

Postural Risk Assessment in Construction Using Rapid Entire Body Assessment (REBA) and Ovako Working Posture Analysis System (OWAS)

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Received 20 January 2026, Received in revised form 15 June 2026
 Accepted 15 July 2026, Available online 30 September 2026

ABSTRACT

Detailed postural assessment is crucial in the construction sector due to the high physical demands, awkward positions, and repetitive manual tasks that contribute to work-related musculoskeletal disorders (WRMSDs). This study aimed to evaluate ergonomic risk levels and their association with musculoskeletal discomfort among Malaysian construction workers using an integrated approach combining the Rapid Entire Body Assessment (REBA) and the Ovako Working Posture Analysis System (OWAS). Integrating both tools provides a comprehensive assessment as REBA captures task-specific biomechanical loads, while OWAS reflects cumulative postural stress during static and dynamic tasks. A cross-sectional study was conducted at four construction sites involving 106 workers. Musculoskeletal discomfort was assessed using the Nordic Musculoskeletal Questionnaire (NMQ), capturing symptoms over the past 12 months and 7 days. Postural risks were quantified using two complementary ergonomic tools the Rapid Entire Body Assessment (REBA) and the Ovako Working Posture Analysis System (OWAS) through video analysis and structured field observations. Within the past 7 days, the most reported musculoskeletal symptoms were localized to the lower back (64.2%), wrists/hands (50.8%) and shoulders (49.1%). REBA analysis revealed that 73.6% of workers were exposed to high to very high ergonomic risk, with fibre installers exhibiting the highest mean score (11.2 ± 2.1). OWAS evaluation indicated that 58.4% of observed postures fell into Action Categories 3 or 4, signifying a need for prompt corrective intervention. A strong positive correlation between REBA and OWAS scores ($r = 0.61$, $p < 0.01$) demonstrated consistent identification of postural risks, particularly among ironworkers and carpenters. Chi-square analysis further confirmed significant associations between elevated ergonomic risk levels and reported discomfort in the lower back and shoulders ($p < 0.05$). The integrated use of REBA and OWAS provides a robust ergonomic evaluation framework that can guide targeted interventions and inform policy to reduce WRMSDs among construction workers.

Keywords: Construction ergonomics; REBA; OWAS; Musculoskeletal disorders; Postural risk assessment

INTRODUCTION

The construction industry is a sector defined by significant physical demands resulting in a high prevalence of work-related musculoskeletal diseases (WRMSDs) among its workers. WRMSDs include different conditions impacting

muscles, tendons, ligaments and nerves. These illnesses are intimately linked to the physically demanding characteristics of construction work, which often include awkward postures, repetitive movements, manual handling, excessive exertion levels and prolonged static loads. Over time, these stressors can lead to chronic pain, reduced

physical function, and even long-term disability, making musculoskeletal health a critical concern in the sector (Jacobsen et al. 2013; Mustapha et al. 2022; Nazri et al. 2018).

In Malaysia, the situation is compounded by factors such as unpredictable workloads, limited ergonomic awareness among workers, and insufficient enforcement of occupational safety guidelines (Rahman et al. 2012; Abas et al. 2020). Prior research indicates that individuals in construction occupations demonstrate an increased risk of musculoskeletal health problems than those working in other sectors (Jacobsen et al. 2013; Kashif et al. 2022). These disorders not only impact the health and well-being of workers, but also impose economic burdens on the industry, including reduced productivity, increased medical costs, and project delays due to worker absenteeism (Chung et al. 2019; Mustapha et al. 2022; Suganthirababu et al. 2023).

Conventional approaches to evaluating musculoskeletal hazards typically concentrate on certain body areas, which may insufficiently reflect the comprehensive risk exposure encountered by workers (Berberoğlu & Tokuç 2013). An integrated methodology employing instruments like the Rapid Entire Body Assessment (REBA) and the Ovako Working Posture Analysis System (OWAS) is essential for obtaining a comprehensive understanding of the biomechanical stresses associated with different construction-related tasks. The REBA framework facilitates a comprehensive biomechanical assessment of task-specific hazards by analysing the load and posture of the complete body during occupational tasks. Conversely, the OWAS method enables an in-depth assessment by classifying postures that may indicate accumulated stress on the musculoskeletal system.

In this study, the aim is to explore the relationship between ergonomic risk factors and self-reported musculoskeletal discomfort employing both REBA and OWAS methodologies. Through this dual analysis approach, the study intends to elucidate a more holistic view of the ergonomic challenges facing construction workers and derive potential interventions that specifically address the identified risk factors. By highlighting the interplay between task-specific demands and overall body postures, this research underlines the necessity for comprehensive ergonomic assessments in the construction sector to mitigate the prevalence of WRMSDs effectively.

Employing integrated ergonomic assessments could empower stakeholders within the construction industry including employers and health professionals, to develop targeted strategies aimed at reducing musculoskeletal injuries among workers. These strategies might encompass training programs to enhance ergonomic awareness, implementation of ergonomic tools and equipment,

structured modifications in work environments, and policy improvements enhancing worker safety protocols. The insights derived from such assessments hold potential not only for fostering healthier working conditions but also for enhancing overall productivity and morale among construction workers, thereby contributing to more sustainable and successful industry practices.

Thus, this investigation into postural risk assessment within the construction industry serves as a vital step toward fostering a safer and more ergonomic work environment. As the findings unfold, they could contribute significantly to the literature on occupational safety and health, potentially guiding future research and shaping policy directives aimed at safeguarding the health and well-being of construction workers.

METHODOLOGY

PARTICIPANTS

This study employed a cross-sectional observational design at four active construction sites located in Johor, Kuala Lumpur, and Malacca. A total of 106 male construction workers were selected through purposive sampling, specifically targeting those involved in physically intensive tasks such as carpentry, fibre installation, ironwork, and scaffolding. Eligible participants were at least 18 years old and had a minimum of six months of experience in construction-related jobs. This ensured that all respondents had adequate exposure to the physical demands of their respective tasks, allowing for a more accurate and relevant assessment of ergonomic risk and musculoskeletal symptoms.

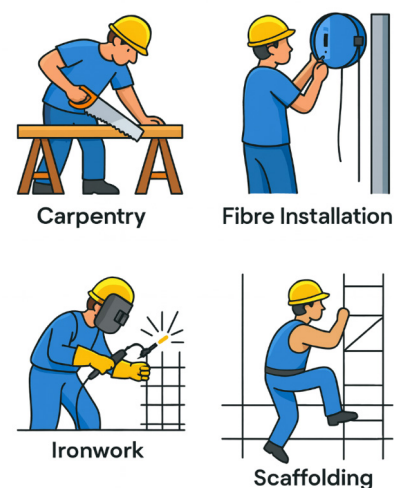


FIGURE 1. Construction work activities

NORDIC MUSCULOSKELETAL QUESTIONNAIRE (NMQ)

In this study, data on musculoskeletal discomfort and ergonomic risk were gathered using three validated instruments to ensure a comprehensive evaluation of the workers' physical well-being. Nordic Musculoskeletal Questionnaire (NMQ) was administered to capture self-reported discomfort across nine anatomical regions. Participants were asked whether they had experienced any musculoskeletal symptoms in each region during the previous 12 months as well as in the past 7 days. This dual timeframe allowed the researchers to assess both chronic and recent symptoms of work-related musculoskeletal disorders (WRMSDs), providing a clearer understanding of ongoing physical strain among construction workers (Dawson et al. 2008).

ERGONOMICS RISK ASSESSMENT

For ergonomic risk assessment, two observational tools were employed: The Rapid Entire Body Assessment (REBA) and the Ovako Working Posture Analysis System (OWAS). The REBA tool was used to evaluate task-specific postural strain by analyzing the positioning of major body segments, movement patterns, repetition of tasks, the level of force exerted, and the quality of the hand grip or coupling. Each observed posture was rated using a standardized scale, which classified the level of risk from low to very high, based on the severity of biomechanical demands (Hignett & McAtamney 2000).

Meanwhile, the OWAS method provided a systematic classification of postural risk by categorizing positions of the back (into four categories), arms (three categories), and legs (seven categories), as well as identifying the type and weight of any load handled (classified into three levels). This allowed for a structured and detailed assessment of cumulative biomechanical strain on the musculoskeletal system throughout various phases of work (Karhu et al. 1981). By combining the NMQ with REBA and OWAS, the study was able to integrate both subjective (self-reported) and objective (observational) data. This comprehensive approach strengthened the understanding of ergonomic risks and provided meaningful insights into the types and distribution of musculoskeletal issues affecting construction workers.

To ensure inter-rater reliability, all assessors participated in a verification session before data collection which included standardized instruction on REBA and OWAS scoring processes, team video-rating activities and

collaboration discussions. Differences in scoring were resolved by repeated review until an agreement was reached. During real data processing, two assessors independently scored 15% of the postures. Any differences were then resolved by mutual agreement to keep the scores consistent and reduce observer bias.

DATA COLLECTION PROCEDURES

Workers were observed while performing typical daily tasks, with each task recorded using video cameras for 20–30 minutes. The work process at every site was broken down into operational phases depending on how tasks flowed and what job function they served. To account for changes in task intensity over the workday, observations were made at different times (morning, mid-shift and late shift) to look for changes that could be caused by fatigue, changes in workload, or changes in the environment.

During each phase, we systematically captured postures at 30- to 60-second intervals to reflect the range of movements involved throughout the task. Trained assessors later reviewed the video footage frame by frame to reduce bias and ensure accuracy. In addition to video, photographs were taken to help verify specific body positions and improve the precision of posture classification after fieldwork. Each posture was coded using the OWAS framework, while REBA scores were calculated in parallel to assess overall ergonomic risk. This combination allowed us to identify how often workers adopted awkward or risky postures and determine the urgency of intervention from no action needed to immediate correction. For every worker, multiple postures across different operational phases were analyzed and these scores were compared with self-reported musculoskeletal symptoms to evaluate associations between ergonomic risk and discomfort.

STATISTICAL ANALYSIS

All statistical analyses were conducted using Statistical Package for the Social Sciences (SPSS) version 27. Descriptive statistics were used to describe participants' demographics and the prevalence of musculoskeletal symptoms. Pearson correlation tests were used to determine the relationship between REBA and OWAS scores, while chi-square tests assessed the association between ergonomic risk levels and musculoskeletal symptoms especially in the lower back, shoulders, and wrists. A *p*-value of less than 0.05 was considered statistically significant.

ETHICAL CONSIDERATION

This study received ethical clearance from the Universiti Kebangsaan Malaysia Research Ethics Committee (JEP-2024-844). All participants were informed about the purpose and procedures of the study, and their voluntary participation was ensured through informed consent. Confidentiality and anonymity were strictly maintained throughout the research process.

RESULTS AND DISCUSSION

This study provides robust evidence of the substantial ergonomic challenges confronting construction workers in Malaysia. By employing both the Rapid Entire Body Assessment (REBA) and the Ovako Working Posture Analysis System (OWAS), the study demonstrates the value of integrating complementary tools to comprehensively evaluate the risk of work-related musculoskeletal disorders (WRMSDs). The results indicate a notably high prevalence

of musculoskeletal symptoms, particularly in the lower back, wrists/hands and shoulders regions commonly subjected to repetitive strain and awkward postures inherent in construction work.

The demographic profile, summarized in Table 1 offers critical context for understanding these ergonomic concerns. The average age of the workers was 32.88 ± 7.39 years, reflecting a relatively young yet seasoned workforce. Notably, most participants (80.2%) had accumulated over five years of experience in the construction industry, implying that many of the reported symptoms are likely the consequence of prolonged exposure to physically demanding tasks.

The sample included workers from four key construction work activities: carpenters (19.8%), fibre installers (20.8%), ironworkers (31.1%), and scaffolders (28.3%). Each construction trade entails specific biomechanical workloads that necessitate an understanding of the unique physical challenges presented to the workers involved:

TABLE 1. Demographic characteristics and work experience of construction workers (n=106)

Variables	n (%)	Mean $\pm$ Standard Deviation
Age (years)		32.88 $\pm$ 7.39
≤ 30	42 (39.6)	
31-35	29 (27.4)	
35>	35 (33.0)	
Work Experience (years)		7.84 $\pm$ 5.08
≤ 5	21 (19.8)	
>5	85 (80.2)	
Construction activities		
Carpenter	21 (19.8)	
Fibre installer	22 (20.8)	
Ironworker	33 (31.1)	
Scaffolder	30 (28.3)	

PREVALANCE OF MUSCULOSKELETAL DISODERS

Table 2 illustrates a notably high burden of musculoskeletal disorders (MSDs) among Malaysian construction workers, affecting multiple anatomical sites. Based on responses to the Nordic Musculoskeletal Questionnaire (NMQ), the lower back was the most commonly reported site of discomfort affecting 65.1% of workers over the past 12 months and 64.2% within the past 7 days. This finding suggests both chronic strain and acute symptom persistence, likely linked to continuous exposure to biomechanical

stressors during daily tasks. The wrist/hand region showed discomfort in 52.8% (12 months) and 50.8% (7 days) of respondents, followed closely by shoulder discomfort reported by 50.9% and 49.1%, respectively. Other regions with notable discomfort include the knees (48.1%), neck (36.8%), and ankles/feet (34.0%), indicating that symptoms are not limited to isolated areas but are instead distributed throughout the body.

The results of this study paint a concerning picture: lower back disorders are alarmingly common among Malaysian construction workers, with rates exceeding those reported internationally 45.2% in Turkey (Sadeghi et al.

2020) and 52.8% in Iran (Nguyen et al. 2018). This higher prevalence may be tied to the unique nature of work conditions in Malaysia, where tasks such as prolonged stooping, repetitive lifting, and awkward trunk postures are part of daily routines. Many of these tasks are performed without ergonomic equipment or mechanical aids, intensifying the burden on the lumbar region. What makes these findings even more troubling is the negligible difference between 12-month (65.1%) and 7-day (64.2%) prevalence rates. This suggests that lower back pain is not only frequent but persistent workers are living with chronic discomfort that doesn't subside with rest. Over time, such chronic pain can erode productivity, increase sick leave, and even drive workers out of the workforce prematurely, with broad implications for both worker wellbeing and industry sustainability (Zerguine et al. 2018).

Beyond lower back issues, many workers also reported discomfort in the wrists/hands (52.8%) and shoulders (50.9%). These symptoms are not surprising, considering that construction tasks often involve repetitive hand movements, heavy tool usage, and overhead work activities especially common in carpentry, scaffolding, and fiber installation roles (Dogbla et al. 2023). For these workers, discomfort in the upper limbs can mean more than pain—it can lead to reduced dexterity, compromised safety, and impaired work quality. Importantly, musculoskeletal symptoms in this workforce are not limited to one region of the body. Many workers reported pain in multiple areas, including the knees (48.1%), neck (36.8%), and ankles/feet (34.0%). This widespread pattern points to a whole-body strain rather than isolated injuries, highlighting how physically taxing and ergonomically risky these jobs can be. The data suggest that many construction workers are not simply dealing with a single injury, they are coping with an accumulation of stress throughout their bodies (Subramaniam et al. 2021).

The nature of construction work means that physical strain is inevitable from lifting and bending to kneeling and standing for long periods, the body is constantly under pressure. These repetitive and strenuous actions can lead to fatigue, tissue damage, and inflammation. Without timely intervention, these injuries become chronic and affect not only the musculoskeletal system but overall job performance and safety (Ashraf et al. 2022). One area of concern is how the body compensates when in pain. For example, a worker with lower back discomfort may unconsciously shift weight or change posture, putting added strain on the knees or shoulders. This compensatory behavior can trigger a

vicious cycle of injury and reduced function. Over time, even simple tasks can become difficult, and the risk of long-term disability increases (Alroomi & Mohamed 2021).

TABLE 2. Prevalence of musculoskeletal disorder by body region (n=106)

Body Region	12- Month prevalence, (%)	7-day prevalence (%)
Lower back	65.1	64.2
Wrists/hands	52.8	50.8
Shoulders	50.9	49.1
Neck	39.6	36.8
Knees	48.1	48.1
Ankles/feet	34.0	34.0
Upper back	20.8	18.9
Elbows	35.8	35.8
Hips/thighs	8.5	8.5

REBA AND OWAS CLASSIFICATION

Musculoskeletal disorders (MSDs) remain a significant occupational health challenge in the construction industry, particularly among workers engaged in physically intensive tasks such as carpentry, fiber installation, ironworking, and scaffolding. Drawing on ergonomic risk assessments using the Rapid Entire Body Assessment (REBA), Ovako Working Posture Analysis System (OWAS), and symptom data from the Nordic Musculoskeletal Questionnaire (NMQ), this study provides robust insight into the biomechanical strain experienced by Malaysian construction workers.

REBA scores (Figure 2) provide a granular understanding of task-specific ergonomic stress. Fiber installers demonstrated the highest mean REBA score (11.2 ± 2.1), placing them firmly in the “very high-risk” category. Carpenters (10.8 ± 1.9) and ironworkers (10.6 ± 2.3) similarly exhibited high to very high risk levels. Although scaffolders had comparatively lower scores (8.9 ± 1.7), they still fell within the medium to high-risk zone. A breakdown of individual task scores reveals that 73.6% of the workforce fell within the high to very high-risk bands, reinforcing the pressing need for task redesign and immediate intervention.

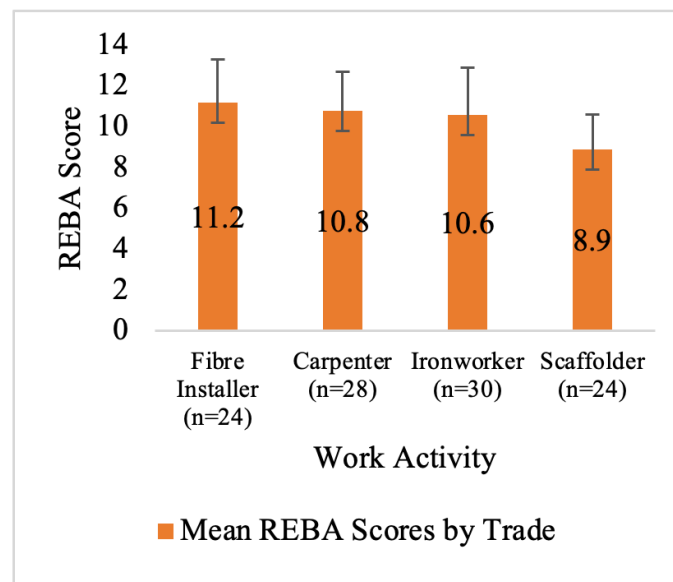


FIGURE 2. REBA score by construction work activities

These REBA findings are consistent with NMQ symptom reports, particularly among fiber installers, who showed both high REBA scores and the highest proportions of Category 4 OWAS postures. This correlation emphasizes the tangible impact of ergonomic risk factors on reported discomfort and potential injury development.

OWAS data supported the REBA results presented in Table 3, further quantifying postural strain. A total of 58.4% of all postures observed were classified as Category 3 or 4, with fibre installers (29.2%) and ironworkers (26.7%) showing the highest proportion of Category 4 postures, indicating immediate correction was necessary.

Scaffolders had relatively safer postures but still presented risks requiring preventive attention. The OWAS categorization highlights how sustained, awkward trunk and limb positions are embedded in construction tasks,

particularly when ergonomic controls are absent. These results illustrate trade-specific ergonomic vulnerabilities and provide empirical support for tailored interventions, especially in tasks involving installation, overhead assembly, and manual manipulation in confined or elevated spaces. Taken together, the results from NMQ, REBA, and OWAS demonstrate a clear convergence of subjective symptom burden and objective ergonomic risk. Workers across all four trades face elevated risks for MSDs, with specific job tasks exacerbating biomechanical strain. Persistent exposure, if unmitigated, may lead to chronic pain, productivity loss, absenteeism, and early retirement, translating into both personal hardship and economic burden to the industry (Zerguine et al. 2018; Alroomi & Mohamed 2021).

TABLE 3. OWAS fin

Construction work activities	Cat 1, n (%)	Cat 2, n (%)	Cat 3, n (%)	Cat 4, n (%)
Fibre installer (n=24)	2 (8.3%)	5 (20.8%)	10 (41.7%)	7 (29.2%)
Carpenter (n=28)	3 (10.7%)	7 (25.0%)	11 (39.3%)	7 (25.0%)
Ironworker (n=30)	4 (13.3%)	8 (26.7%)	10 (33.3%)	8 (26.7%)
Scaffolder (n=24)	6 (25.0%)	9 (37.5%)	7 (29.2%)	2 (8.3%)

CORRELATION BETWEEN REBA AND OWAS

Figure 3 illustrates how ergonomic risk levels vary between work activities when evaluated using two complementary assessment tools, REBA and OWAS. REBA expressed as a percentage of its maximum score (15) reflects the overall severity of postural load for each trade. OWAS Category 4 percentages indicate the proportion of observed postures

requiring immediate corrective action. Fiber installers demonstrated the highest ergonomic risk based on both REBA (74.7%) and OWAS (29.2%). Carpenters and ironworkers also showed high-risk patterns while scaffolders exhibited the lowest combined risk profile. Overall, the comparison highlights that while REBA identifies high general postural strain across all work activities, OWAS helps pinpoint the frequency of the most hazardous postures. Together, these tools provide a more

comprehensive evaluation of ergonomic risk in construction work.

Table 4 presents the Pearson correlation analysis, which highlights notable variations in the strength of association between REBA and OWAS across the four construction trades. Moderate correlations were observed among ironworkers ($r = 0.68$, $p < 0.01$) and carpenters ($r = 0.64$, $p < 0.01$) indicating a good level of consistency between the two tools in identifying postural risks within these occupations. Fiber installers ($r = 0.55$, $p < 0.01$) and scaffolders ($r = 0.52$, $p < 0.01$) also demonstrated moderate correlations reflecting differences in task characteristics, movement patterns and biomechanical demands inherent to each work activities. These results suggest that both REBA and OWAS are capturing similar ergonomic risk factors, though with varying sensitivity depending on the nature of the trade. The strong correlation supports previous findings in the literature that demonstrate compatibility between different observational ergonomic tools (Widyanti 2020; Sánchez-Robles et al. 2023). The consistency of these results across construction occupations further reinforces the value of applying both methods as complementary tools in ergonomic risk profiling.

The demonstrated correlation between REBA and OWAS reinforces the practical benefit of using both tools in tandem for a well-rounded ergonomic evaluation. While

REBA is particularly suited for assessing task-specific and dynamic postures such as lifting, bending, or twisting during high-movement activities OWAS excels at identifying repetitive or sustained postural stress that accumulates over time during more static phases of work. By combining these tools, practitioners are better equipped to capture a fuller picture of ergonomic risks, enabling them to identify both immediate hazards and chronic stressors that may lead to musculoskeletal disorders. For example, a carpenter may be flagged by REBA for dynamic tasks like sawing or hammering, while OWAS could highlight risk during prolonged standing or trunk flexion when measuring and aligning materials. This complementary assessment framework provides valuable guidance for targeted ergonomic interventions, including the redesign of workstations, scheduling of rotational tasks, and implementation of rest breaks. Moreover, these findings can strengthen the confidence of occupational health professionals in using observational tools for proactive risk management (Sadeghi-Yarandi et al. 2019; Choi et al. 2020). When used together, REBA and OWAS help translate ergonomic observations into actionable insights, informing interventions that not only reduce physical strain but also promote long-term worker health and productivity (Li et al. 2020).

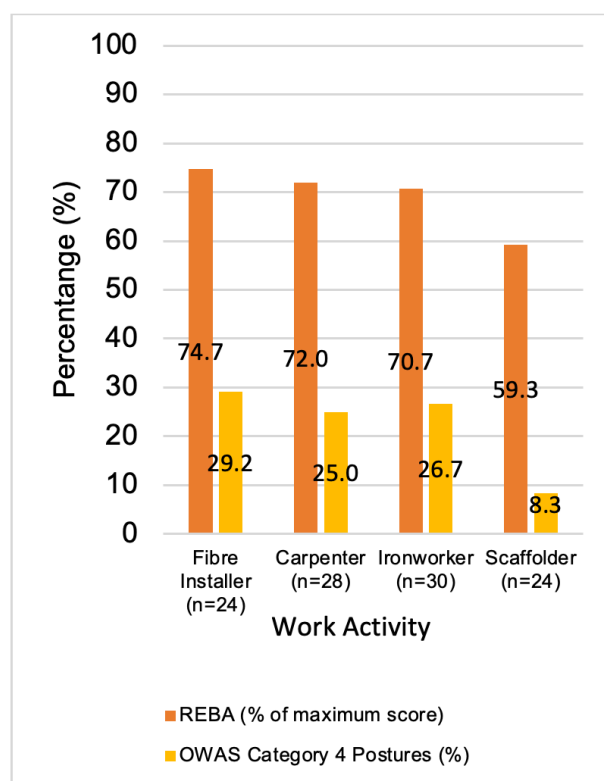


FIGURE 3. Comparison of REBA and OWAS outcomes by construction trade.

TABLE 4. Pearson Correlation between REBA and OWAS scores.

	Fibre installer (OWAS)	Carpenter (OWAS)	Ironworker (OWAS)	Scaffolder (OWAS)
Fibre installer (n=24) (REBA)	1.00			
Carpenter (n=28) (REBA)	0.55*	1.00		
Ironworker (n=30) (REBA)	0.60*	0.64*	1.00	
Scaffolder (n=24) (REBA)	0.52*	0.59	0.68*	1.00

Note: Values represent Pearson's correlation coefficient (r) between REBA and OWAS scores. All correlations are significant at $*p < .01$.

ASSOCIATION BETWEEN ERGONOMIC RISK AND MUSCULOSKELETAL DISORDERS

The findings (in Table 5) from the chi-square analysis revealed a clear and statistically significant link between ergonomic risk levels and self-reported musculoskeletal discomfort, particularly in the lower back region. Workers with high REBA scores (≥ 8) were considerably more likely to report lower back pain, both over the past 12 months ($\chi^2 = 12.47$, $p < 0.001$) and past 7 days ($\chi^2 = 8.93$, $p < 0.01$). Similarly, those categorized under OWAS action levels 3 and 4 which indicate urgent or immediate need for corrective action also showed a significant association with 12-month lower back symptoms ($\chi^2 = 9.82$, $p < 0.01$). These results reinforce the critical role of ergonomic assessments like REBA and OWAS in identifying work-related risks and predicting potential injury outcomes. The strong link between postural risk and lower back pain highlights how cumulative strain from awkward positions, lifting, and forceful tasks contributes to persistent discomfort. Such findings underscore the urgency of implementing ergonomic interventions ranging from task redesign and mechanical aids to training in safe lifting techniques and job rotation to alleviate biomechanical loads (Valentim et al. 2022). These patterns are echoed in previous studies, which have emphasized that poor ergonomic conditions are strongly correlated with higher MSD prevalence, and that a safety culture prioritizing ergonomics leads to

healthier and more productive workplaces (Kumar & Thangavelu 2024).

Beyond the lower back, the analysis also uncovered notable associations between high ergonomic risk scores and discomfort in other key body regions, particularly the shoulders and wrists/hands. Shoulder discomfort was significantly associated with both REBA ($\chi^2 = 7.65$, $p < 0.05$) and OWAS ($\chi^2 = 6.23$, $p < 0.05$) risk levels, indicating that overhead work and static shoulder elevation are consistent contributors to musculoskeletal issues. Meanwhile, wrist and hand pain showed a strong connection with REBA scores ($\chi^2 = 8.41$, $p < 0.05$) but a weaker, non-significant association with OWAS classifications ($\chi^2 = 4.87$, $p = 0.08$). This difference may be due to the way REBA captures task-specific hand and wrist movements such as gripping, twisting, or using hand tools—whereas OWAS is better suited for evaluating whole-body postural loads over time. This suggests that each tool offers distinct but complementary insights, and choosing the appropriate tool depends on the specific ergonomic questions being asked (Brandl et al. 2024; Gómez-Galán et al. 2017). The findings also extend to the neck and upper limbs, with REBA demonstrating greater sensitivity in detecting risks for these dynamic regions. Overall, the association patterns highlight the importance of using both REBA and OWAS in tandem, particularly when assessing trades that involve both repetitive upper limb tasks and sustained whole-body postures.

TABLE 5. Association between REBA, OWAS and NMQ

Body Region	REBA (High risk ≥ 8), χ^2 (p-value)	OWAS (Action category, 3 & 4) χ^2 (p-value)
12- Month prevalence,		
Lower back	12.47 (<.001)***	9.82 (<.01)**
Shoulders	7.65 (<.05)*	6.23 (<.05)*
Wrists/hand	8.41 (<.05)*	4.87 (.08)
Neck	5.23 (<.05)*	3.94 (.14)
7-day prevalence		
Lower back 8.93	8.93 (<.01)**	6.45 (<.05)*
Shoulders	4.82 (<.05)*	4.11 (<.05)*
Wrists/Hands	6.23 (<.05)*	2.98 (.22)

* $p < .05$, ** $p < .01$, *** $p < .001$

CONCLUSION

This study provides compelling evidence of substantial ergonomic risks and a high prevalence of work-related musculoskeletal disorders (WRMSDs) among Malaysian construction workers, particularly in high-strain trades such as fiber installation, carpentry, and ironwork. The integrated application of Rapid Entire Body Assessment (REBA) and Ovako Working Posture Analysis System (OWAS) enabled a comprehensive evaluation of both task-specific biomechanical loads and cumulative postural stress, demonstrating strong concordance between objective ergonomic risk scores and self-reported musculoskeletal symptoms. The consistently high prevalence of lower back, wrist/hand, and shoulder discomfort underscores the urgent need for systematic ergonomic intervention in construction work processes.

From a practical and engineering perspective, the findings highlight several actionable intervention pathways. These include the redesign of work methods and tools (e.g., lighter hand tools, ergonomically designed grips), engineering controls such as adjustable scaffolding heights, mechanical lifting aids, and modular material handling systems, as well as administrative controls including task rotation, structured rest breaks, and ergonomics-focused training programs tailored to specific construction trades. At the policy level, integrating ergonomic risk assessment tools such as REBA and OWAS into routine site safety audits, contractor safety compliance frameworks, and occupational safety and health (OSH) guidelines could strengthen preventive strategies and reduce WRMSD burden in the construction sector.

Several study limitations should be acknowledged. First, the sample consisted exclusively of male construction workers, limiting the generalizability of the findings to female workers, who may experience different ergonomic exposures and risk profiles. Second, data were collected from only four construction sites, which may not fully capture the variability of construction practices across different regions or project types. These limitations suggest caution in extrapolating the findings to the broader construction workforce. Looking forward, future research should expand to include female workers, larger multi-site samples, and longitudinal study designs to better examine cumulative exposure and causal relationships between ergonomic risk and WRMSDs. The integration of wearable motion sensors, digital posture monitoring systems, or AI-based posture analysis offers promising opportunities for real-time risk detection and early intervention. Furthermore, evaluating the effectiveness of automation-assisted construction processes and ergonomic redesign strategies may provide sustainable solutions for reducing

biomechanical strain. Collectively, such advancements can strengthen evidence-based ergonomic decision-making and contribute to safer, healthier, and more productive construction workplaces in Malaysia.

ACKNOWLEDGEMENT

This study was funded by Universiti Kebangsaan Malaysia under the Geran Galakan Penyelidik Muda (GGPM 2024-073).

DECLARATION OF COMPETING INTEREST

None.

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