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Assessing Occupational Hazards in the Construction Industry: Risk of Orofacial Trauma, Musculoskeletal Injuries and Ergonomic Challenges with Implications for Safety and Prevention

K. Esha Gayathri[1], Sri Sakthi D.[2], Indumathy Pandiyan[3] and Nadathur Doraiswamy Jayakumar[4]

[1]Saveetha Dental College and Hospitals, Saveetha Institution of Medical and Technical Sciences (SIMATS), 600077, Chennai, India
[2,3]Department of Public Health Dentistry, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University, 600 077, Chennai, India
[4]Department of Periodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India

Author Designation: [3]Senior Lecturer

*Corresponding author: Sri Sakthi D. (e-mail: srisakthi@saveetha.com).

Abstract **Introduction:** The construction industry is among the most hazardous sectors, with high rates of musculoskeletal disorders (MSDs) and orofacial trauma due to physically demanding tasks, awkward postures and poor ergonomics. These injuries contribute to long-term disability risks and productivity loss. This study evaluates the prevalence of MSDs, ergonomic risks and orofacial trauma among construction workers in Chennai, India, while proposing preventive strategies. **Methods:** A cross-sectional survey was conducted among 297 male construction workers in Chennai using a pre-validated questionnaire based on the Nordic Musculoskeletal Questionnaire. Data were collected through in-person camps and Google Forms. The analysis was performed using SPSS (Version 20), with statistical significance set at $p<0.05$. Subgroup analyses were conducted to identify injury patterns by age, job role and experience level, enhancing the study's insights into risk factors. **Results:** Workers aged 25-34 reported the highest prevalence of MSDs, particularly in the neck (28.5%) and back (22.5%) within the past 7 days, resulting in significant activity restrictions. The study also identified repetitive tasks, prolonged standing and awkward postures as major contributors to MSDs. Additionally, cases of orofacial trauma were noted, highlighting the need for enhanced protective equipment use. The findings underscore the role of environmental and organizational factors in injury prevalence. **Conclusion:** The significant prevalence of MSDs, ergonomic risks and orofacial trauma underscores the urgent need for targeted interventions. Recommendations include comprehensive ergonomic training, improved use of Personal Protective Equipment (PPE) and enhanced workplace design. Introducing education campaigns, implementing injury prevention strategies and adopting emerging technologies such as wearable devices can further mitigate risks. Future research should explore gender disparities, rural construction settings and long-term intervention outcomes to enhance worker safety and productivity.

Key Words Construction ergonomics, musculoskeletal disorders, orofacial trauma, occupational safety, preventive strategies, workplace design, ergonomic training

INTRODUCTION

The construction industry is essential for infrastructure development and economic growth, but it also stands as one of the most hazardous occupations globally [1]. According to data from the International Labour Organization (ILO) and Occupational Safety and Health Administration (OSHA), construction workers face a high risk of injury and illness due to the demanding and often hazardous nature of their work environment [2]. They often face chronic stress from demanding schedules, physical exertion and workplace hazards. This prolonged stress can weaken the immune system, increase inflammation and exacerbate periodontal issues like gum disease [3]. Due to which they have higher rates of smoking due to job related stress and a culture that may normalise tobacco use [4,5]. However,many workers show willingness to quit if provided with accessible support and cessation programs tailored to their needs [6]. Among the various types of injuries construction workers experience, musculoskeletal disorders (MSDs) and orofacial trauma are particularly prevalent and concerning. Musculoskeletal

Disorders (MSDs) are injuries or conditions affecting muscles, nerves, tendons, joints and cartilage [7]. These disorders are common in construction work due to the physical strain associated with repetitive movements, heavy lifting, awkward postures and prolonged standing. OSHA reports that nearly 37% of all work-related injuries are musculoskeletal in nature, emphasizing the need for targeted preventive measures within the construction sector [8]. Workers in this industry are frequently required to perform tasks such as lifting heavy materials, operating machinery and working in uncomfortable positions for extended periods, all of which contribute to the high rate of MSDs [8]. Symptoms of MSDs can range from mild discomfort to severe pain, potentially leading to chronic disabilities if left unaddressed [9]. Beyond the physical toll, such injuries often result in significant socioeconomic impacts, including prolonged absences from work, reduced earning potential and increased medical expenses for workers and their families. Long-term effects may include chronic disabilities that hinder career progression, forcing some workers to prematurely exit the workforce, thus exacerbating financial instability. These consequences ripple through the industry, affecting productivity and increasing turnover rates, further highlighting the urgency for effective intervention strategies.

In addition to MSDs, orofacial trauma is a significant risk in construction [10]. Orofacial trauma involves injuries to the face and mouth, often caused by falls, collisions with equipment and contact with sharp or heavy objects [11]. Without proper protective equipment, construction workers are vulnerable to injuries that could lead to fractures, lacerations and damage to the teeth or jaw [12]. Falls from heights, a common hazard in construction sites, are a major cause of facial injuries, as workers might lack adequate face shields or other protective gear [13]. This type of trauma can result in long-term health issues, aesthetic concerns and high medical costs, underscoring the need for stringent safety protocols [14]. Ergonomics issues are another prevalent concern in the construction industry [15]. Ergonomics refers to the design of equipment, tasks and work environments to fit the physical capabilities of workers. Poor ergonomics in construction workstations and equipment can exacerbate physical strain and lead to chronic musculoskeletal pain [16]. For instance, repetitive motions, bending, twisting and working in awkward positions contribute to cumulative strain on the body over time [17]. Many construction sites lack proper ergonomic accommodations, increasing the likelihood of injury and reducing workers' ability to perform tasks effectively [18]. Addressing ergonomic issues is critical, as it can enhance productivity, reduce fatigue and minimize the risk of long-term musculoskeletal damage [19].

The impact of these injuries extends beyond individual workers. Musculoskeletal injuries, orofacial trauma and ergonomic issues not only affect the physical wellbeing of construction workers but also have significant economic implications [20]. Injured workers may experience reduced productivity, lost wages and long recovery periods, leading to financial strain [21]. For employers, these injuries translate into increased healthcare costs, higher workers' compensation claims and potential project delays [22]. Moreover, the construction sector's high injury rate can discourage workers from joining or remaining in the industry, resulting in a shortage of skilled labor over time [23]. Thus, the aim of the study is to assess the risk factors and prevalence of work-related musculoskeletal disorders, orofacial trauma and ergonomic issues among construction workers in Chennai, India [24].

METHODS

This study was designed as a cross-sectional observational study aimed at assessing the prevalence of musculoskeletal disorders (MSDs), orofacial trauma and ergonomic issues among construction workers in Chennai, India. The cross-sectional design provided a snapshot of injury patterns and risk factors across different demographics within the construction workforce, offering insights into the current health risks in this population.

Study Design

The study utilized a structured approach to gather data from construction workers across multiple sites within Chennai. By focusing on a single metropolitan area, the research aimed to understand the typical challenges faced by urban construction workers. However, the exclusion of rural construction sites was acknowledged as a limitation. Future studies may benefit from including rural populations to expand generalizability:

- **Type of Study:** Cross-sectional observational study
- **Setting:** Data were collected through a combination of on-site camps and digital forms. A camp was conducted at an industry called Urban Rise and several smaller construction industries near Poonamallee, Chennai. Out of approximately 350 workers approached, 297 consented to participate in the survey

Study Population and Sample Size

The target population for this study consisted of male construction workers aged between 18 and 60 years, representing diverse age groups, roles and experience levels within the workforce.

Sample Size

A total of 350 construction workers were initially selected based on a power analysis to ensure statistical validity, with a confidence level of 95% and a margin of error of ±5%. The sample was chosen to be representative of Chennai's construction workforce.

Inclusion Criteria

- Male workers aged 18 to 60 years actively employed at construction sites in Chennai00

- Workers with at least six months of construction experience to ensure sufficient exposure to workplace hazards
- Participants who provided informed consent

Exclusion Criteria

- Workers under 18 years of age
- Workers engaged in administrative or managerial roles
- Workers undergoing medical treatment or physical therapy for non-construction-related injuries
- Workers on extended leave or with irregular work schedules
- Workers with disabilities unrelated to construction work
- Workers who declined to provide informed consent
- Workers who failed to complete the survey questionnaire fully or accurately

Survey Instrument

Data collection utilized a pre-validated questionnaire primarily based on the Nordic Musculoskeletal Questionnaire (NMQ), which is widely recognized for assessing musculoskeletal symptoms and injury prevalence in occupational health research. The NMQ was modified and supplemented with additional questions tailored to the construction industry. These additional sections covered orofacial trauma, ergonomic practices and the impact of injuries on daily activities. The modified questionnaire allowed for a comprehensive evaluation of both physical injury risks and ergonomic challenges.

Data Collection Procedure

Data collection was conducted on-site through face-to-face interactions to ensure participants fully understood the questions. This direct engagement allowed for real-time clarification of doubts and improved data accuracy. Additionally, Google Forms were utilized to facilitate participation among workers with limited availability.

Data Collection Period

The survey was conducted over a three-month period, with visits scheduled to multiple construction sites to capture a representative sample.

Environmental and Organizational Factors

Recognizing the influence of workplace conditions on injury prevalence, the study captured data on factors such as safety protocols, access to protective equipment and ergonomic work practices.

Ethical Considerations

- The study received Institutional Ethical Clearance (SRB/SDC/UG-2054/24/PHD/392)
- Informed consent was obtained from all participants, with participants briefed on the study's purpose, voluntary nature and the confidentiality of their responses
- Participants were assured anonymity and data were used solely for research purposes
- Ethical challenges regarding the exclusion of female workers and rural populations were acknowledged as limitations, recommending future research to address these gaps

Statistical Analysis

The collected data were analyzed using descriptive statistics to summarize the prevalence, types and severity of injuries across different demographics. The analysis provided insights into injury frequency by body region and identified ergonomic practices contributing to injury risks.

Descriptive Statistics

- Frequencies and percentages were calculated for categorical variables such as age group, job role and types of injuries
- Mean and standard deviation were computed for continuous variables such as age and years of experience

Comparative Analysis Using Chi-Square Test

- The chi-square test was employed to compare injury prevalence and ergonomic issues across different age groups and roles. This helped identify high-risk subgroups within the construction workforce
- The significance level was set at $p<0.05$, meaning any p-value below this threshold was considered statistically significant

Subgroup Analysis

To improve insights into injury patterns, subgroup analysis was performed by age, job role and years of experience. This provided additional clarity on which groups were most vulnerable to MSDs, ergonomic issues, or orofacial trauma.

Software and Tools

- SPSS Version 23 was used for statistical analysis, ensuring accurate data management and meaningful interpretation of results
- Visual aids such as bar graphs were incorporated to effectively illustrate injury prevalence across demographics, facilitating clear communication of key findings

RESULTS

The results of this study provide valuable insights into the prevalence of musculoskeletal disorders (MSDs) and their impact on construction workers across different age groups.

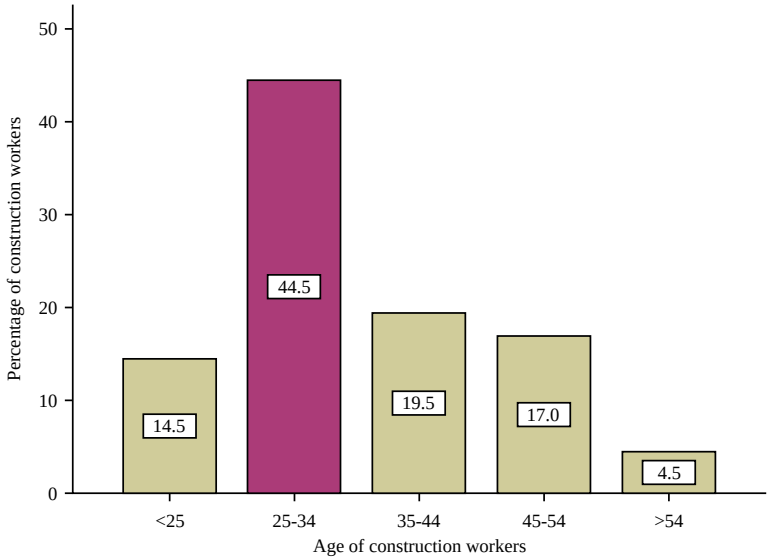

Figure 1: Percentage distribution of construction workers across different age groups

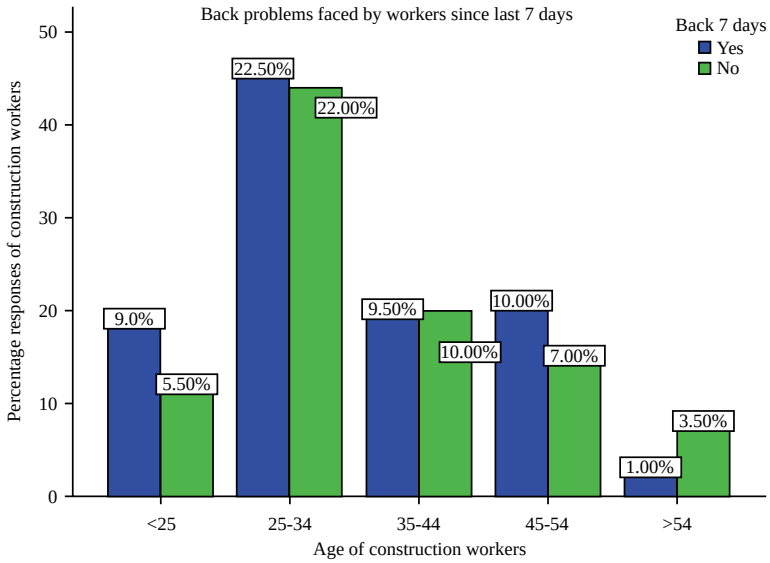

Figure 2: Percentage of workers in each age group who reported experiencing back problems in the past week

The findings emphasize the need for targeted interventions to address these issues, particularly among younger and middle-aged workers.

Figure 1 presents the percentage distribution of construction workers across different age groups. The majority of workers fall within the 25-34 age group, suggesting that construction work may be more physically sustainable for younger individuals. The decline in older age groups may reflect the physically demanding nature of the work, which becomes increasingly difficult to sustain as workers age. This trend highlights the importance of early preventive measures to minimize long-term physical strain.

Figure 2 illustrates the percentage of workers in each age group who reported experiencing back problems in the past week. Back problems were most prevalent among workers aged 25-34, underscoring the physically intensive nature of their work tasks. This finding highlights the urgent need for ergonomic interventions such as improved lifting techniques, posture training and back support systems, especially for younger and middle-aged workers who are at greater risk.

Figure 3 shows the percentage of construction workers in each age group who reported that back problems affected their ability to perform activities in the past week. Workers aged 25-34 reported the highest impact, suggesting that back

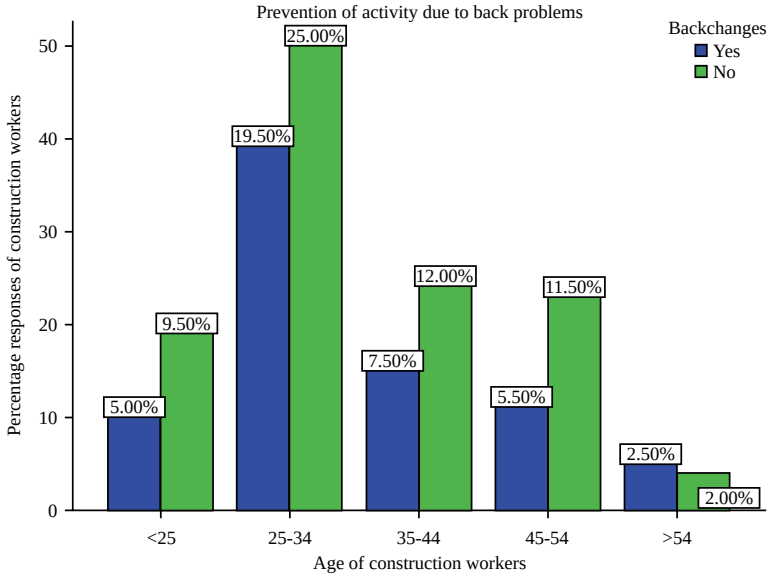

Figure 3: Percentage of construction workers in each age group who reported that back problems affected their ability to perform activities in the past week

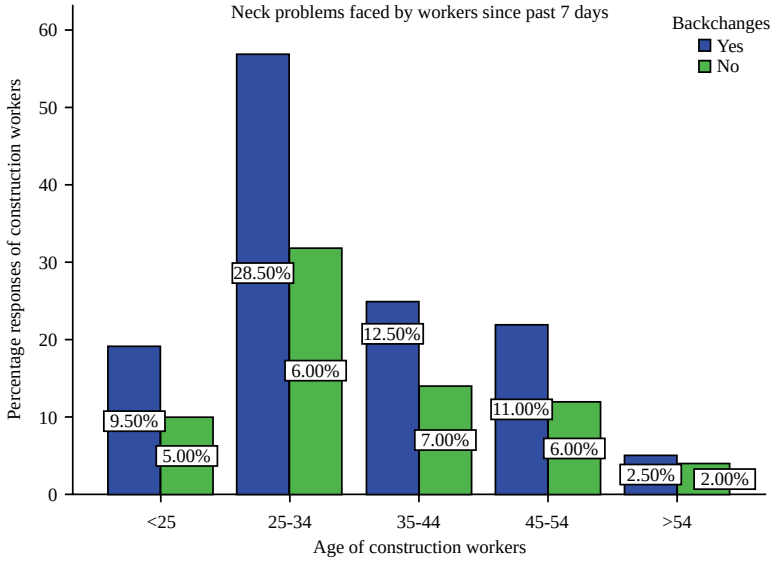

Figure 4: Percentage of construction workers in each age group who reported experiencing neck problems over the last week

pain not only occurs frequently but also interferes significantly with daily activities. These findings emphasize the need for comprehensive strategies such as stretching programs, workload management and workplace modifications to reduce activity limitations in this age group.

Figure 4 depicts the percentage of construction workers in each age group who reported experiencing neck problems in the past week. The data reveals that neck problems are most commonly reported among workers aged 25-34, followed closely by the 35-44 age group. This trend points to the physical demands of construction work, including prolonged overhead tasks, awkward postures and repetitive movements that contribute to neck strain.

Figure 5 highlights the percentage of construction workers in each age group who reported that neck problems affected their ability to perform activities in the past week. The 25-34 age group again reported the highest impact on activity levels, reinforcing the need for targeted ergonomic interventions such as improved workstation designs, neck exercises and posture correction strategies. Conversely, workers over 54 reported minimal activity limitations, potentially reflecting

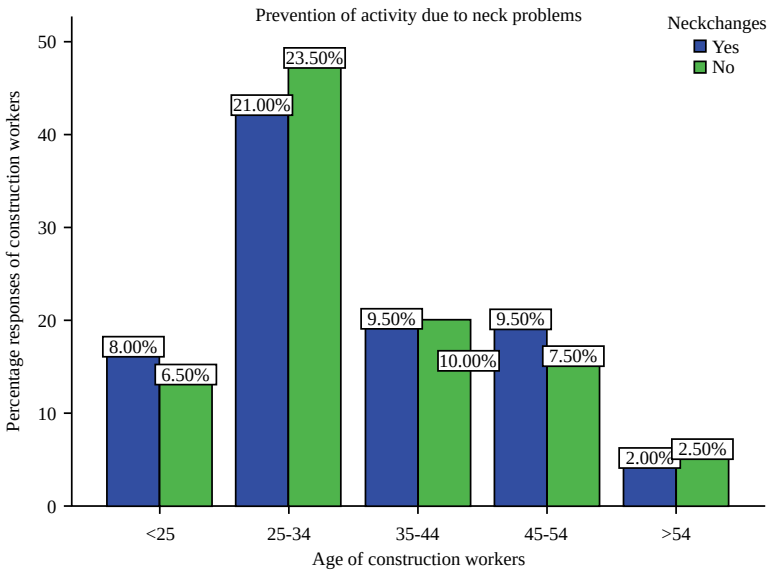

Figure 5: Percentage of construction workers in each age group who reported that neck problems affected their ability to perform activities in the past week

differences in job roles, reduced exposure to physically strenuous tasks, or adaptive coping strategies over time.

DISCUSSION

The construction industry is widely recognized for its physically demanding work environment, where workers are frequently exposed to risks that contribute to musculoskeletal disorders (MSDs). These risks include repetitive movements, awkward postures and heavy lifting, which can lead to chronic pain in areas such as the neck, back and shoulders. The present study reveals a significant prevalence of MSDs among construction workers, particularly among those in the 25-34 age group. This aligns with previous research, which highlights that younger workers are disproportionately affected by MSDs due to their frequent involvement in physically demanding tasks.

Consistent with the findings of Reddy *et al.* [25] the current study indicates that construction workers face a high risk of MSDs due to repetitive lifting, bending and prolonged awkward postures, contributing to back and neck pain in over 50% of participants. Similar to previous findings, the present study emphasizes that younger workers may be more vulnerable to MSDs as they are often assigned physically intense tasks that require strength and endurance. This increased workload at an early stage in their careers may explain the higher prevalence of neck and back pain among workers aged 25-34 in this study.

Interestingly, the present study found a lower prevalence of MSDs among workers over 45 years of age, which differs from some previous studies. For instance, Graveling *et al.* [26] reported that older construction workers experienced high rates of MSDs, likely due to cumulative strain over the years. The lower incidence of MSDs among older workers in this study may suggest improved ergonomic practices or a shift in task allocation, where older workers are assigned less physically strenuous roles. This adaptation could reflect better awareness of injury prevention strategies or a greater focus on task modifications for aging workers.

The current study also identifies factors such as insufficient ergonomic training, inadequate use of Personal Protective Equipment (PPE) and repetitive movements as primary contributors to MSDs. Similar observations were made by previous research, which found that construction workers employed by companies with poor safety training experienced significantly higher rates of MSDs [27]. Jeong and Byoung-Hee [28] similarly highlighted that inadequate ergonomic practices and limited rest breaks increased the risk of MSDs among construction workers, further supporting the present study's conclusions.

A notable finding in this study is the higher prevalence of neck pain compared to shoulder pain, which deviates from earlier research. Previous studies, such as that by Soares *et al.* [29], reported that shoulder pain was common among construction workers due to tasks involving overhead lifting, which places substantial strain on the shoulder muscles. The discrepancy may reflect differences in the nature of construction tasks performed by participants in this study, where prolonged neck bending or frequent downward-looking postures were likely more common than overhead work. Additionally, previous research has linked neck pain prevalence to specific construction roles that involve sustained forward head postures or repetitive neck movements, which may explain the findings of the present study [30].

Overall, the findings emphasize the urgent need for improved ergonomic training, workplace modifications and the provision of adequate PPE to minimize the risk of MSDs. Incorporating regular rest breaks, promoting safe lifting techniques and implementing early intervention strategies can significantly reduce the incidence of MSDs among construction workers. Future research should explore the long-term impact of ergonomic interventions and assess the role of educational programs in improving worker safety. Additionally, expanding research to include female construction workers and rural populations would enhance the generalizability of the findings and provide a more comprehensive understanding of MSD risks across diverse workforce demographics.

CONCLUSION

This study highlights the significant prevalence of musculoskeletal injuries and ergonomic challenges among construction workers, particularly within the 25-34 age group. The physically demanding nature of construction tasks, coupled with poor ergonomic practices and limited preventive strategies, contributes to the high occurrence of back and neck pain. Such injuries not only reduce productivity but also pose long-term health risks for affected workers.

Addressing these concerns requires comprehensive strategies that include ergonomic training, improved workstation designs and the proper use of Personal Protective Equipment (PPE). Incorporating injury prevention programs that emphasize safe lifting techniques, posture correction and regular health screenings can help reduce the burden of MSDs.

Furthermore, exploring innovative solutions such as wearable technology could significantly improve injury prevention by identifying risky postures and promoting real-time adjustments. By prioritizing worker safety and implementing proactive strategies, the construction industry can create healthier and more sustainable work environments. This proactive approach would not only improve worker well-being but also enhance productivity and reduce long-term healthcare costs for employers.

Limitations

This study has certain limitations that should be considered when interpreting the findings.

- **Sample Size and Representativeness:** While the sample size of 350 participants provided valuable insights, it may not fully capture the diversity of construction workers across different regions, industries and job roles. Future studies involving larger and more demographically diverse samples are recommended to improve the generalizability of the results. Expanding research to include workers from rural areas, female construction workers and those in specialized construction roles would offer broader insights
- **Uncontrolled Variables:** This study did not account for certain variables such as specific job roles, duration of employment, or individual health conditions, all of which may significantly influence injury prevalence and severity. Future studies should aim to incorporate these factors to provide a more comprehensive understanding of risk patterns in construction work
- **Potential Recall Bias:** Since the data were collected through self-reported questionnaires, there is a possibility of recall bias, particularly regarding injury frequency and severity. Combining self-reports with observational data or medical records in future studies would enhance data reliability

Future Scope

- **Integration of Wearable Technology:** Future research should explore the use of wearable devices that monitor posture, muscle strain and movement patterns in real-time. Such technology could identify high-risk activities, provide immediate feedback and prevent injuries by encouraging safer work practices
- **Expanding to Diverse Populations:** Conducting similar studies across multiple regions, construction types and job roles would offer deeper insights into region-specific and job-specific risks. Broader population sampling would help address the socioeconomic, environmental and demographic factors that may contribute to injury rates
- **Longitudinal Studies:** Future research should focus on long-term studies to assess the sustained impact of ergonomic interventions and training programs. This would help evaluate how preventive strategies influence musculoskeletal health over extended periods
- **Exploring Psychosocial Factors:** Investigating the role of workplace stress, mental health and job satisfaction in injury risk could provide additional insights into improving construction worker well-being

Authors Contributions

K. Esha Gayathri: Literature search, data collection, analysis, manuscript drafting. Dr Srisakthi: Aided in conception of the topic, has participated in the study design, statistical analysis and has supervised in preparation and final correction of the manuscript. Dr Indumathy Pandiyan: Aided in conception of the topic, has participated in the study design, statistical analysis and has supervised in preparation and final correction of the manuscript.

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Conflict of Interest

The author declares that there were no conflicts of interest in the present study.

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