Tropical Built Environment Journal. Volume 14, No. 3, 1-20, 2026 www.tbejournal.com
ISSN: 1118-1790

Evaluation of Ergonomic Practices and Associated Problems among Construction Workers in South-East Nigeria

Onyili N.J.[1], Okolie K.C.[1]. Obodoh D.A.[1], and *Okongwu M.I.[1,]

[1]Department of Building, Faculty of Environmental Sciences, Nnamdi Azikiwe University, Awka, Nigeria.

[*]Corresponding Author, okongwuikechukwu01@gmail.com

Abstract

Construction work involves substantial physical demands that may expose workers to ergonomic risks and work-related musculoskeletal disorders (WMSDs). This study evaluated ergonomic practices and associated problems among construction workers in South-East Nigeria. A descriptive survey design was adopted, covering Anambra, Enugu, Imo, Abia and Ebonyi States. The study population comprised 114,330 respondents, from which a sample of 692 was determined using Taro Yamane and Cochran formulae. A multi-stage sampling procedure was employed, and 650 valid questionnaires were retrieved and analysed, representing a 93.9% usable response rate. Data were collected using a structured questionnaire whose reliability coefficients were 0.987 and 0.890, these coefficients indicate a high level of internal consistency for the respective scales Descriptive statistics, Mean, Pearson Product-Moment Correlation, were employed at the 5% significance level. The findings revealed that ergonomic practices were unevenly implemented. Appropriate use of personal protective equipment recorded a high mean of 3.84, while supervisory monitoring and worker involvement in identifying ergonomic challenges recorded means of 3.59 and 3.47, respectively. However, provision of mechanical aids for lifting and moving heavy materials (2.33), manual material-handling training (2.49), established ergonomic policies (2.47), and consideration of ergonomic principles during site planning and task allocation (2.54) were comparatively weak. General musculoskeletal disorders recorded the highest group mean (4.04), followed by specific MSD conditions (4.01) and multi-site MSDs (4.00), with lower back pain recording the highest specific MSD mean (4.18). Pearson correlation revealed a significant moderate negative relationship between current ergonomic practices and ergonomic problems ($r = -0.472$, $p < 0.001$), leading to rejection of the null hypothesis. The study concludes that inadequate implementation of task-specific and preventive ergonomic measures remains an important concern among construction workers in South-East Nigeria. Strengthening ergonomic training, mechanical material-handling assistance, ergonomic planning, formal guidelines and systematic risk assessment is recommended to reduce ergonomic problems and improve workers' well-being and construction performance.

Keywords: *Ergonomic; construction workers; musculoskeletal disorders; occupational health; South-East Nigeria.*

I.0 INTRODUCTION

1.1 Background to the Study

The construction industry is essential to economic and physical development, providing residential, commercial, institutional and public infrastructure. However, construction work is characterised by changing site conditions and physically demanding activities, including manual handling, lifting, carrying, bending, kneeling, reaching, pushing, pulling and repetitive movements. These activities expose workers to occupational hazards and place considerable demands on their physical capacity (ILO, 2022). Consequently, attention to ergonomics is important for protecting worker health and supporting safe and efficient construction project delivery.

Ergonomics involves adapting work, tasks, tools and working environments to human capabilities and limitations. In construction, poor ergonomic conditions can expose workers to awkward postures, excessive force, repetitive movements, prolonged static positions and manual handling of heavy materials. Such exposures have been associated with work-related musculoskeletal disorders (WMSDs), particularly affecting the lower back, shoulders, knees, neck and upper limbs (Umer et al., 2018; Anwer et al., 2021). These problems extend beyond worker discomfort, as persistent pain and fatigue can affect work ability, absenteeism and productivity. Evidence also indicates that appropriate workplace modifications, equipment and training can reduce ergonomic risks and musculoskeletal pain (Heidarimoghadam et al., 2022).

The Nigerian construction industry presents similar concerns. Ekpenyong and Inyang (2014), in a study of 1,200 construction workers in Uyo, reported a 39.25% prevalence of WMSDs, while Adedoyin et al. (2022) found substantially higher 12-month and seven-day prevalence rates among Nigerian bricklayers. Aaron et al. (2023) also reported frequent exposure to awkward working positions among construction workers in Port Harcourt, alongside inadequate safety training and musculoskeletal complaints. More recently, Ilesanmi (2026) identified limited knowledge and minimal implementation of ergonomic practices on Nigerian construction sites. These findings suggest that the presence of ergonomic risks may be linked not only to the physical demands of construction tasks but also to deficiencies in training, equipment, work methods and management practices.

The concern is particularly relevant to South-East Nigeria, where construction activities are widespread across Abia, Anambra, Ebonyi, Enugu and Imo States (Okongwu et al, 2025),. Existing evidence indicates broader challenges in occupational health and safety compliance in the region, including inadequate training, insufficient safety personnel, inadequate funding, weak safety culture and limited awareness among construction stakeholders (Emma-Ochu et al., 2021). Although these studies provide useful evidence on occupational safety, limited attention has been given specifically to the relationship between actual ergonomic practices and the problems experienced by construction workers in the region.

Furthermore, much of the existing Nigerian literature has focused on the prevalence of musculoskeletal disorders or specific construction trades, with relatively limited evidence examining ergonomic practices alongside the problems associated with those practices. Understanding this relationship is important because the occurrence of ergonomic problems cannot be adequately addressed by identifying health outcomes alone; it also requires examination of how construction tasks are performed, the extent to which ergonomic principles are applied, and the constraints affecting their implementation. Therefore, this study evaluates ergonomic practices and associated problems among construction workers in South-East Nigeria. It examines the ergonomic practices adopted by workers, the ergonomic problems experienced, and the relationship between current ergonomic practices and the occurrence of such problems. The study provides context-specific evidence that can support improved ergonomic management, worker protection and construction project performance in the region.

1.2 Statement of the Research Problem

Construction work involves physically demanding activities such as manual material handling, repetitive movements, awkward postures, prolonged standing, kneeling, bending and working above shoulder level. When these activities are performed using unsuitable methods, tools or working conditions, they can expose workers to excessive physical strain, fatigue, pain and work-related musculoskeletal disorders (WMSDs). Previous studies have documented substantial musculoskeletal problems among construction workers, particularly affecting the lower back, shoulders, knees and upper limbs (Anwer et al., 2021; Antwi-Afari et al., 2023). In Nigeria, Ekpenyong and Inyang (2014) reported a substantial prevalence of WMSDs among construction workers in Uyo, while Adedoyin et al. (2022) found a high prevalence among bricklayers. Similarly, Aaron et al. (2023) reported exposure to awkward working positions and musculoskeletal pain among construction workers in Port Harcourt.

Although these studies establish the physical health concerns associated with construction work, they do not sufficiently explain the extent to which ergonomic practices are currently adopted by construction workers in South-East Nigeria or the problems associated with their implementation. This gap is important because appropriate ergonomic practices can help control physical demands and reduce workers' exposure to harmful working conditions. Evidence of limited ergonomic knowledge and implementation among Nigerian construction professionals (Ilesanmi, 2026), alongside challenges such as inadequate training, limited safety culture, insufficient funding and weak stakeholder commitment to construction health and safety compliance (Emma-Ochu et al., 2021), further suggests that the application of ergonomic principles may be constrained in practice. However, the specific practices adopted, the problems workers experience in relation to these practices and the implications for construction project delivery in South-East Nigeria remain insufficiently established. This study therefore evaluates current ergonomic practices and the associated problems among construction workers in the region to provide empirical evidence that can inform improvements in workplace ergonomics and construction project delivery.

1.3 Aim and Objectives of the Study

The aim of the study is to evaluate ergonomic practices and its associated problems among construction workers in South-East Nigeria, with a view to improving workers' well-being, reducing ergonomic risks and enhancing construction project delivery.

The study addressed the following objectives, to:

1. examine the current ergonomic practices adopted on construction sites in South-East Nigeria;
2. assess the problems associated with current ergonomic practices among construction workers in South-East Nigeria

1.4 Research Hypotheses

This null hypothesis was tested at the 5% level of significance:

H_{01}: There is no significant relationship between current ergonomic practices and the occurrence of ergonomic problems among construction workers in South-East Nigeria.

2.0 LITERATURE REVIEW

A. Global overview of ergonomic practices on construction sites

The construction industry remains one of the most physically demanding sectors globally due to the nature of activities such as lifting, bending, climbing, repetitive motion, awkward postures, vibration

exposure, and prolonged manual handling of materials. In response to the increasing rate of work-related musculoskeletal disorders (WMSDs), many countries have integrated ergonomic principles into construction health and safety management systems. Contemporary ergonomic practices in construction are aimed at reducing physical stress on workers, improving productivity, minimizing accidents, and enhancing overall project performance (Albers and Estill 2007; Tao et al., 2024).

Globally, ergonomic practices on construction sites have evolved from traditional manual safety approaches to technology-driven systems that combine engineering controls, wearable devices, automation, and digital monitoring techniques (Table 1). Developed countries such as the United States, the United Kingdom, Canada, Germany, Sweden, and Australia have increasingly adopted proactive ergonomic strategies including adjustable scaffolding systems, powered lifting equipment, ergonomic hand tools, exoskeleton technologies, and motion-capture systems for posture assessment (Sardinha et al., 2024; Afolabi et al., 2024).

One of the most notable global ergonomic trends in recent years is the application of wearable technologies and artificial intelligence in monitoring workers' posture and physical stress. Motion capture systems, wearable sensors, and computer vision technologies are now being used to identify high-risk tasks and predict ergonomic hazards before injuries occur. Rahman et al. (2024) observed that Industry 4.0 and Industry 5.0 technologies have significantly improved ergonomic assessment capabilities in construction environments through real-time worker monitoring and predictive health analysis.

Similarly, automated ergonomic risk assessment systems are increasingly becoming common in advanced construction industries. Tao et al. (2024) explained that automated ergonomic assessment technologies now integrate machine learning, computer vision, and digital modeling to analyze workers' posture, repetitive motion, and body mechanics during construction operations. These technologies improve the accuracy of ergonomic evaluations and support timely intervention measures. Another major ergonomic practice currently gaining global acceptance is the use of construction exoskeletons. Exoskeletons are wearable assistive devices designed to reduce muscular strain and support workers during physically demanding tasks such as overhead drilling, lifting, and repetitive bending. Afolabi et al. (2024) noted that exoskeletons are increasingly recognized as effective ergonomic interventions capable of reducing fatigue and musculoskeletal injuries among construction workers.

In many developed nations, ergonomic interventions are also incorporated during the planning and design stages of construction projects. This approach, often referred to as "Prevention through Design" (PtD), ensures that ergonomic considerations are embedded into construction methods, material handling processes, and site layout planning before project execution begins. Gokler et al. (2024) emphasized that integrating lean construction principles with ergonomic design improves worker safety, operational efficiency, and workflow coordination.

Training and worker education also constitute an important aspect of global ergonomic practices. Construction workers are increasingly trained on safe lifting techniques, posture management, proper tool handling, and fatigue management. Regular ergonomic awareness programs help workers identify

hazardous work conditions and encourage compliance with safety standards. In many European countries, ergonomic training has become mandatory within occupational health and safety certification systems. In addition, construction firms worldwide are increasingly redesigning workstations, tools, and equipment to accommodate workers' physical capabilities. Ergonomic hand tools with vibration control, adjustable handles, anti-fatigue flooring, and mechanical lifting devices are now commonly used to reduce strain-related injuries. According to Tao et al. (2024), ergonomic redesign of tools and work methods significantly lowers physical workload exposure among construction workers.

Table 1: Common Ergonomic Practices on Construction Sites Globally

Ergonomic Practice	Purpose	Common Countries
Wearable sensors and motion tracking	Monitoring posture and fatigue	USA, Germany, Japan
Exoskeleton technologies	Reducing muscular strain	USA, Canada, Sweden
Adjustable scaffolding systems	Minimizing awkward postures	UK, Australia
Ergonomic hand tools	Reducing vibration and hand injuries	Europe, North America
Mechanical lifting devices	Reducing manual handling stress	Global
AI-based ergonomic assessment	Predicting injury risks	USA, China
Worker ergonomic training	Improving safety awareness	Global

Sources: Sardinha *et al.,* 2024;

B. Ergonomic practices in developing countries and Sub-Saharan Africa specifically

In developing countries, ergonomic practices in construction are still evolving and remain relatively underdeveloped compared to industrialized nations. Although awareness of occupational health and ergonomic safety has improved in recent years, the implementation of ergonomic interventions across many developing countries remains limited due to inadequate funding, weak enforcement of safety regulations, shortage of skilled professionals, and high dependence on manual labor (Abina et al., 2023). Construction activities in many developing countries are predominantly labor-intensive. Workers are frequently exposed to excessive physical demands such as repetitive lifting, prolonged standing, bending, kneeling, climbing, and carrying heavy materials without mechanical assistance. As a result, work-related musculoskeletal disorders remain highly prevalent among construction workers in these regions.

In Sub-Saharan Africa, ergonomic practices are generally characterized by low awareness levels, poor implementation of occupational safety standards, and limited adoption of technological solutions. Construction workers often operate in unsafe environments with minimal ergonomic support systems. In many cases, construction firms focus more on project completion and cost reduction than on worker health and ergonomic wellbeing. Nigeria, South Africa, Ghana, Kenya, and Ethiopia are among the Sub-Saharan African countries where ergonomic and occupational safety discussions have gained increasing research attention in recent years. However, actual implementation on construction sites remains inconsistent. Abina et al. (2023) found that although construction professionals in Nigeria

increasingly recognize the importance of modern health and safety technologies, the adoption of ergonomic innovations is still at an early stage.

Recent studies on Nigeria's construction industry indicate that ergonomic practices are gradually improving through increased awareness campaigns, professional training, and the adoption of selected technological tools (Ajayi & Adeoye, 2018). Ilesanmi and Moyanga (2024) observed that the Nigerian construction industry has witnessed growing awareness regarding the importance of ergonomics in reducing injuries and improving worker productivity. However, the study revealed that implementation levels remain low due to inadequate training, financial limitations, and poor regulatory enforcement. Many construction sites across Sub-Saharan Africa still rely heavily on manual material handling techniques due to limited access to mechanized equipment. Workers often carry cement bags, reinforcement bars, concrete materials, and blocks manually over long distances. This exposes them to severe musculoskeletal stress and chronic body pain. Furthermore, personal protective equipment provided on many sites rarely addresses ergonomic risks directly.

Another significant challenge affecting ergonomic practices in Sub-Saharan Africa is the dominance of informal construction sectors. Informal construction workers usually lack access to ergonomic training, occupational health services, and structured safety management systems. Consequently, injury reporting and ergonomic risk assessments are often inadequate or nonexistent.

Despite these limitations, some positive developments are emerging within the region. South Africa has demonstrated relatively higher progress in integrating ergonomic considerations into construction safety policies and occupational health frameworks. Larger multinational construction firms operating in African countries are also introducing ergonomic tools, lifting aids, and digital safety monitoring systems on major projects. The growing influence of digital technologies is beginning to reshape ergonomic practices within African construction industries. Mobile safety applications, wearable sensors, and digital reporting systems are gradually being introduced to improve hazard detection and worker monitoring. According to Abina et al. (2023), Fourth Industrial Revolution technologies such as drones, wearable devices, and smart monitoring systems have significant potential to transform construction health and safety management in Nigeria and other African countries

C. Theoretical Review

I. Ergonomic Systems Theory

Ergonomic Systems Theory provides a useful theoretical foundation for evaluating ergonomic practices in construction because it views work as an interaction between the worker, task, tools and equipment, physical environment, and organisational conditions rather than treating injury as a consequence of worker behaviour alone. The central idea is that work performance and worker well-being depend on how well these elements fit together. In construction, this perspective is particularly relevant because workstations, tasks and environmental conditions change frequently, while workers are required to adapt continuously to different materials, equipment and site conditions.

The systems perspective is consistent with the broader development of ergonomics, which recognises that occupational problems can arise from interactions among multiple components of a work system. Wong et al. (2016) demonstrated the importance of considering construction workers' body movements and working postures when assessing musculoskeletal risks. Their review showed that

construction activities involve complex physical movements and that technological approaches can be used to identify unsafe postures and movements. Similarly, Antwi-Afari et al. (2023) observed that ergonomics and work-related musculoskeletal disorders remain central themes in construction research, reflecting the complex relationship between construction tasks and worker health.

The theory is particularly useful because an ergonomic problem may not originate from the worker alone. For example, a worker may repeatedly bend because materials are stored at ground level, lift heavy loads because mechanical handling equipment is unavailable, or maintain an awkward posture because the work surface cannot be adjusted. In each case, the worker's behaviour is partly a response to the way the work system has been designed. Consequently, improving ergonomic performance requires attention to the task, equipment, workplace layout and organisational arrangements rather than relying solely on worker instruction.

This systems perspective is supported by evidence from construction ergonomics research. Antwi-Afari et al. (2017), using biomechanical analysis, demonstrated that repetitive lifting tasks can produce substantial physical loading and identified factors that can be modified to reduce musculoskeletal risk. Wong et al. (2016) similarly emphasised the importance of analysing body motion and working posture when assessing construction ergonomic risks. These studies suggest that ergonomic problems can be understood more effectively when the interaction between workers and their work environment is examined.

For the present study, Ergonomic Systems Theory provides a basis for examining current ergonomic practices across several dimensions, including manual material handling, working posture, task design, use of tools and equipment, work organisation, workplace conditions, training and management support. It therefore provides a broad theoretical lens for explaining why some construction practices may expose workers to ergonomic problems while others may reduce such exposure.

3.0 METHODOLOGY

The study adopted a descriptive survey research design to evaluate ergonomic practices and associated problems among construction workers in South-East Nigeria. The study covered the five states of the South-East geopolitical zone, namely Anambra, Enugu, Imo, Abia, and Ebonyi. The study population comprised 114,330 respondents, including 1,330 management-level professionals comprising architects, builders, and structural engineers, quantity surveyor, project managers, site supervisors and 113,000 operational-level workers comprising artisans and labourers. Respondents were eligible where they were actively involved in construction activities within the study area and had relevant experience of construction site operations.

Using the Taro Yamane formula at a 5% level of precision, a sample size of 308 was obtained for the management-level population, while Cochran's formula produced a sample size of 384 for the operational-level population, giving a total sample of 692 respondents. Proportionate sampling was used to ensure representation across the five states and respondent categories, while purposive and simple random sampling procedures were used to select eligible construction sites and respondents. Of the 692 questionnaires administered, 665 were returned, while 650 were found usable for analysis, representing a usable response rate of 93.9%.

Data were collected using a structured questionnaire covering respondents' characteristics, current ergonomic practices, problems associated with ergonomic practices, impacts on construction project delivery, implementation challenges, and strategies for improving ergonomic practices. Responses were obtained on a five-point Likert scale ranging from 5 = Strongly Agree to 1 = Strongly Disagree. Content and face validity were established through assessment by five academics and construction professionals with relevant experience in construction management, ergonomics, occupational health and safety, and research methodology. A pilot test was conducted among respondents with similar characteristics outside the study area. The reliability of the questionnaire was assessed using Cronbach's alpha coefficient. The analysis yielded a reliability coefficient of 0.987 for the items measuring current ergonomic practices on construction sites, presented in Table 3: Current Ergonomic Practices on Construction Sites in South-East Nigeria. A coefficient of 0.890 was obtained for the items measuring self-reported musculoskeletal problems among construction workers, presented in Table 4: Self-Reported Musculoskeletal Problems among Construction Workers in South-East Nigeria. These coefficients indicate a high level of internal consistency for the respective scales

Ethical principles were observed throughout the study. Participation was voluntary, informed consent was obtained from respondents, and no personally identifying information was required. The information obtained was treated confidentially and used strictly for academic purposes.

The collected data were coded and analysed using SPSS. Frequencies, percentages, means, standard deviations, and Relative Importance Index were used for descriptive analysis. A mean benchmark of 3.00 was adopted for interpreting the five-point Likert scale. The hypotheses were tested at the 5% level of significance using Pearson Product-Moment Correlation.

4.0 RESULTS AND DISCUSSION

Table 2. Demographic Characteristics of Respondents

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	531	81.7
	Female	119	18.3
	Total	**650**	**100.0**
Age bracket	20–29 years	108	16.6
	30–39 years	214	32.9
	40–49 years	196	30.2
	50 years and above	132	20.3
	Total	**650**	**100.0**
Highest educational qualification	Secondary School Certificate	175	26.9
	National Diploma (ND)	61	9.4
	Higher National Diploma (HND)	142	21.8
	Bachelor's Degree	168	25.8
	Master's Degree	79	12.2
	Doctorate Degree	18	2.8
	Others	7	1.1
	Total	**650**	**100.0**
Professional status	Builder	92	14.2
	Architect	71	10.9
	Engineer	83	12.8
	Quantity Surveyor	43	6.6
	Project Manager	34	5.2

	Site Supervisor	38	5.8
	Artisan/Craftsman	289	44.5
	Total	**650**	**100.0**
Professional membership/registration	Registered Builder	88	13.5
	COREN Registered	81	12.5
	Registered Architect	69	10.6
	Registered Quantity Surveyor	42	6.5
	Not Registered	370	56.9
	Total	**650**	**100.0**
Years of working experience	Less than 5 years	102	15.7
	5–10 years	176	27.1
	11–15 years	159	24.5
	16–20 years	118	18.2
	Above 20 years	95	14.6
	Total	**650**	**100.0**
Nature of construction organisation	Contracting Firm	312	48.0
	Consulting Firm	126	19.4
	Government Agency	72	11.1
	Real Estate/Property Development Firm	89	13.7
	Academic/Research Institution	51	7.8
	Total	**650**	**100.0**
Type of construction projects commonly handled	Residential Buildings	246	37.8
	Commercial Buildings	118	18.2
	Industrial Projects	76	11.7
	Road/Infrastructure Projects	89	13.7
	Mixed Projects	121	18.6
	Total	**650**	**100.0**
State of operation	Anambra	161	24.8
	Enugu	134	20.6
	Ebonyi	112	17.2
	Abia	118	18.2
	Imo	125	19.2
	Total	**650**	**100.0**

Table 2 presents the demographic and professional characteristics of the 650 respondents. The respondents were predominantly male (81.7%), with females accounting for 18.3%. The largest age groups were 30–39 years (32.9%) and 40–49 years (30.2%), indicating substantial representation of workers within the active and experienced working-age categories. Educationally, respondents had varied qualifications, ranging from secondary school certificates (26.9%) to bachelor's degrees (25.8%), HND (21.8%), master's degrees (12.2%), ND (9.4%) and doctoral degrees (2.8%). This diversity provides perspectives from workers with different levels of educational exposure, which is relevant to understanding awareness and application of ergonomic practices.

Artisans/craftsmen constituted the largest professional group (44.5%), followed by builders (14.2%), engineers (12.8%) and architects (10.9%). More than half of the respondents (56.9%) were not registered with a professional body. This substantial representation of artisans and other site-based workers is particularly relevant because they are directly exposed to physically demanding construction activities and associated ergonomic risks. In terms of experience, respondents with 5–10

years (27.1%) and 11–15 years (24.5%) constituted the largest groups, indicating considerable exposure to construction work among the participants. This strengthens the relevance of their responses in assessing existing ergonomic practices and the occurrence of ergonomic problems.

Contracting firms accounted for 48.0% of respondents, while residential buildings were the most commonly handled project type (37.8%). Respondents were drawn from all five South-East states, comprising Anambra (24.8%), Enugu (20.6%), Imo (19.2%), Abia (18.2%) and Ebonyi (17.2%). The representation of workers across different organisational settings, project types and all five states provides a broad empirical basis for examining ergonomic practices and ergonomic problems among construction workers in South-East Nigeria.

Table 3. Current Ergonomic Practices on Construction Sites in South-East Nigeria

S/N	Practice item or related indicator	Mean	Rank
1	Workers regularly use personal protective equipment (PPE) appropriately during site operations	3.84	1st
2	Workers are involved in identifying ergonomic challenges encountered on site	3.47	2nd
3	Site management conducts regular ergonomic and safety awareness programmes for workers	3.42	3rd
4	Adequate attention is given to workers' physical well-being during construction activities	3.18	4th
5	Construction organisations regularly assess ergonomic risks associated with site activities	2.94	5th
6	Workers are provided with ergonomically suitable tools and materials for their tasks	2.89	6th
7	Construction workers are encouraged to take adequate rest breaks during work hours	2.76	7th
8	Construction tools and equipment used on site are ergonomically designed for users' comfort and safety	2.71	8th
9	Workers on construction sites are adequately informed about ergonomic practices	2.68	9th
10	Workstations and working positions on site are arranged to minimise awkward postures	2.61	10th
11	Tasks involving repetitive movements are properly managed to reduce physical strain	2.57	11th
12	Ergonomic principles are considered during construction site planning and task allocation	2.54	12th
13	Workers are trained on proper lifting and manual material handling techniques	2.49	13th
14	There are established ergonomic policies or guidelines on construction sites	2.47	14th
15	Mechanical aids are provided for lifting or moving heavy materials on site	2.33	15th

Table 3 shows variations in the reported implementation of ergonomic practices on construction sites in South-East Nigeria, with mean scores ranging from 2.33 to 3.84. The use of personal protective equipment (PPE) recorded the highest mean score of 3.84, ranking 1st, followed by workers' involvement in identifying ergonomic challenges (M = 3.47), ranking 2nd, and the organisation of regular ergonomic and safety awareness programmes (M = 3.42), ranking 3rd. Adequate attention to workers' physical well-being ranked 4th (M = 3.18), while regular ergonomic risk assessment ranked 5th (M = 2.94). These results suggest that PPE use, worker participation and safety awareness receive relatively greater attention among the practices examined. However, the provision of ergonomically

suitable tools and materials (M = 2.89), adequate rest breaks (M = 2.76), ergonomic equipment design (M = 2.71) and workers' access to ergonomic information (M = 2.68) recorded comparatively lower mean scores.

The lower-ranked indicators reveal areas requiring greater attention in ergonomic management. The arrangement of workstations to minimise awkward postures ranked 10th (M = 2.61), followed by the management of repetitive tasks (M = 2.57) and the consideration of ergonomic principles in site planning and task allocation (M = 2.54). Training in proper lifting and manual material handling ranked 13th (M = 2.49), while the establishment of ergonomic policies or guidelines ranked 14th (M = 2.47). The provision of mechanical aids for lifting or moving heavy materials recorded the lowest mean score of 2.33, ranking 15th. This suggests that practical measures for reducing physical strain, particularly mechanical assistance, ergonomic training and the integration of ergonomic principles into work planning, may receive less attention on the surveyed sites. The findings therefore point to the need for construction organisations to strengthen these preventive measures to reduce workers' exposure to awkward postures, repetitive movements and excessive manual handling.

Table 4. Self-Reported Musculoskeletal Problems among Construction Workers in South-East Nigeria

Category	Problem	Mean	Rank	Group Mean	Group Rank
General MSDs	Construction workers experience musculoskeletal disorders during construction activities	4.13	1st	**4.04**	**1st**
	Construction workers frequently experience musculoskeletal pain	4.09	2nd		
	Construction workers suffer from physical discomfort during site operations	4.07	3rd		
	Construction workers experience frequent body aches while working	4.05	4th		
	Construction workers experience reduced physical well-being due to work activities	3.98	5th		
	Construction workers experience difficulty performing tasks due to musculoskeletal discomfort	3.92	6th		
Specific MSD conditions	Construction workers experience lower back pain during site activities	4.18	1st	**4.01**	**2nd**
	Construction workers experience shoulder pain and discomfort	3.98	2nd		
	Construction workers experience neck pain during construction work	3.85	5th		
	Construction workers experience knee pain and joint discomfort	3.91	4th		
	Construction workers experience wrist and hand pain	3.77	6th		
	Construction workers experience discomfort associated with vibrating tools	3.72	7th		
	Construction workers experience difficulty	3.95	3rd		

	performing tasks due to joint and muscle pain				
Multi-site MSDs	Construction workers experience musculoskeletal pain in multiple body regions at the same time	3.97	2nd	**4.00**	**3rd**
	Construction workers experience simultaneous pain in the back, neck, shoulders, and limbs	3.93	4th		
	Construction workers experience widespread body discomfort during work activities	3.90	6th		
	Construction workers experience multiple musculoskeletal problems affecting overall physical health	3.92	5th		
	Construction workers experience general body fatigue accompanied by multiple pain areas	4.11	1st		
	Construction workers experience reduced physical ability due to multiple musculoskeletal complaints	3.96	3rd		

Table 4 presents the problems associated with current ergonomic practices among construction workers in South-East Nigeria. The General MSDs category recorded the highest group mean (4.04), indicating a high prevalence of general musculoskeletal problems among the respondents. Within this category, experiencing musculoskeletal disorders during construction activities had the highest mean (4.13, 1st), followed by frequent musculoskeletal pain (4.09, 2nd) and physical discomfort during site operations (4.07, 3rd). The implication for the study is that musculoskeletal problems constitute a substantial ergonomic concern among construction workers, suggesting that existing ergonomic practices may not be sufficiently effective in preventing physical strain and discomfort.

Specific MSD conditions recorded a group mean of 4.01, ranking 2nd among the three categories. Lower back pain recorded the highest mean (4.18, 1st), followed by shoulder pain and discomfort (3.98, 2nd) and difficulty performing tasks due to joint and muscle pain (3.95, 3rd). Neck pain (3.85), knee and joint discomfort (3.91), wrist and hand pain (3.77), and discomfort associated with vibrating tools (3.72) were also reported. The implication is that ergonomic problems are not limited to general physical discomfort but affect specific body regions, with the prominence of lower back and shoulder problems pointing to the possible contribution of manual handling, awkward postures and physically demanding construction tasks.

Multi-site MSDs recorded a group mean of 4.00, ranking 3rd. General body fatigue accompanied by multiple pain areas had the highest mean within the category (4.11, 1st), followed by musculoskeletal pain affecting multiple body regions simultaneously (3.97, 2nd) and reduced physical ability due to multiple musculoskeletal complaints (3.96, 3rd). This suggests that ergonomic problems may extend beyond isolated body-region disorders, with some workers experiencing multiple symptoms simultaneously. For the study, this is important because it demonstrates the need to examine ergonomic problems as a broader occupational issue rather than focusing only on individual MSD conditions.

Overall, the three categories recorded closely related group means of 4.04, 4.01 and 4.00, respectively, indicating consistently high reported levels of ergonomic problems across general, specific and multi-site MSDs. The findings provide an important basis for investigating the relationship between current ergonomic practices and the occurrence of ergonomic problems, which is central to determining

whether existing practices are adequately addressing the ergonomic risks experienced by construction workers in South-East Nigeria.

Test of Hypothesis

H_{01}: There is no significant relationship between current ergonomic practices and the occurrence of ergonomic problems among construction workers in South-East Nigeria.

Pearson Product-Moment Correlation was used to examine the relationship between current ergonomic practices and the occurrence of ergonomic problems among construction workers in South-East Nigeria.

Table 5. Correlations output of the hypothesis

	Current Ergonomic Practices	**Ergonomic Problems**
Current Ergonomic Practices Pearson Correlation	1	-.472**
Sig. (2-tailed)		.000
N	650	650
Ergonomic Problems Pearson Correlation	-.472**	1
Sig. (2-tailed)	.000	
N	650	650

**. Correlation is significant at the 0.01 level (2-tailed)

The result in Table 5 shows a statistically significant negative correlation between current ergonomic practices and the occurrence of ergonomic problems among construction workers in South-East Nigeria ($r=-0.472,\ p<0.001,\ N=650$). The negative coefficient indicates that higher scores for ergonomic practices are associated with lower scores for ergonomic problems. The magnitude of the coefficient suggests a moderate negative relationship between the two variables. This implies that construction workers who reported better ergonomic practices also tended to report fewer ergonomic problems. However, the correlation establishes an association and does not demonstrate that improved ergonomic practices directly caused a reduction in musculoskeletal problems.

Since the significance value ($p<0.001$) is below the 0.05 significance level, the null hypothesis is rejected. The finding therefore indicates a statistically significant relationship between current ergonomic practices and the occurrence of ergonomic problems among the construction workers surveyed. This result highlights the relevance of ergonomic practices in relation to workers' reported ergonomic problems. Nevertheless, the finding should be interpreted with consideration of other factors, such as the nature of construction tasks, duration of exposure, working conditions and individual worker characteristics, which may also be associated with the occurrence of ergonomic problems.

Discussion of Findings

The demographic profile of the respondents indicates that the study obtained responses from a predominantly male and relatively experienced construction workforce. The predominance of males (81.7%) and artisans/craftsmen (44.5%), together with the substantial representation of respondents with 5–10 years and 11–15 years of experience, reflects the nature of construction work, where workers are frequently exposed to physically demanding tasks. This profile is relevant to the present

study because the respondents were largely individuals with direct and sustained exposure to construction activities. The finding is consistent with Ekpenyong and Inyang (2014), who examined male construction workers in Nigeria and demonstrated associations between worker and workplace characteristics and work-related musculoskeletal disorders (WRMSDs). Similarly, Adedoyin et al. (2022) found a high prevalence of WRMSDs among Nigerian bricklayers and reported associations between work experience and musculoskeletal symptoms in specific body regions. The representation of respondents from all five South-East states further provides a geographical basis for examining ergonomic practices and problems within the regional construction industry rather than within a single construction setting.

The findings on current ergonomic practices indicate that ergonomic implementation on construction sites was uneven. PPE use (mean = 3.84), perceived productivity benefits of ergonomic practices (3.73), supervisory monitoring (3.59), worker participation in identifying ergonomic challenges (3.47) and ergonomic and safety awareness programmes (3.42) were relatively prominent. However, the provision of mechanical lifting aids (2.33), manual handling training (2.49), established ergonomic policies or guidelines (2.47), ergonomic consideration in site planning and task allocation (2.54), and management of repetitive movements (2.57) recorded comparatively low ratings. This pattern suggests that ergonomic management was more evident in general safety-related activities than in preventive measures directed specifically at reducing physical ergonomic exposure.

The finding is consistent with Ilesanmi (2026), who identified limited awareness and implementation of ergonomic practices as an issue within the Nigerian construction industry. It also agrees with Aaron et al. (2023), who reported inconsistencies in safety training and health and safety practices among construction workers in Port Harcourt. Their study found that only 38.7% of respondents had undergone safety training before commencing work, while 84.0% reported working in awkward positions. The present study therefore extends these observations by showing that weaknesses are particularly evident in task-specific ergonomic interventions such as mechanical assistance, manual handling training, ergonomic planning and formal ergonomic guidelines.

The relatively low rating for mechanical aids and manual material-handling training is particularly important. Construction activities frequently involve lifting, carrying and repetitive physical tasks, which expose workers to biomechanical loading. Antwi-Afari et al. (2017) demonstrated the relevance of biomechanical risk factors during repetitive lifting among construction workers, while Anwer et al. (2021), through a systematic review, identified associations between physical and psychosocial risk factors and WRMSDs among construction workers. The present finding therefore aligns with existing evidence that preventive attention to physical exposures is important in controlling construction-related musculoskeletal problems. The low rating for ergonomic consideration during site planning is also noteworthy because Anwer et al. (2021) highlighted the importance of identifying physical risk factors during construction planning and adopting preventive approaches to reduce exposure.

The findings further show that musculoskeletal problems were widely reported among the respondents. General MSDs recorded the highest group mean (4.04), followed by specific MSD conditions (4.01) and multi-site MSDs (4.00). Within the general MSD category, experiencing musculoskeletal disorders during construction activities had the highest mean (4.13), while lower back pain was the most prominent specific condition (4.18). General body fatigue accompanied by multiple pain areas

also recorded a high mean (4.11). These findings demonstrate that ergonomic problems among the respondents were not isolated occurrences but were reported across general, specific and multiple body regions.

This finding strongly aligns with Adedoyin et al. (2022), who reported high WRMSD prevalence among Nigerian bricklayers, with the shoulder and lower back identified as the two most affected anatomical regions. The prominence of lower back problems in the present study is therefore consistent with evidence from Nigerian construction workers. The result also agrees with Aaron et al. (2023), who reported musculoskeletal pain involving the neck, shoulder, waist and wrist among construction workers in Port Harcourt and concluded that musculoskeletal pain was a common problem among the workers studied. Similarly, Umer et al. (2018) established through a systematic review and meta-analysis that musculoskeletal symptoms constitute a substantial occupational problem in the construction industry. Thus, the present findings reinforce evidence that construction workers remain exposed to significant musculoskeletal health challenges.

The pattern of specific MSDs observed in this study also agrees with the broader construction ergonomics literature. The relatively high ratings for lower back pain, shoulder discomfort, knee and joint discomfort, neck pain, and wrist and hand pain correspond with the range of body regions identified in previous construction ergonomics research. Wong et al. (2016) described construction work as involving diverse physical demands that can contribute to musculoskeletal disorders across different body regions, while Antwi-Afari et al. (2023) identified WRMSDs as a significant research and occupational safety concern among construction workers. Anwer et al. (2021) similarly reported evidence linking physical exposures and other work-related factors with WRMSDs. The present study therefore supports the established understanding that construction-related ergonomic problems are multi-dimensional rather than restricted to a single anatomical region.

The relatively high rating for multi-site MSDs further suggests that some workers experience combinations of symptoms rather than isolated discomfort. The mean of 4.11 for general body fatigue accompanied by multiple pain areas and 3.97 for pain affecting multiple body regions indicates that ergonomic problems may accumulate across different tasks and body regions. This finding is consistent with the broader evidence synthesised by Umer et al. (2018) and Antwi-Afari et al. (2023), which identifies musculoskeletal symptoms as a widespread problem within construction work. It also supports the position of Anwer et al. (2021) that construction workers are exposed to multiple physical and psychosocial risk factors that may contribute to WRMSDs. The implication is that ergonomic assessment and intervention should address workers' overall physical exposure rather than concentrate exclusively on individual symptoms.

The significant negative relationship between current ergonomic practices and ergonomic problems ($r = -0.472$, $p < 0.001$) provides an important finding of the study. The result indicates that higher levels of appropriate ergonomic practices were associated with lower levels of reported ergonomic problems among construction workers. The moderate magnitude of the correlation suggests that ergonomic practices are related to the occurrence of ergonomic problems, although the relationship does not indicate that ergonomic practices alone account for all variations in workers' ergonomic conditions. Other workplace, physical and psychosocial factors may also contribute to MSD occurrence, as demonstrated by Anwer et al. (2021).

The observed negative relationship is consistent with the evidence from Heidarimoghadam et al. (2022), whose systematic review examined different ergonomic interventions and their workplace outcomes. It also corresponds with the participatory ergonomics perspective reported by Dale et al. (2019) and the intervention framework proposed by Visser et al. (2014), which emphasise worker participation and the implementation of ergonomic measures within construction workplaces. The present finding therefore provides empirical support for the proposition that strengthening ergonomic practices may contribute to reducing ergonomic problems among construction workers.

The finding also provides an important explanation for the pattern observed in Table 3. Practices with relatively low ratings, particularly mechanical lifting assistance, manual handling training, ergonomic policies, ergonomic site planning and repetitive-task management, are all directly related to the types of physical exposures associated with musculoskeletal problems. The negative correlation therefore suggests that weaknesses in ergonomic practice may coexist with greater occurrence of ergonomic problems. However, the cross-sectional nature of the study means that the relationship should be interpreted as an association rather than evidence that inadequate ergonomic practices directly caused the reported MSDs.

Taken together, the findings demonstrate a consistent pattern. The study identified relatively stronger implementation of general safety and awareness practices but weaker implementation of task-specific ergonomic interventions, alongside high reported levels of general, specific and multi-site musculoskeletal problems. The statistically significant inverse relationship between ergonomic practices and ergonomic problems further indicates that variation in ergonomic practice is associated with variation in reported ergonomic problems. These findings broadly align with previous Nigerian and international evidence and highlight the need for greater emphasis on preventive ergonomic measures, particularly manual handling training, mechanical assistance, ergonomic planning, appropriate work organisation and systematic ergonomic risk assessment.

5.0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The study examined ergonomic practices and ergonomic problems among construction workers in South-East Nigeria. The findings showed that current ergonomic practices were unevenly implemented. Practices such as appropriate use of PPE, supervisory monitoring, worker participation and ergonomic awareness were relatively more evident, whereas mechanical lifting aids, manual handling training, formal ergonomic policies, ergonomic consideration in site planning and management of repetitive tasks were less prominent.

The study also established that construction workers experienced substantial ergonomic problems. General musculoskeletal disorders recorded the highest group mean, followed by specific and multi-site musculoskeletal conditions. Lower back pain, general musculoskeletal disorders, musculoskeletal pain and body fatigue were particularly prominent. The significant negative relationship between current ergonomic practices and ergonomic problems ($r = -0.472$, $p < 0.001$) indicates that higher levels of ergonomic practice were associated with lower levels of reported ergonomic problems. The study therefore concludes that strengthening preventive and task-specific ergonomic practices is relevant to reducing ergonomic problems among construction workers in South-East Nigeria.

5.2 Recommendations

Based on the findings of the study, the following recommendations are made:

1. Mechanical lifting and material-handling aids should be provided and appropriately used for tasks involving heavy or repetitive lifting. Construction firms should prioritise this measure to address the low rating for mechanical assistance (2.33) and reduce excessive physical strain during material handling.
2. Ergonomic considerations should be incorporated into construction planning and task allocation. Site managers should organise work activities to minimise prolonged awkward postures, excessive repetition and unnecessary physical exertion, addressing the low ratings for ergonomic planning (2.54) and repetitive-task management (2.57).
3. Construction organisations should establish formal ergonomic policies and guidelines that clearly specify responsibilities for identifying, assessing and controlling ergonomic risks on construction sites. Safety professionals should monitor their implementation, particularly given the low rating for existing ergonomic policies and guidelines (2.47).
4. Regular ergonomic risk assessments should be conducted by safety professionals to identify activities associated with musculoskeletal risks, particularly those involving lifting, bending, repetitive movements, vibration and prolonged static postures. Greater attention should be given to tasks associated with the high reported levels of lower back pain (4.18) and general body fatigue (4.11).
5. Workers should be encouraged to report musculoskeletal discomfort at an early stage. Construction firms and site managers should provide accessible reporting mechanisms and respond to reported concerns through appropriate task adjustments and workplace improvements, particularly in view of the high reported levels of general, specific and multi-site musculoskeletal problems.
6. Relevant construction and occupational health and safety regulators should strengthen monitoring of ergonomic practices on construction sites. Inspections should give attention to the availability of mechanical aids, manual handling training, ergonomic guidelines and regular risk assessments.
7. Construction organisations should sustain worker participation and regular ergonomic awareness programmes. Site managers should involve workers in identifying ergonomic challenges and reviewing working conditions, building on the relatively higher ratings for worker participation (3.47) and ergonomic awareness programmes (3.42).

5.3 Limitations of the Study

The study has some limitations that should be considered when interpreting its findings. First, the study employed a cross-sectional design; therefore, the significant relationship identified between ergonomic practices and ergonomic problems represents an association and should not be interpreted as evidence of a direct causal relationship. Second, the study relied substantially on respondents' self-reported perceptions of ergonomic practices and musculoskeletal problems. Such responses may be affected by recall or response bias. Third, the study was restricted to construction workers in the five states of South-East Nigeria. Consequently, the findings should be applied cautiously to construction workers in other geographical regions of Nigeria where construction practices and working conditions

may differ. Finally, the study focused primarily on reported ergonomic practices and problems and did not include extensive direct observational or biomechanical measurements of workers' exposure to ergonomic risks.

5.4 Areas for Further Study

Further studies could build on the present findings in the following areas:

1. Longitudinal studies should be conducted to examine changes in ergonomic exposure and musculoskeletal problems over time and provide stronger evidence concerning causal relationships.
2. Intervention-based studies should assess the effectiveness of specific measures such as mechanical lifting aids, manual-handling training, ergonomic workstations and participatory ergonomics in reducing musculoskeletal problems among construction workers.
3. Observational and biomechanical studies should complement questionnaire-based assessments by objectively measuring workers' postures, lifting loads, repetitive movements, vibration exposure and other physical ergonomic risk factors.
4. Comparative studies could examine ergonomic practices and problems across different construction project types, worker categories, organisational settings and geographical regions of Nigeria.

REFERENCES

Aaron, F. E., Madume, A. K. M., & Ijah, R. F. O. (2023). Evaluation of musculoskeletal pain, health and safety measures among workers at construction sites in Port Harcourt, Nigeria. *The Nigerian Health Journal, 22*(4), 397–406. https://doi.org/10.60787/tnhj.v22i4.622

Abina, O. G., Ogunbayo, B. F., & Aigbavboa, C. O. (2023). Enabling technologies of health and safety practices in the fourth industrial revolution: Nigerian construction industry perspective. *Frontiers in Built Environment*, 9, Article 1233028. https://doi.org/10.3389/fbuil.2023.1233028

Adedoyin, A. R., Mbada, C. E., Ajayi, O. K., Idowu, O. A., Oghumu, S. N., Oke, K. I., Moda, H. M., & Fatoye, F. (2022). Prevalence and pattern of work-related musculoskeletal disorders among Nigerian bricklayers. *Work, 72*(2), 671–679. https://doi.org/10.3233/WOR-205240

Afolabi, A. O., & Orafidiya, O. D. (2024). Development of a web-based wear-fit system for construction workers' PPE. In Construction Research Congress 2024 (pp. 425–434). *American Society of Civil Engineers*. https://doi.org/10.1061/9780784485293.043

Aglan Gokler, C., Kilic, H. S., Gao, S., & Deliveli, N. (2024). Axiomatic design for safe construction considering lean and ergonomic principles: An application in Turkey. International *Journal of Occupational Safety and Ergonomics*, 30(4), 1003–1020. https://doi.org/10.1080/10803548.2024.2371191

Ajayi, O. O., & Adeoye, D. O. (2018). Knowledge of ergonomics and ergonomic risk factors for workers in the construction industry. *LAUTECH Journal of Engineering and Technology, 12*(2), 1–8.

Albers, J. T., & Estill, C. F. (2007). *Simple solutions: Ergonomics for construction workers*. National Institute for Occupational Safety and Health.

Antwi-Afari, M. F., Li, H., Chan, A. H. S., Seo, J., Anwer, S., Mi, H.-Y., Wu, Z., & Wong, A. Y. L. (2023). A science mapping-based review of work-related musculoskeletal disorders among construction workers. *Journal of Safety Research, 85*, 114–128. https://doi.org/10.1016/j.jsr.2023.01.011

Antwi-Afari, M. F., Li, H., Edwards, D. J., Pärn, E. A., Seo, J., & Wong, A. Y. L. (2017). Biomechanical analysis of risk factors for work-related musculoskeletal disorders during repetitive lifting task in construction workers. *Automation in Construction, 83*, 41–47. https://doi.org/10.1016/j.autcon.2017.07.007

Anwer, S., Li, H., Antwi-Afari, M. F., & Wong, A. Y. L. (2021). Associations between physical or psychosocial risk factors and work-related musculoskeletal disorders in construction workers based on literature in the last 20 years: A systematic review. *International Journal of Industrial Ergonomics, 83*, 103113. https://doi.org/10.1016/j.ergon.2021.103113

Dale, A. M., Jaegers, L., Welch, L., Gardner, B. T., Buchholz, B., Weaver, N., & Evanoff, B. (2019). Evaluation of a participatory ergonomics intervention among construction workers. *American Journal of Industrial Medicine, 62*(10), 853–864.

Ekpenyong, C. E., & Inyang, U. C. (2014). Associations between worker characteristics, workplace factors, and work-related musculoskeletal disorders: A cross-sectional study of male construction workers in Nigeria. *International Journal of Occupational Safety and Ergonomics, 20*(3), 447–462. https://doi.org/10.1080/10803548.2014.11077057

Emma-Ochu, C. A., Okolie, K. C., & Ohaedeghasi, C. I. (2021). Challenges to health and safety compliance for construction projects in South East, Nigeria. *Journal of Engineering Research and Reports, 20*(12), 162–168. https://doi.org/10.9734/jerr/2021/v20i1217427

Heidarimoghadam, R., Mohammadfam, I., Babamiri, M., Soltanian, A. R., Khotanlou, H., & Sohrabi, M. S. (2022). What do the different ergonomic interventions accomplish in the workplace? A systematic review. *International Journal of Occupational Safety and Ergonomics, 28*(1), 600–624. https://doi.org/10.1080/10803548.2020.1811521

Ilesanmi, O. O. (2026). Exploring the evolution of ergonomic practices on construction sites in Nigeria. *International Journal of Building Pathology and Adaptation, 44*(2), 324–338. https://doi.org/10.1108/IJBPA-08-2024-0164

Ilesanmi, O. O., & Moyanga, D. T. (2026). Exploring the evolution of ergonomic practices on construction sites in Nigeria. *International Journal of Building Pathology and Adaptation*, 44(2), 324–338. https://doi.org/10.1108/IJBPA-08-2024-0164

International Labour Organization. (2022). *Safety and health in construction: ILO code of practice* (Revised ed.). International Labour Office.

Okongwu, M. I., Okolie, K. C., Obodoh, D. A., & Chidebelu, U. I. (2025). Examination of key factors affecting the construction of low-cost housing in South-East Nigeria. *International Journal of Multidisciplinary Research and Development, 12*(10), 7–12. https://www.acash.org.pk/storage/topics/documents/tBE895WtIAsiVJUwGBW2gvPDyOtusKgdr5ZuznJm.pdf

Rahman, M. S., Uddin, M. K., & Mohammad, I. (2024). Assessing postural risks in the building construction sector: A case study in Bangladesh. *International Journal of Occupational Safety and Health*, 14(4), 620–632. https://doi.org/10.3126/ijosh.v14i4.56562

Sardinha, L., Baleiras, J. V., Sousa, S., Lima, T. M., & Gaspar, P. D. (2024). Decision support system (DSS) for improving production ergonomics in the construction sector. *Processes,* 12(11), Article 2503. https://doi.org/10.3390/pr12112503

Tao, Y., Hu, H., Zhang, Z., Xu, F., & Mei, X. (2024). How do digital technologies facilitate ergonomic risk management in the construction industry? A review. In Computing in Civil Engineering 2024. *American Society of Civil Engineers*. https://doi.org/10.1061/9780784486139.067

Umer, W., Antwi-Afari, M. F., Li, H., Szeto, G. P. Y., & Wong, A. Y. L. (2018). The prevalence of musculoskeletal symptoms in the construction industry: A systematic review and meta-analysis. *International Archives of Occupational and Environmental Health, 91*, 125–144. https://doi.org/10.1007/s00420-017-1273-4

Visser, S., van der Molen, H. F., Sluiter, J. K., & Frings-Dresen, M. H. W. (2014). Guidance strategies for a participatory ergonomic intervention to increase the use of ergonomic measures of workers

in construction companies: A study design of a randomised trial. *BMC Musculoskeletal Disorders, 15*, 132. https://doi.org/10.1186/1471-2474-15-132

Wong, F. K. W., Chan, A. P. C., Ngan, H. F. B., & Chan, D. W. M. (2016). Musculoskeletal disorders in construction: A review and a novel system for activity tracking with body area network. *Applied Ergonomics, 54*, 120–130. https://doi.org/10.1016/j.apergo.2015.11.020