and may ultimately lead to premature departure from the workforce [5].

Globally, studies have consistently shown that construction-related occupations such as masonry, carpentry, electrical work, and plumbing are subject to high ergonomic risk levels due to poor workstation layout and excessive task repetition [5]. In the Malaysian context, these ergonomic stressors are often aggravated by tropical climatic conditions and the limited availability of ergonomic interventions or adaptive tools, especially on small- to mid-sized project sites. Yet, there remains a notable lack of empirical evidence directly linking ergonomic risk exposure to the prevalence of musculoskeletal discomfort among construction workers in regional areas. As construction demands escalate, workers are increasingly subjected to prolonged physical workloads under suboptimal environmental and ergonomic conditions. These exposures may significantly contribute to the development of musculoskeletal discomfort, with potential consequences such as reduced work capacity, chronic pain, and occupational injuries. This study aims to assess the ergonomic risk factors that contribute to musculoskeletal discomfort among construction workers in Kuala Terengganu. The findings are expected to support the design of targeted ergonomic interventions, foster a safer working environment, and offer evidence-based insights to guide occupational health policies and preventive strategies within Malaysia's construction sector.

2. Methodology

The study used a cross-sectional design to evaluate ergonomic risk factors and musculoskeletal discomfort (MSDs) among construction workers in Kuala Terengganu. A cross-sectional technique is commonly used for being able to quantify conditions prevalence and investigate connection between risk factors and health outcomes at a given period [6]. Compared to longitudinal or cohort studies, this design is less costly, takes less time, and is appropriate for resource-limited occupational health research [7]. As an observational method, it allowed data collection from a defined sample to determine group differences in exposure to ergonomic risk and self-reported discomfort levels. Simple random sampling was used to ensure sample representativeness. This probability-based strategy gives each individual in the population an equal chance of being selected, reducing selection bias and supporting ability to be generalized [8]. A total of 44 workers were chosen at random from a pool of about 50 possible participants based on a list provided by the management of the site. All participants were given clear information about the study and were only included after obtaining signed informed permission.

Eligibility requirements have been set up to ensure that respondents were equal. Participants had to be full-time construction workers with at least one year of experience and be able to give their permission voluntarily. Exclusion criteria included site managers, workers who had recently experienced trauma or surgery (within the last three months), chronic illnesses such as diabetes, cardiovascular problems, pregnancy, or refusal to participate. These criteria were chosen to allow accurate assessment of ergonomic risks while minimizing confounding variables [9]. Data was collected using three established tools. First, a socio-demographic questionnaire was utilised to collect background information such as age, gender, job type, duration of work, and educational level. Second, the Nordic Musculoskeletal Questionnaire (NMQ) was used to estimate the 12-month prevalence of musculoskeletal discomfort in various body regions. The NMQ is a

standardized instrument that is widely used in ergonomics and occupational health research due to its accuracy and worldwide comparability [10,11]. Third, ergonomic risks were assessed using a structured checklist modified from the Guidelines on Ergonomic Risk Assessment (ERA) at Work published by the DOSH [12].This tool helps the observational assessment of job-related ergonomic hazards such as awkward postures, repetitive motion, manual handling, and environmental conditions. The data were analyzed with SPSS version 26.0. Descriptive statistics such as mean, standard deviation, frequency, and percentages were used to summarize socio-demographic characteristics and MSD prevalence. The relationship between ergonomic risk factors and musculoskeletal discomfort has been assessed using Chi-square tests, which are suitable for analyzing associations between categorical variables in cross-sectional studies [13]. Histograms were used to visualize the prevalence of discomfort and associated ergonomic concerns, facilitating interpretation and emphasizing relevant findings.

3. Results

3.1 Socio Demographic Data

A total of 44 questionnaires were distributed and returned from a target population of 50 construction workers, yielding a response rate of 88%. This sample size was determined using Krejcie and Morgan's [14] sample size determination table, which recommends a sample of 44 for a finite population of 50. Table 1 summarizes the demographic characteristics of the respondents.

Table 1
Socio demographic data of respondents

Variables	n (%)
Gender	
Male	44 (100)
Below than 20 years old	1 (2)
21 - 30 years old	14 (32)
31 - 40 years old	17 (39)
More than 41 years old	12 (27)
Marital Status	
Single	6 (14)
Married	38 (86)
Divorced	0 (0)
Work Experience	
1 - 10 years	13 (30)
11 - 20 years	20 (45)
More than 20 years	11 (25)
Position Title	
Mason	10 (23)
Carpenter	3 (7)
Concrete worker	5 (11)
Steel wall worker	3 (7)
Plasterer	8 (18)
Electrician	4 (9)
Roofer	6 (14)
Painter	3 (7)
Ceiling Installer	1 (5)

All participants were male (100%), which reflects the male-dominated nature of the construction workforce at the selected sites. In terms of age distribution, 32% of respondents were

aged 21–30, 39% aged 31–40, and 27% were above 41 years old, while only 2% were under the age of 20. The mean age was 2.91 (SD = 0.830), based on categorical age coding. The majority of workers (86%) were married, with a mean marital status of 1.86 (SD = 0.347). Regarding work experience, 30% of participants had worked in construction for 1–10 years, 45% for 11–20 years, and 25% for more than 20 years, with a mean duration of 2.95 (SD = 0.746). Participants represented nine different occupational roles within the construction sector. The most common occupations were mason (23%), plasterer (18%), and roofer (14%). The ceiling installer category had the lowest number of respondents (5%). The mean number of occupations held by participants was 4.34 (SD = 2.542), reflecting the multi-skilled nature of construction labour. It was noted that plumbers had a comparatively lower response rate, possibly due to the sampling variation across job types 5. Previous study has shown that manual workers, particularly masons, plumbers, carpenters, and steel binders, are more likely to experience musculoskeletal discomfort due to repetitive and physically demanding tasks 6.

3.2 Prevalence of MSDs in the Past 12 Months

Most commonly affected body part was the shoulder (25.6%), followed by the lower back (19.7%), upper back (17.1%), and wrists/hands (16.2%) as shown in Figure 1. These findings are consistent with previous studies which reported high prevalence of MSDs in the shoulders and back among construction workers [3,4]. Repetitive lifting, awkward postures, and overhead work are among the major contributors [5]. By occupation, masons reported the highest percentage of lower back discomfort (6%), supporting findings by Ahmad *et al.,* [15] in Pakistan where masonry was linked to high physical strain. Similarly, carpenters showed notable discomfort in the shoulders (1.7%), consistent with the findings of Xu *et al.,* [4], which highlighted overhead tool use and prolonged standing as key risk factors.

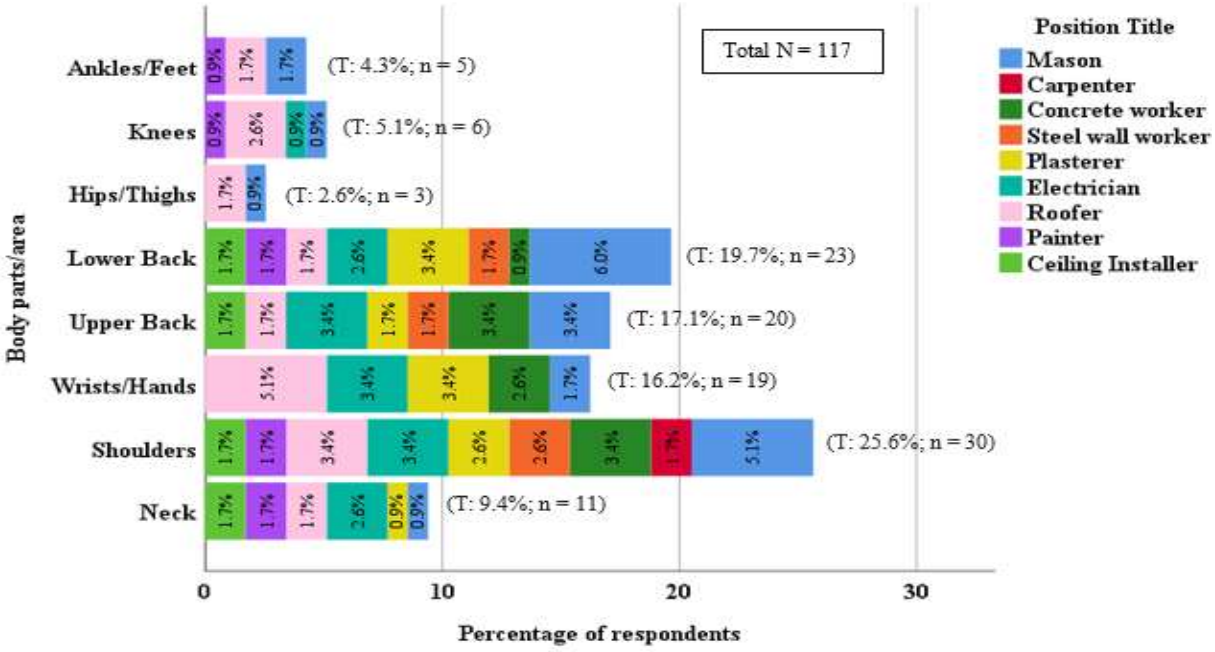

Fig. 1. Prevalence of MSDs for each occupation within the last 12 months

This study separates slightly from the findings of Palikhe *et al.,* [17], where neck discomfort was ranked higher among all trades. In this study, neck discomfort was minimal. This difference could be

due to task rotation or shorter exposure durations in Terengganu construction sites. Overall, the findings confirm that MSDs are highly prevalent in the construction sector, varying by trade and task type. The study supports the need for trade specific ergonomic interventions, especially in masonry, carpentry, and plastering work.

3.3 Association between ERF and MSDs among Respondents

Table 2 presents the association between ERFs and MSDs. A statistically significant association was found between static and sustained postures and neck pain ($p<0.05$). Occupations such as electricians, painters, ceiling installers, and carpenters showed increased neck discomfort, likely due to prolonged fixed head and neck positioning. This supports findings by Palikhe *et al.,* [17], who reported static posture as a key contributor to cervical MSDs.

Table 2
Relationship between ERF and MSDs

Variables	Number of respondents	p-value
Static and sustained work posture		
Neck	7	0.001
Shoulder	9	0.092
Wrists/hands	4	0.817
Upper back	6	0.293
Lower back	7	0.202
Hips/thighs	0	0.331
Knees	2	0.505
Ankles/feet	1	0.877
Vibration		
Neck	4	0.131
Shoulder	7	0.488
Wrists/hands	6	0.111
Upper back	5	0.495
Lower back	4	0.598
Hips/thighs	2	0.040
Knees	3	0.054
Ankles/feet	2	0.250
Temperature		
Neck	3	0.022
Shoulder	18	0.533
Wrists/hands	10	0.625
Upper back	10	0.405
Lower back	11	0.208
Hips/thighs	2	0.721
Knees	4	0.600
Ankles/feet	4	0.266
Noise		
Neck	3	0.162
Shoulder	16	0.124
Wrists/hands	6	0.107
Upper back	11	0.246
Lower back	12	0.349
Hips/thighs	0	0.101
Knees	1	0.128
Ankles/feet	2	0.795

Vibration exposure was significantly associated with hip/thigh pain ($p<0.05$), particularly among steel wall workers, roofers, and ceiling installers. This finding aligns with Mohan *et al.,* [16], suggesting that whole-body vibration contributes to lower limb discomfort, especially in elevated or platform-based tasks. Exposure to extremely hot temperatures also showed a significant association with neck pain ($p<0.05$). Heat-related stress can increase muscle fatigue and tension, supporting studies from tropical environments like those by Zare *et al.,* [3]. No significant associations were found for excessive noise, repetitive movements, or awkward postures, likely due to homogeneity in task repetition across jobs or limitations in variation of these factors in this study. These findings partially contrast with past research, such as Ndiwa [18], which reported strong overall correlations between ERFs and MSDs ($r=0.622$, $p<0.001$). The weaker associations in this study may be due to sample size, task distribution, or ERF measurement sensitivity. However, significant links found here emphasize the need for task-specific ergonomic interventions in Malaysian construction settings.

3.4 Ergonomic Risk Factors among Respondents that Causes MSDs

Figure 2 illustrates the key ergonomic risk factors that contribute to MSDs among construction workers. The most prevalent risk factors identified in this study include awkward postures, repetitive movements, and static or sustained postures. These factors were directly linked to musculoskeletal discomfort (MSD) in various body parts, particularly in the neck, lower back, and shoulders. Activities such as bending, working with hands above the head, elevating arms repeatedly, and holding the head tilted backward for prolonged periods were all noted as common causes of awkward postures. These findings align with previous studies that have shown how prolonged awkward postures contribute significantly to MSDs [19].

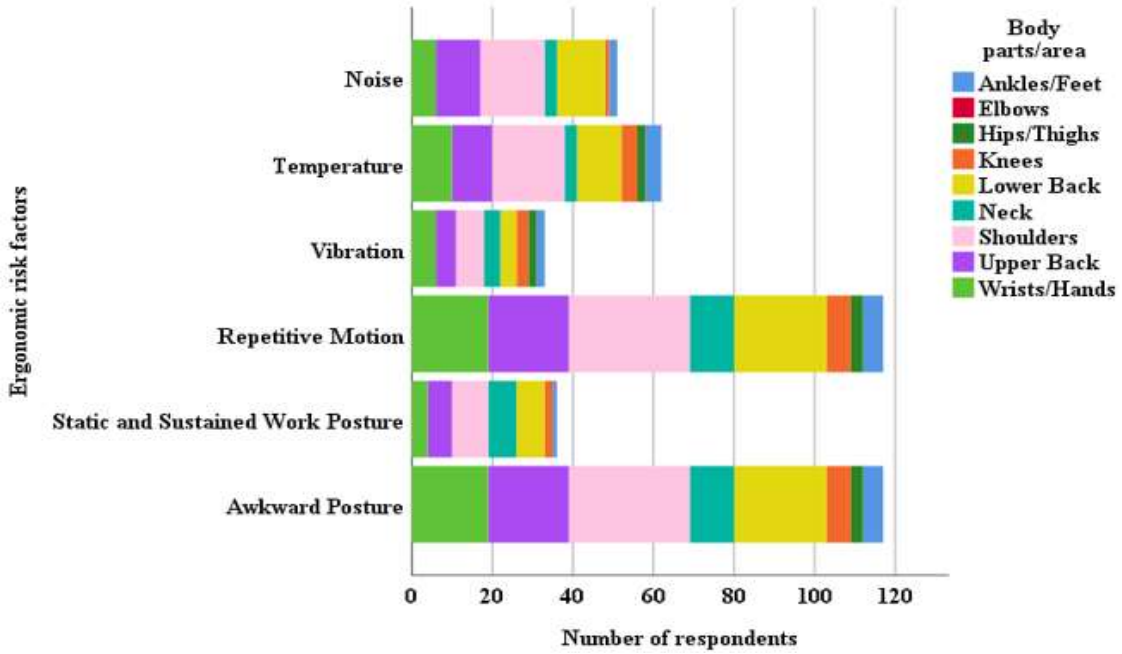

Fig. 2. ERF that contributes to MSDs among respondents

Additionally, repetitive movements, especially those requiring the use of fingers, hands, wrists, and arms for repetitive tasks, were identified as another significant ergonomic risk. Workers engaged in tasks that involve frequent hand and arm movements without sufficient rest breaks

were particularly prone to MSDs. Static postures, such as standing in one position for long periods without shifting weight or moving, were also found to increase the risk of musculoskeletal discomfort. This supports findings from prior studies that highlight the negative impact of prolonged static postures on musculoskeletal health. However, this study's findings contrast with other research, particularly studies conducted on Pakistani construction workers, which identified a wider array of risk factors for MSDs. For instance, the Pakistani study emphasized the role of lifting heavy loads, inadequate rest breaks, and prolonged static postures as major contributors to MSDs [20]. These differences might be attributed to variations in the work environment, sample size, and cultural factors influencing the construction industry in different regions.

3.5 Ergonomic Risk Factors among the Occupations

Figure 3 illustrates the ergonomic risk factors associated with various occupations in the construction industry. Masons, plasterers, and roofers predominantly reported pain or discomfort resulting from awkward postures and repetitive movements. Masons, roofers, and concrete workers also indicated that extreme heat was a significant contributor to their discomfort. Furthermore, noise was a major cause of pain and discomfort for concrete workers and masons. For electricians, static positions and prolonged postures were the main contributors to their discomfort, while roofers primarily attributed their pain to vibration exposure.

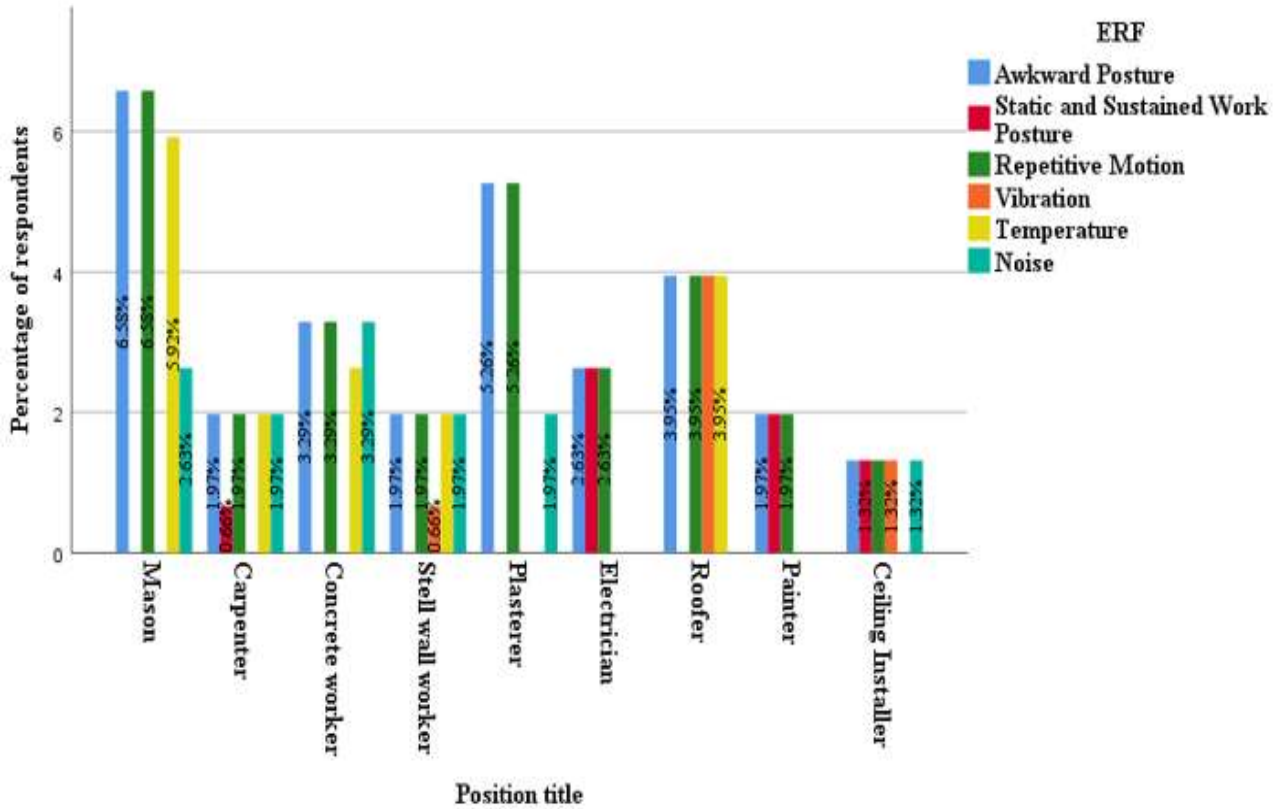

Fig. 3. ERF that contributes to MSDs according to their occupation

This aligns with previous findings, such as those by Abas *et al.,* [21], which highlighted repetitive motion as a significant cause of pain for masons and plasterers. However, the variation in results across different occupations may be due to differences in the geographical location of previous studies, the types of projects workers were engaged in, and sample size differences. For instance,

research conducted in Windhoek, Namibia [22], identified a broader range of ergonomic risks faced by building painters, such as repetitive motion, heavy lifting, prolonged standing and hanging, forceful exertion, and contact stress, in addition to awkward postures and excessive force.

The inconsistency in the findings highlights the importance of considering occupation-specific risk factors when addressing musculoskeletal discomfort in construction workers. It is obvious that certain tasks and environmental conditions disproportionately affect workers in particular roles. Therefore, targeted ergonomic interventions based on occupational roles are crucial to mitigate the risk of MSDs in the construction sector.

4. Conclusions

The highest prevalence of MSDs was found in the shoulders (25%), lower back (19.7%), upper back (17.1%), and wrists/hands (16.2%). Key ERFs linked to MSDs included awkward postures, repetitive motion, extreme temperatures, noise, static postures, and vibration. Demographic analysis revealed that most respondents were married male workers aged between 21 and 40 years. Significant associations were found between MSDs and static postures, vibration, and extreme heat. However, no significant link was found between repetitive motion or awkward postures and MSDs, likely due to their constant nature in the workplace. Workplace interventions, such as using PPE, taking breaks, and ensuring hydration, can help reduce these risks. This study successfully met its objectives by identifying critical ERFs and their impact on MSDs, offering insights for future preventative measures.

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