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Case Study

Assessing postural risks in the building construction sector: A case study in Bangladesh

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ABSTRACT

Introduction: Among the different parts of the construction sector, the building sector needs more workers for materials handling, because of the absence of proper infrastructural facilities. Work-related musculoskeletal disorders (WRMSDs) can occur due to awkward body postures, repetitive movement, and long-term contact of body parts with this activity. The main aim of this study was to evaluate the body posture risk levels among building construction workers in Bangladesh.

Methods: The data of this study were collected by taking videos of workers while they worked in their natural postures. An ergonomic technique called Rapid Entire Body Assessment (REBA) was used to analyze the body postures of the building construction workers and assess the risk level of WRMSDs. Eight workers were randomly selected from the construction sites. This study was conducted from June 2019 to December 2019. This research examined primary construction tasks such as concrete laying, lifting and carrying materials, bricklaying, plastering, and sand mixing.

Results: The results revealed that the selected tasks' average REBA score was 9.50. It indicates that the postural risk level is high and that certain workers worked in poor postures, putting them at risk of developing WRMSDs. Traditional working methods, as well as non-ergonomic tools and equipment are responsible for these problems.

Conclusion: The findings of this study showed that the postural risk level for building construction workers is alarming. This problem may be mitigated by redesigning or changing working methods and equipment in an ergonomic way. Working in proper postures may also minimize the risk of WRMSDs.

Keywords: Building construction workers, Postural risk level, REBA, WRMSDs

Introduction

Building construction tasks are one of the significant activities that are labor-intensive. These tasks involve activities such as sand mixing, lifting and carrying materials, bricklaying, plastering, concrete laying, etc. These jobs require construction workers to perform significant body movements and unusual body postures, which frequently affect different body parts such as the back, shoulder, knee, wrist, arm, and leg.[1] The continuous and long-lasting experience of carrying heavy loads, repetitive movement, awkward body postures, incorrect materials handling techniques, and contact stress vibration leading to work-related musculoskeletal disorders (WRMSDs).[2] WRMSDs are injuries in the muscles, ligaments, tendons, joints, skeleton, and related

tissues of the body.[3] WRMSDs have been a significant worry in the construction industries as they influence laborers' profitability, non-attendance, turnover, pay, and work quality.[4]

Proper implementation of ergonomic principles can mitigate the worker's WRMSDs-related problems. For example, Hire and Zhang et al., implemented ergonomic principles in the construction industry to improve workers' safety, health, and productivity.[5,6] Working with a natural posture is one of the main principles of ergonomics. Awkward working postures have been considered risk factors for developing WRMSDs. It leads to fatigue, injuries, and stress on the musculoskeletal system. The Rapid Entire Body Assessment (REBA) is one of the ergonomic methods used to identify the risk level of the human body during daily activity.[7] This method was developed to assess workers' body postures and muscle activities with repetitive tasks related to whole-body disorders.

WRMSD problems among Construction workers are not only a regional problem but also a worldwide theme. Several previous studies have evaluated WRMSDs and postural risk levels in various construction fields as well as other sectors. For instance, a study was carried out by Vikram et al., to assess the degree of postural risk among Indian building construction workers.[8] In this study, they used REBA and Rapid Upper Limb Assessment (RULA) as ergonomic tools to assess the risk due to awkward body posture. They discovered that the REBA score for brickwork and plastering work ranged between 11 and 13. In addition, they found that both the plastering and brickwork had RULA scores of seven. From there, it may be inferred that building construction employees work in awkward positions and dangerous areas. Domingo et al., also carried out a study among Filipino construction workers through REBA and RULA.[9] They found the ranges of REBA scores for construction workers to be from 5 to 11.

From an ergonomic perspective, construction tasks may possess high risks for WRMSDs, and it is necessary to redesign the methods and techniques. Zein et al., in their investigation, found that 77.1% of the absolute employees experienced physical weakness, with continuous injuries striking the neck, shoulder, and leg.[10] Researchers studied 40 residential construction workers in India to evaluate the ergonomic risk level through the REBA tool.[11] In their study, the REBA result for the construction works indicated that about 85% of workers fell under medium risk, and 15% fell under high risk. Poor work postures are identified as the main factors contributing to this risk. However, the postural attitude analysis of the worker during their job is essential in evaluating and preventing WRMSDs.[12] Sang-Young et al., used the REBA tool to find the high workloads at workstations and to improve the job rotation schedule for an automotive assembly line worker.[13] The results showed the highest REBA score as seven.

However, in Bangladesh, the building construction industry employs about 3.5 million people.[14] Approximately 70.20% of the workers in the construction sectors in Bangladesh suffered from WRMSDs.[15] Among the various ergonomic risk factors, awkward posture is one of them. Therefore, the previous study has yet to assess the postural risk level in the building construction sectors in Bangladesh. Consequently, the purpose of this study was to evaluate and analyze the postural risk level of workers in the building construction sectors in Bangladesh. At the end of the study, the authors made some guidelines to remedy postural risk problems.

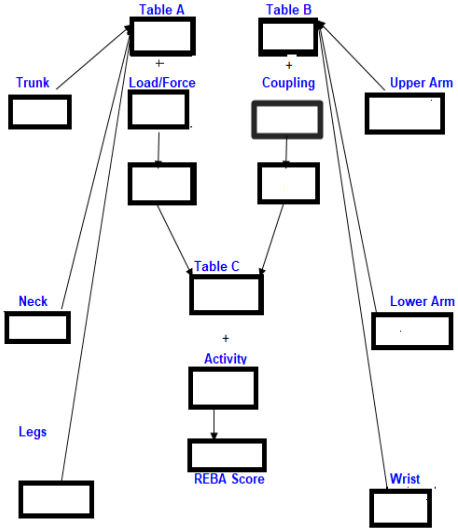
Methods

The subjects of this study were male building construction workers from different construction sites in Jashore (Figure 1), Bangladesh. The various construction tasks were observed and randomly selected eight workers for this study. Among the other construction tasks, the selected activities were: concrete laying, lifting and carrying materials, bricklaying, plastering, and sand mixing. Due to their high level of physical performance, the workers from the mentioned

tasks were selected. The authors chose workers with more than five years of experience and aged between 25 to 45 years. On the other hand, the workers who had less than five years of working experience and were less than 25 years old were excluded from this study. Before selecting the participants, they signed an informed consent form granted by the Khulna University of Engineering and Technology approval committee. The authors asked the selected workers to perform their assigned daily activities and observed their activity for 30 minutes on their job sites. Then the videos of the working procedures of the workers were taken for final body posture analysis.

Figure 1: Data collection site

In this study, the research data were collected by taking videos of selected construction workers while they worked in their natural postures. Then the videos were taken to analyze construction workers' body movements and different working postures. The snapshots of critical body postures were taken from the analyzed video. The Ergo Fellow software, version 6, was used to analyze the photos. When an image is uploaded to the Ergo Felow software, then the software provides the angle value of each body posture. After that, the body angles are used in the Rapid Entire Body Assessment (REBA) tool. The authors also monitored the body's movement, position, and postures associated with WMRSDs. The Rapid Entire Body Assessment (REBA) worksheet was used to find the postural risk condition of the workers. The REBA is an ergonomic tool that is used to evaluate the degree of postural risk associated with several crucial professional activities.[7] Each body part and activity receives a score based on the postural parameters. The human body is separated into two groups on the REBA worksheet: group A for the left postures (trunk, neck, and legs) and group B for the right postures (upper arms, lower arms, and wrists). For group A, a score is determined by summing the scores from Table A and the force/load value. The load/force score is set to zero for loads weighing less than 5 kg, one for loads weighing between 5 and 10 kg, and two for loads weighing more than 10 kg. Moreover, group B receives a score by combining Table B and the coupling score for each hand. For a handle that is well designed, the coupling score is zero; for one, that is okay but not ideal; for two, that is poorly constructed; and for three, that is not acceptable but still practicable to grip. By integrating scores A and B, table C's score is determined. Lastly, the grand REBA score is determined by multiplying score C by the activity score. For a static position, the activity score is 1; for repeating the body in a short range, it is 2; and for quick changes in posture, it is 3. Figure 2 depicts the REBA assessment worktable as well as the degrees of the associated risk level.



Notes

REBA Score	Risk Level	Action
1	Negligible	None necessary
2 – 3	Low	May be necessary
4 – 7	Medium	Necessary
8 – 10	High	Necessary soon
11 – 15	Very High	Necessary now

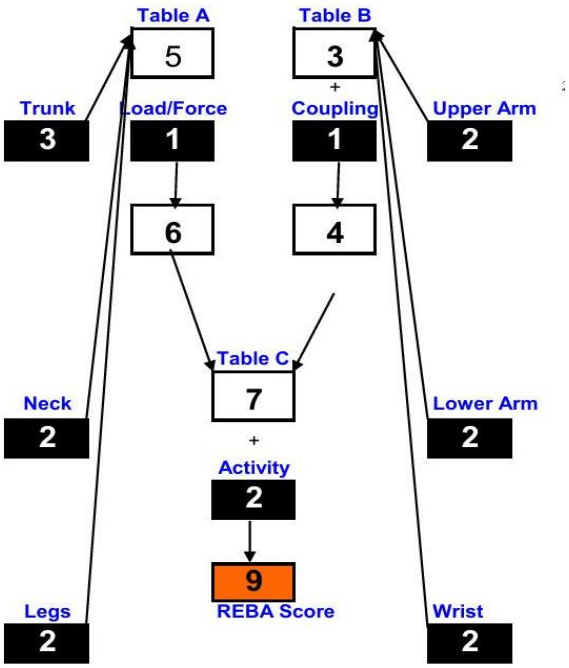
Figure 2: REBA score assessment table and associated risk level

Results

The critical body posture for a sand and cement mixer is shown in Figure 3. The worker performed this activity by moving body parts more than four times per minute. Bending and twisting were identified as the awkward body postures of sand-mixing tasks. These types of body postures may induce problems in several body parts.[16] The sand mixing worker's body components most commonly injured are the neck, shoulders, lower back, knees, and wrists.[17,18] REBA analysis is made by using several postures' angles.

Figure 4 indicates the REBA score was 9 for cement and sand mixing workers, which is considered high risk. Thus, it needs to take the necessary action to design or redesign the work procedures and tools as soon as possible.

Figure 3: Body posture of a sand and cement mixing worker



Notes

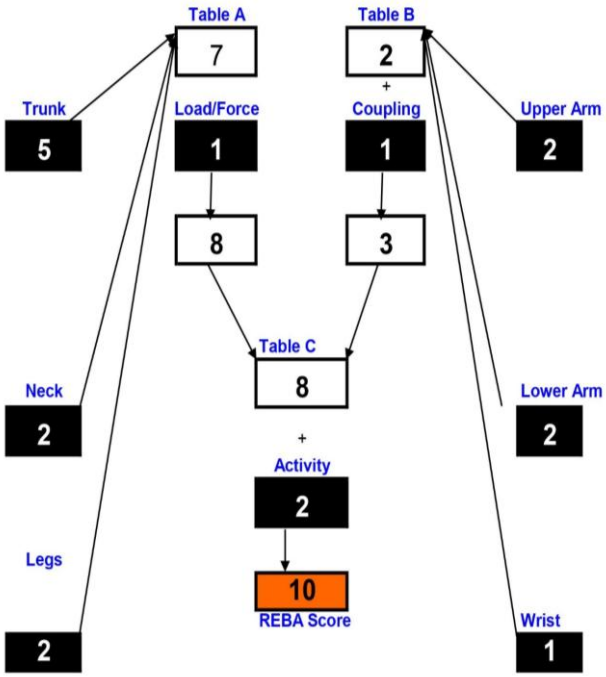
i. Load/force score 1 is used for 5-10 kg inserted forces.
ii. Coupling score 1 for fair design of hand tools.
iii. Repeating a body movement more than four times in a minute results in an activity score of two.

Figure 4: REBA score for sand and cement mixing worker

The working posture for lifting materials is depicted in Figure 5. Workers must kneel to lift sand or other materials from the ground or below the knee. Workers held the load for about 15 seconds. Working below knee height increases thigh muscle forces and knee-joint moments because of the effects of working below knee height.[19] The maximum tibiofemoral joint forces for kneeling on people during their daily work have been discovered through research.[20] As a result, the repetitive lifting materials cause pain in several body areas, including the knee, lower back, upper back, elbow, and shoulders.

The REBA score of 10 (Figure 6) for lifting materials shows the workers in this task were in a high discomfort risk zone. The working method should be changed as soon as possible.

Figure 5: Workers' body posture during the lifting of the materials



Notes

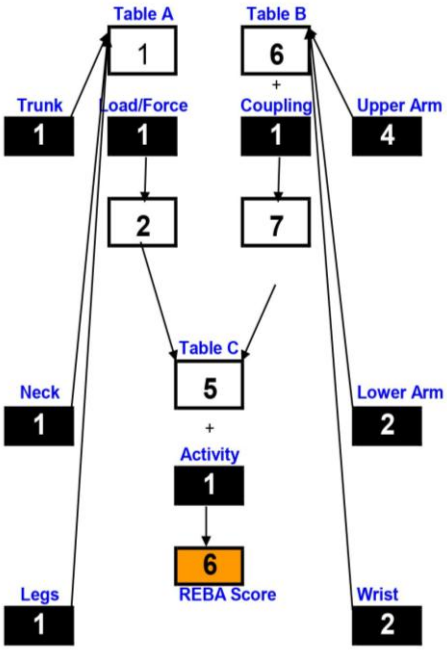
i. Load/force score 1 is used for 5-10 kg inserted forces.
ii. Coupling score 1 for fair design of hand tools.
iii. Activity score 2 for repeating the body movement more than 4 in a minute.

Figure 6: REBA score for the lifting task

The posture of carrying the task is shown in Figure 7. Carrying materials on one's head or shoulders is a common task in construction. The hands support the loads while carrying the materials on the head. The participants righted their hands for around 2 minutes to complete one cycle. This is an awkward working posture. Raising a hand above shoulder height repeatedly and for an extended period causes musculoskeletal problems in the workers' shoulders, elbows, and neck.

Figure 8 represents the carrying worker's lead in the medium risk zone of WRMSDs (REBA score 6).

Figure 7: Body posture of the worker while carrying materials



Notes

i. Load/force score 1 is used for 5-10 kg inserted forces.
ii. Coupling score 1 for fair design of hand tools.
iii. Activity score 2 for repeating the body parts static more than 1 minute.

Figure 8: REBA score for material carrying task

Figure 9 describes bricklayers' body postures while constructing a wall. Workers stoop to raise the cement mixer and bricks, then straighten themselves up and turn their bodies to place the cement and bricks where they need to be placed. The selected worker held this position for about 20 seconds. Physical discomfort resulted from the body's prolonged repeated motion. Knee, lower back, shoulder, and elbow pain are common among bricklayers. Boschman et al. found similar problems among bricklayer workers in the Netherlands.[21]

The REBA score for bricklayers was 11 (Figure 10). It indicates that bricklaying workers are in the high-risk zone and should modify the work method and technique as soon as possible.

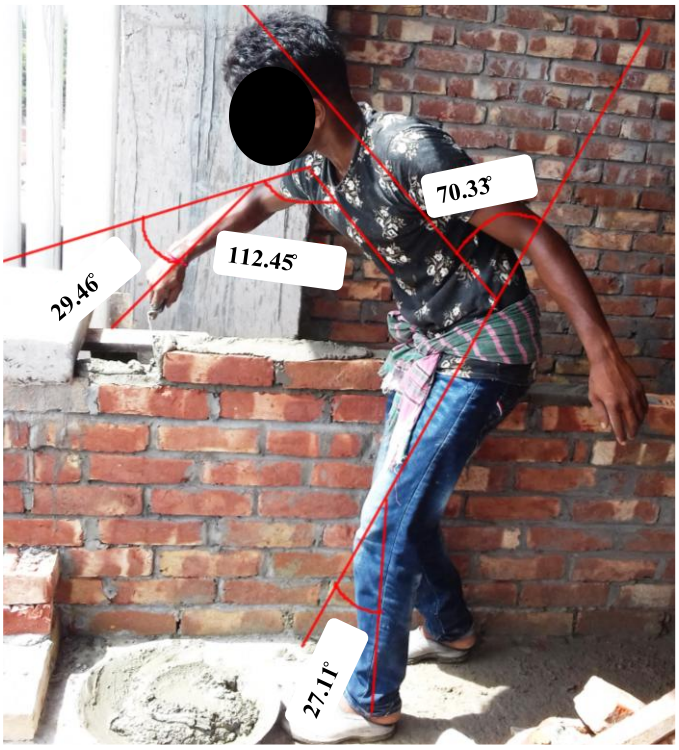
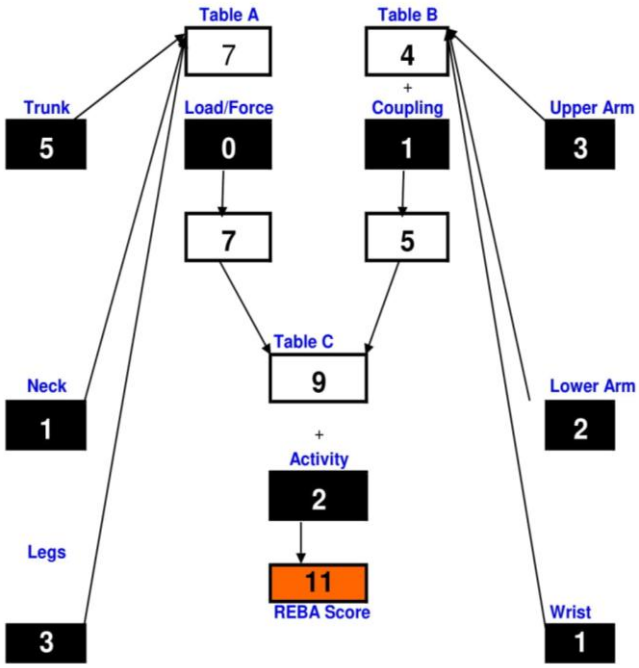


Figure 9: Body posture of bricklaying task



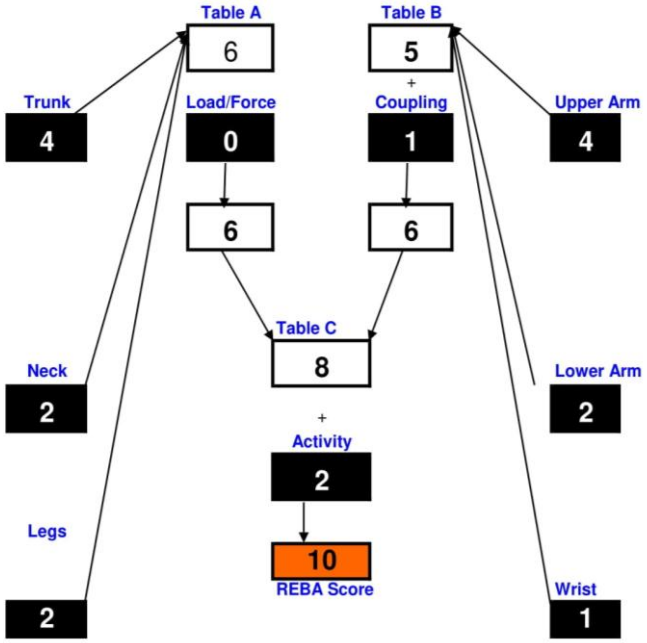
Notes

i. Load/force score 0 is used for <5 kg inserted forces.
ii. Coupling score 1 for fair design of hand tools.
iii. Activity score 2 for repeating the body parts static more than 1 minute.

Figure 10: REBA score for bricklaying task

Figure 11 depicts the body state of the wall plastering task. The worker repeatedly stretches, lifts, and twists their body to complete this activity. The participant kept this posture for 20 seconds. As a result, plasterers' knees, lower backs, upper backs, elbows, and necks are the most commonly affected body parts. Figure 12 displays the REBA result of 10 for the plasterer's demand to change the working approach quickly. Lop et al., identified that plastering workers suffer from various musculoskeletal problems.[22] Researchers also revealed that about 50% of plastering workers feel upper back pain, followed by lower back pain (22.2%) in Malaysia.[23]

Figure 11: Body posture of the plastering task



Notes

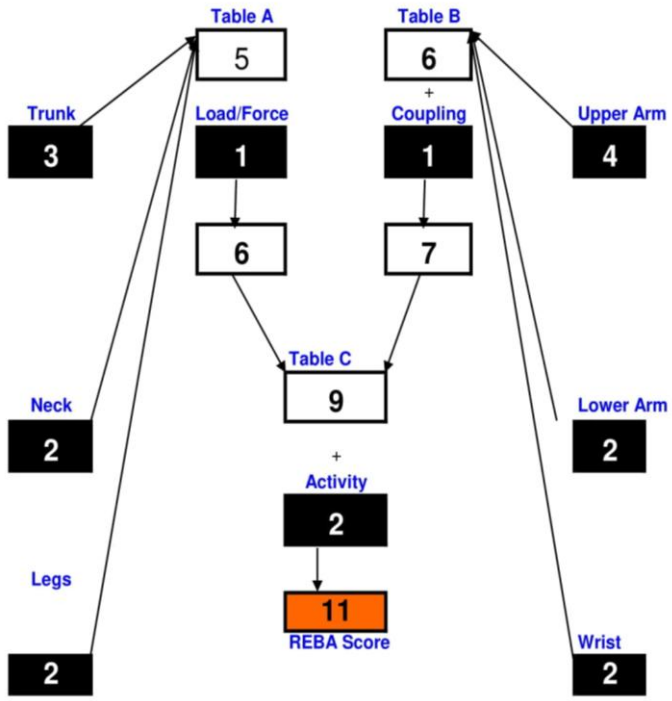
i. Load/force score zero is used for <5 kg inserted forces.
ii. Coupling score 1 for fair design of hand tools.
iii. Activity score 2 for repeating the body parts static more than 1 minute.

Figure 12: REBA score for the plastering task

Kneeling is a common issue for those who manually lay the concrete. The workers' constant kneeling brings on significant musculoskeletal problems. The primary body parts impacted by concrete-laying employees are the knee, lower back, upper back, wrist, elbow, and neck. Figure 13 shows the concrete-laying activity. Workers performed this task by changing their body posture six times per second.

Figure 14 shows the REBA score of 11 for concrete-laying workers. It means the concrete laborer works in a high-risk position. The necessary action should take place as early as possible. Working in kneeling positions has been identified as a cause of work-related knee disorders in concrete layering. In order to prevent musculoskeletal diseases, tools that can be used while standing are recommended for tasks such as laying concrete.[24]

Figure 13: Body posture of the concrete-layer



Notes

i. Load/force score one is used for 5-10 kg inserted forces.
ii. Coupling score 1 for fair design of hand tools.
iii. Activity score 2 for repeating the body parts static more than 1 minute.

Figure 14: REBA score for the concrete-laying task

Discussion

Table 1 provides a summary of the selected tasks' REBA scores, risk levels, and relative action. The results of the REBA scores were 9, 10, 6, 10, 11, and 11 for mixing sand and cement; lifting; carrying; plastering; bricklaying; and concrete laying, respectively. For the tasks mentioned earlier, the overall REBA result was 9.50. This indicates that construction workers in Bangladesh are in a high postural risk zone. The main reason for this high postural risk is awkward body postures. Most of the participants were illiterate, which is why they didn't know the proper guidelines for the tasks. The management is also careless about their workers' safety and comfortless. Researchers investigated similar results among Indian construction workers.[18] It should take the necessary action soon to design or redesign the workplaces, tools, and equipment. The least REBA for carrying out tasks among the selected tasks was six. This shows that the carrying workers had moderately risky conditions. So, appropriate steps should be taken to enhance the procedure or methods. It demonstrates that lifting, plastering, sand mixing, and concrete laying personnel appeared to have the highest prevalence of WRMSD. It can be seen that the danger of musculoskeletal problems was the most elevated among bricklaying and concrete laying works, followed by mixing sand and plastering works while carrying materials works was least influenced among the six tasks. According to researchers, the average REBA score for sawmill workers in Bangladesh was 9.25.[25] Also, they revealed that the carrying and lifting tasks received REBA scores of 10 and 11, respectively. The findings of this study can be used to develop a body postural risk management program for construction workers. Properly implementing ergonomic principles and the use of mechanical manual handling equipment can help to mitigate these problems.

Nevertheless, the prevention of WRMSDs can be implemented by better applying ergonomic principles. Finally, this study's results may help better understand the postural risk conditions of Bangladeshi construction workers. When they launch new tools for construction workers, anthropometric tool designers may consider this study.

Table 1: REBA scores of the selected tasks

Task	REBA Score	Risk Level	Action
Mixing sand and cement	9	High	Necessary soon
Lifting	10	High	Necessary soon
Carrying	**6**	Medium	Necessary
Plastering	10	High	Necessary soon
Bricklaying	**11**	Very high	Necessary now
Concrete laying	**11**	Very High	Necessary now
Average	**9.50**	**high**	**Necessary soon**

This study has some limitations: Firstly, authors should have considered the angular relationship between body parts, the distribution of masses, the forces exerted, or the effects on the worker of maintaining the posture in each work activity. Therefore, another study can be conducted by considering the mentioned issues. Secondly, the authors selected the participants from six types of construction tasks; workers from other kinds of work can be taken on for work in the future.

Conclusions

Based on the examination of results and scores acquired by the ergonomics evaluation tool REBA, the construction laborers in Bangladesh were at medium to very high risk of WRMSDs. The average REBA score was 9.50. The outcomes were contrasted, and necessary action should be taken as far as possible. It was discovered that all the chosen tasks were in the high-risk zone. This assessment demonstrates that there is a requirement for examinations and that rapid changes are required in the working environment. Along these lines, the WRMSDs are evident in the different activities done in the construction sections, where countless laborers were working in terrible postures, demonstrating that there is a need to change the body positions. The current study suggests a critical need for construction workers to use ergonomic mediations with legitimate mindfulness. Finally, the management of the construction project needs to examine and actualize changes and improvements in their working methods, procedures, and workspace configuration to decrease WMRSDs.

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Conflicts of Interest

The authors have no potential conflict of interest to declare.

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