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การศึกษาความเสี่ยงของระบบกระดูกและกล้ามเนื้อ ที่สัมพันธ์การทำงานในกลุ่มคนงานก่อสร้างรถไฟฟ้า ในกรุงเทพมหานคร

A Comprehensive Study on Work-Related Musculoskeletal Risks Among SkyTrain Construction Workers in Bangkok

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บทคัดย่อ

การศึกษานี้เป็นการศึกษาในภาพรวม เพื่อศึกษาความผิดปกติของระบบกล้ามเนื้อและกระดูก (Musculoskeleton Disorder (MSD)) ในกลุ่มคนงานก่อสร้างรถไฟฟ้า ที่ปฏิบัติงานที่แตกต่างกันจำนวน 14 ประเภทงาน ภายในสถานที่ก่อสร้างรถไฟฟ้า ที่กรุงเทพมหานคร ประเทศไทย โดยมีวัตถุประสงค์หลักเพื่อระบุประเภทความเสี่ยงเกี่ยวกับกล้ามเนื้อและกระดูกที่พบในกลุ่มคนงานก่อสร้างรถไฟฟ้า และปัจจัยเอื้อที่ทำให้เกิดความเสี่ยงดังกล่าว เครื่องมือที่ใช้ในการศึกษาคือแบบสอบถาม Nordic Musculoskeletal Questionnaire (NMQ) และแบบประเมินทั้งร่างกายอย่างรวดเร็ว (Rapid Entire Body Assessment: REBA) กลุ่มตัวอย่างของการศึกษาเป็นคนงานจำนวน 42 คน จากผลการวิเคราะห์ข้อมูลแบบสอบถาม NMQ พบความชุกของความผิดปกติระบบกล้ามเนื้อและกระดูก(MSD)ใน กลุ่มตัวอย่างอยู่ในระดับสูง โดยพบว่า อาการปวดหลังส่วนล่างเป็นปัญหาที่พบบ่อยที่สุด (55%) ส่วนอาการปวดข้อมือ/ ปวดมือ และปวดคอ พบบ่อยเช่นกัน (45% และ 50% ตามลำดับ) คะแนนจากแบบประเมิน REBA พบว่า งานต่างๆ เช่น การพรวนดิน การกวาดเศษโลหะ และการเจียร มีความเสี่ยงสูงที่จะเกิดความผิดปกติของระบบกล้ามเนื้อและกระดูก (MSD) อันเนื่องมาจากปัจจัยทางด้านชีวกลศาสตร์ จากผลการศึกษานี้ ควรมีการดำเนินการต่างๆ เพื่อลดอุบัติการณ์ความผิดปกติของระบบกล้ามเนื้อและกระดูก (MSD) เช่น การปรับปรุงเครื่องมือและอุปกรณ์การปฏิบัติงานให้ถูกต้องตามหลักสรีรศาสตร์ จัดให้มีโปรแกรมการฝึกอบรมเกี่ยวกับหลัก และวิธีการปฏิบัติงานที่ปลอดภัยให้กับคนงาน รวมถึงการใช้กลยุทธ์ การหมุนเวียนสลับเปลี่ยนการปฏิบัติงานในกลุ่มคนงานเพื่อลดความเสี่ยง การส่งเสริมสุขภาพและหลักความปลอดภัยของคนงาน

Abstract

A comprehensive study was conducted to investigate work-related musculoskeletal disorders (MSDs) among SkyTrain construction workers in Bangkok, Thailand. Focusing on a specific group of 42 workers employed across 14 job categories within a SkyTrain construction site. The primary objectives were to identify the types of musculoskeletal risks encountered and the contributing factors. A combined approach utilizing the Nordic Musculoskeletal Questionnaire (NMQ) and Rapid Entire Body Assessment (REBA) was employed on a sample of 42 workers across 14 job categories. Analysis of the NMQ data revealed a high prevalence of MSDs, with lower back pain being the most frequent complaint (55%). Wrist/hand and neck pain were also prevalent (45% and 50%, respectively). REBA scores identified tasks like shoveling, sweeping metal scraps, and grinding operations as having a higher risk of MSDs due to biomechanical factors. Based on these findings, the study recommends targeted interventions such as ergonomic improvements in the tools and equipment, training programs on safe work practices, and job rotation strategies to mitigate MSD risks and enhance worker health and safety in similar construction projects.

Keywords: Musculoskeletal disorders (MSDs); Construction workers; Nordic Musculoskeletal Questionnaire (NMQ); Rapid Entire Body Assessment (REBA)

Introduction

The construction industry is a cornerstone of global development, but it often comes at a cost to the health of its workforce. Construction workers perform physically demanding tasks that can lead to a high prevalence of work-related musculoskeletal disorders (WMSDs). These disorders, encompassing pain and discomfort in muscles, tendons, ligaments, and nerves, can significantly impact worker well-being, productivity, and overall quality of life.

The prevalence of WMSDs among construction workers is a well-documented concern. A study by Suda Hanklang in 2014 found that over half (57.7%) of female construction workers in Thailand reported WMSD symptoms, with the lower back and shoulders being the most commonly affected areas (46.0%). This study identified prolonged working hours and awkward postures as key contributing factors¹

Similarly, In a study conducted by Boschman in the Netherlands among bricklayers and supervisors revealed a high prevalence of MSDs, with 67% and 57% of workers reporting symptoms, respectively. Back, knee, and shoulder/upper arm complaints were most frequent, and a majority of participants attributed their issues to work-related activities²

A broader study in the United States by Wang in 2017 reported that construction laborers had the highest number of WMSD cases, while helpers, heating and air-conditioning mechanics, cement masons,

and sheet metal workers had the highest rates. Overexertion was identified as the main cause, with back injuries accounting for over 40% of WMSD cases among construction workers³

These studies underscore the heightened risk of musculoskeletal problems faced by construction workers compared to other industries. Continuous exposure to ergonomic risk factors like Awkward postures, Forceful exertions, and Repetitive motions significantly contribute to the development of WMSDs⁴

This study focuses on the critical issue of WMSDs among construction workers specifically involved in Bangkok's SkyTrain construction projects. SkyTrain construction is a complex endeavor requiring a diverse workforce with specialized skills. From operating heavy machinery and erecting steel structures to laying tracks and installing intricate electrical systems, each role presents unique musculoskeletal risk factors.

This research aims to bridge the knowledge gap regarding WMSDs among SkyTrain construction workers in Bangkok. By employing a comprehensive approach, this study will not only assess the prevalence and severity of WMSDs but also delve into the contributing factors associated with specific job tasks and postures.

The following sections of the paper will delve deeper into the methodology employed (Nordic Musculoskeletal Questionnaire and Rapid Entire Body Assessment), the identified specific risks after assessing the worker posture, and the questionnaire. Finally, the study will propose concrete recommendations for mitigating these risks and promoting a healthier work environment for construction workers.

Methods

The study focused on a specific group of 42 construction workers employed at a SkyTrain construction site in Bangkok, Thailand. These workers were selected to represent a diverse range of job categories within the construction project, covering 14 different roles. Inclusion criteria required workers to be actively employed at the SkyTrain construction site, engaged in physically demanding tasks with potential ergonomic risks, and willing to participate in the study by completing the Nordic Musculoskeletal Questionnaire (NMQ) and Rapid Entire Body Assessment (REBA). Workers who were not directly involved in physically demanding construction tasks or those unwilling or unable to participate in the study were excluded.

Nordic Musculoskeletal Questionnaire (NMQ)

The Nordic Musculoskeletal Questionnaire (NMQ) is a standardized tool developed for epidemiological studies to compare low back, neck, shoulder, and general musculoskeletal complaints. It

aids in assessing musculoskeletal problems and their impact⁵. The NMQ tool is designed to gather information about musculoskeletal symptoms experienced by workers in various body regions over a specific timeframe. Developed under the Nordic Council of Ministers, the NMQ facilitates the comparison of musculoskeletal complaints across various regions and professions, not intended for clinical diagnosis⁶

The questionnaire's design allows for use in both self-administered and interview formats, with evidence suggesting a higher report of musculoskeletal problems when focused on work-related factors⁷. Section 1 of the Nordic Musculoskeletal Questionnaire (NMQ) comprises a general questionnaire consisting of 40 forced-choice items aimed at identifying areas of the body contributing to musculoskeletal problems. Respondents are provided with a body map to facilitate indicating nine specific symptom sites, including the neck, shoulders, upper back, elbows, lower back, wrists/hands, hips/thighs, knees, and ankles/feet. They are then queried about any musculoskeletal troubles experienced within the past 12 months and within the last 7 days, which have impeded normal activities.

Section 2 of the questionnaire includes additional inquiries pertaining to the neck, shoulders, and lower back, delving deeper into relevant issues. This section comprises twenty-five forced-choice questions designed to ascertain any accidents affecting each area, the functional impact experienced both at home and at work (such as changes in job or duties), the duration of the problem, whether assessment by a health professional has been sought, and any musculoskeletal problems encountered within the past 7 days.

Reliability and validity studies have shown acceptable ranges of agreement with clinical history, indicating the NMQ's utility as a screening tool^{8,9}. Further research has underscored its repeatability and sensitivity, affirming its value in occupational health surveillance¹⁰.

In a comprehensive study conducted by Purani in 2017, the Extended Version of the Nordic Musculoskeletal Questionnaire (NMQ-E) was utilized to assess musculoskeletal disorders among construction workers in Gujarat. The findings revealed a notably high prevalence of musculoskeletal disorders, with low back pain reported by 83% of the subjects. This research underscores the critical necessity for implementing ergonomic interventions within the construction industry to effectively mitigate such prevalent health risks¹¹

The NMQ has been employed in various studies to assess musculoskeletal issues among diverse occupational groups, including computer workers, car drivers, and forestry workers, underscoring its versatility and applicability in different work environments^{12,13,14}

The NMQ can be a valuable tool in assessing musculoskeletal risks among construction workers, including back, neck, shoulder, and knee pain. Its application could inform targeted interventions to improve

worker health and safety. By employing the NMQ, this study aims to gain valuable insights into the scope and severity of WMSD issues experienced by construction workers in Bangkok. The analysis of NMQ data obtained will serve as a crucial foundation for identifying contributing factors and developing targeted interventions for promoting musculoskeletal well-being in this workforce.

Rapid Entire Body Assessment (REBA)

REBA is a quick and user-friendly method for evaluating the ergonomic demands of specific work tasks. REBA assesses the biomechanical and postural loading on the musculoskeletal system during work activities. The REBA method, first introduced by Hignett and McAtamney (2000), divides the body into two main segments: the first segment comprises the neck, trunk, and legs, with their scores combined using Table A in the REBA worksheet to generate a unified value. The second segment encompasses the upper arm, lower arm, and wrist, and their scores are amalgamated using Table B in the REBA worksheet. By integrating scores related to coupling and force, and then consolidating them using Table C, the final REBA score is calculated. Additionally, the score associated with the type of activity is added. The resulting REBA score ranges from one to greater than eleven, with higher scores indicating a heightened risk of work-related musculoskeletal disorders (WMSDs)¹⁵. Detailed scores and corresponding action levels can be referenced in the REBA worksheet illustrated in Figure 1.

The REBA tool has proven valuable in assessing ergonomic risks and improving work practices across various industries. In a study conducted by Hita-Gutiérrez et al. (2020), the application of the REBA ergonomic assessment method worldwide was reviewed. The analysis involved the examination of 314 documents, out of which 91 were selected for detailed study. The findings revealed that the REBA method was predominantly utilized in the knowledge areas of "Manufacturing" (24.18%), "Agriculture, forestry, and fishing" (21.98%), and in "Other activities" (19.78%)¹⁶. REBA's effectiveness extends to healthcare, with research by Choi et al. (2017) establishing its value in evaluating postural risks faced by healthcare workers¹⁷.

REBA Employee Assessment Worksheet

Task Name: _____ Date: _____

A. Neck, Trunk and Leg Analysis

Step 1: Locate Neck Position

Neck Score

Neck	
Legs	Neck
1	1 2 3 4 1 2 3 4 1 2 3 4
2	1 1 2 3 4 1 1 2 3 4 1 2 3 4
3	2 2 3 4 5 3 4 5 6 4 5 6 7
4	3 2 4 5 6 4 5 6 7 5 6 7 8
5	4 3 5 6 7 5 6 7 8 6 7 8 9
6	4 6 7 8 6 7 8 9 7 8 9 9

Step 2: Locate Trunk Position

Trunk Score

Lower Arm	
Wrist	Lower Arm
1	1 1 2 2 1 2 3
2	1 1 2 3 2 3 4
3	3 4 5 4 5 5
4	4 5 5 5 6 7
5	6 7 8 7 8 8
6	7 8 8 8 9 9

Step 3: Legs

Leg Score

Table C	
Score A	Score B
1	1 1 1 1 2 3 4 5 6 7 8 9 10 11 12
2	1 1 2 3 4 5 6 7 7 7 7 7 7 7 7
3	2 3 3 3 4 5 6 7 7 8 8 8 8 8
4	3 4 4 4 5 6 7 8 8 9 9 9 9 9
5	4 4 5 6 7 8 8 9 9 10 10 10 10
6	6 6 6 7 8 8 8 9 9 10 10 10 10
7	7 7 7 8 9 9 9 10 10 11 11 11 11
8	8 8 8 9 10 10 10 10 10 11 11 11
9	9 9 9 10 10 10 11 11 11 12 12 12
10	10 10 10 11 11 11 12 12 12 12 12
11	11 11 11 12 12 12 12 12 12 12 12
12	12 12 12 12 12 12 12 12 12 12 12

B. Arm and Wrist Analysis

Step 7: Locate Upper Arm Position:

Upper Arm Score

Step 8: Locate Lower Arm Position:

Lower Arm Score

Step 9: Locate Wrist Position:

Wrist Score

Step 10: Look up Posture Score in Table B

Posture Score B

Step 11: Add Coupling Score

Coupling Score

Step 12: Score B

Score B

Step 13: Activity Score

Activity Score

REBA Score

Original Worksheet Developed by Dr. Alan Hedge. Based on Technical note: Rapid Entire Body Assessment (REBA), Hignett, McAtamney, Applied Ergonomics 31 (2000) 201-205

Fig. 1 REBA Worksheet (Proposed by Hignett and McAtamney, 2000)

The application of the REBA method extends beyond the manufacturing and healthcare sectors. In a study conducted by Kulkarni & Devalkar (2018), ergonomics in construction tasks were examined employing both RULA and REBA methods. The findings indicated that all analyzed activities surpassed safe ergonomic thresholds, indicating a heightened risk of musculoskeletal disorders (MSDs) for workers involved in construction tasks. To address this issue, the authors proposed interventions such as the implementation of elevated platforms and the proper use of ladders to enhance work postures and mitigate the risk of MSDs¹⁸. One of the notable advantages of the REBA method highlighted in the study is its ability to assess various body parts comprehensively. This includes the evaluation of upper limbs (arm, forearm, and wrist), lower extremities, trunk, and neck. Such comprehensive assessment capability makes REBA a valuable tool for analyzing ergonomic risks associated with diverse work activities across different industries

Result and Discussions

This research focuses on a specific group of 42 workers (14 women and 28 men) employed across 14 job categories within a SkyTrain construction site. The study collected demographic data including age, gender, height, and weight. Body Mass Index (BMI) calculations revealed that most workers fell within the healthy normal weight range (20-25). Only five workers were categorized as overweight (BMI 25-30).

The workers selected for this study were based on 14 job categories – Crane and truck Operation, Welding Operation, Grinding Operation, Excavation Work (Shoveling), Steel Section Lifting, Erecting Steel Beams, Floor-Level Survey Works, Concrete Work (Mixing, Pouring, Finishing) Concrete Floor Chiseling, Pillar

Wall Installation, Steel Bending Machinery Operation, Sweeping and Clearing Metal Scraps, Shoring and Piling and Rail Installation. For each category, three workers were selected, and their postures were analyzed using the Rapid Entire Body Assessment (REBA) method.

The REBA analysis of works like Excavation truck operation and shoveling works are shown in Figures 2 and 3 respectively. The Final REBA analysis results of all 14 job categories are shown in Table 1.

The activities with higher REBA scores indicate a higher level of risk associated with the task in terms of posture, force/load, coupling, and activity factors. The highest REBA scores are seen in tasks like Shoveling Works, Sweeping and Clearing Metal Scraps, and Grinding Operations, suggesting these activities require immediate ergonomic improvements to reduce the risk of musculoskeletal disorders. These highest scores are because of the awkward postures of workers while carrying out this manual work. Welding Operation, Pillar Wall Installation Works, and Rail Installation show relatively lower scores, indicating they may have better ergonomic conditions compared to other tasks. The scores provide insights into which activities may require immediate attention in terms of ergonomic adjustments to minimize the risk of work-related injuries.

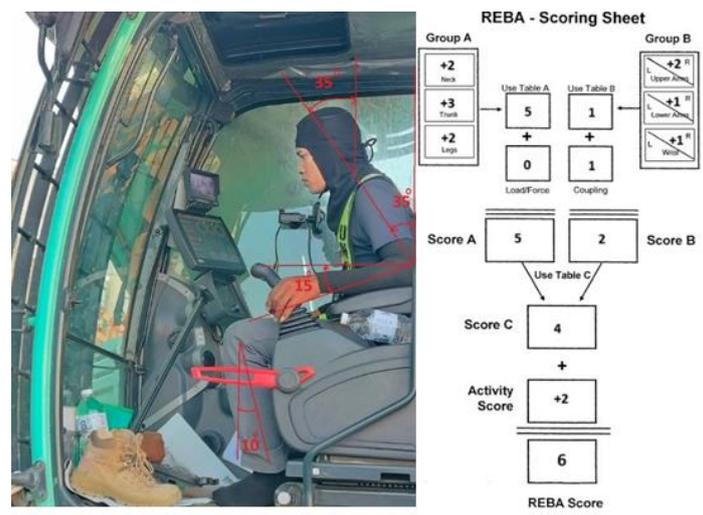


Fig. 2 REBA of Excavation truck operation

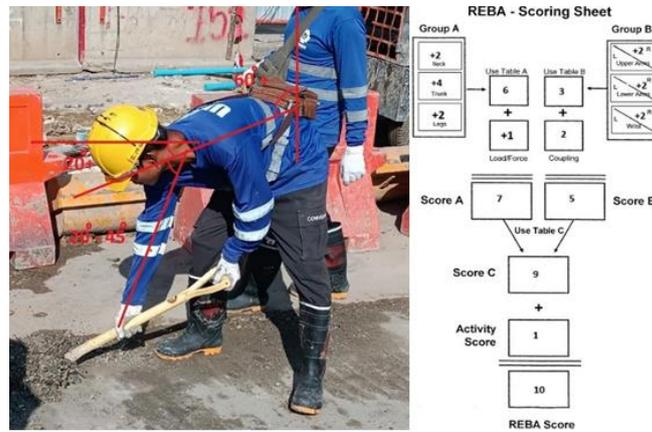


Fig. 3 REBA of Shoveling works

Table 1 REBA Score for 14 categories of SkyTrain construction works

Works/ Operations/ activities	Sample No:	Posture Score A	Force/ Load Score	Posture Score B	Coupling	Activity Score	REBA Score
Crane and truck Operations	1	5	0	2	1	2	6
	2	5	0	2	1	2	6
	3	5	0	4	1	2	7
Welding Operations	4	5	1	1	0	1	5
	5	6	1	3	0	1	7
	6	5	1	1	0	1	5
Grinding Operations	7	5	1	5	0	2	8
	8	4	1	5	0	2	7
	9	5	1	5	0	2	8
Shoveling works	10	7	1	5	2	1	10
	11	7	1	4	2	1	9
	12	7	1	5	2	1	10
Steel section lifting works	13	4	2	5	2	2	7
	14	4	2	4	2	2	6
	15	4	2	5	2	2	7
Erecting steel beams	16	4	2	5	2	2	7
	17	4	2	5	2	2	7
	18	4	2	4	2	2	6

Works/ Operations/ activities	Sample No:	Posture Score A	Force/ Load Score	Posture Score B	Coupling	Activity Score	REBA Score
Survey works- floor- level inspection	19	5	1	1	0	1	5
	20	6	1	3	0	1	7
	21	5	1	1	0	1	5
Concrete works: mix, pour, and finish concrete	22	4	2	5	2	2	7
	23	4	2	5	2	2	7
	24	4	2	5	2	2	7
Concrete floor chiseling	25	6	1	3	1	2	8
	26	6	1	3	1	2	8
	27	4	2	5	2	2	7
Pillar wall installation works	28	4	2	5	2	2	7
	29	4	2	4	2	2	6
	30	4	2	5	2	2	7
Steel bending machinery works	31	4	2	5	2	2	7
	32	4	2	5	2	2	7
	33	4	2	4	2	2	6
Sweeping and clearing the metal scraps	34	7	1	5	2	1	10
	35	7	1	5	2	1	10
	36	7	1	4	2	1	9
Shoring and piling	37	4	2	5	2	2	7
	38	4	2	4	2	2	6
	39	4	2	5	2	2	7
Rail Installation	40	4	2	5	2	2	7
	41	4	2	5	2	2	7
	42	4	2	4	2	2	6

The Nordic Musculoskeletal Questionnaire was utilized to gather data on musculoskeletal symptoms experienced by participants over specific time frames, including the last 12 months and the past 7 days. The results from the Nordic Musculoskeletal Questionnaire are shown in Table 2. The analysis of the NMQ data reveals the following key findings: A significant portion of the workers reported experiencing MSD symptoms in various body regions within the last 12 months. The highest prevalence was observed in

the lower back, with 55% of workers reporting symptoms. The Wrists/Hands & Neck are the next areas followed closely, with 45% and 50% of workers reporting symptoms, respectively. The Shoulders, Upper Back, Hips/Thighs, Knees, and Ankles/Feet all these regions also showed a notable presence of MSD symptoms, ranging from 10% to 25% of workers reporting issues. While a smaller percentage of workers reported their symptoms preventing normal activities (ranging from 0% to 30%), it still highlights a potential impact on work performance and overall well-being. Despite experiencing symptoms, a relatively low percentage of workers (0% to 15%) consulted a healthcare professional for their MSDs. This could indicate the under-reporting of pain or a lack of awareness regarding treatment options. The prevalence of symptoms reported in the last 7 days was generally lower compared to the past 12 months, but it still suggests the presence of ongoing discomfort for some workers across various body regions.

Table 2 Results from the Nordic Musculoskeletal Questionnaire

Anatomical Region	Symptoms in the Last 12 Months (%)	Preventing Normal Activities in the last 12 Months because of this Issue (%)	Consultation with a Healthcare Professional (Doctor or Physical Therapist) because of this Condition (%)	Symptoms in the Last 7 Days (%)
Neck	50	0	0	10
Shoulders	40	10	0	15
Upper back	25	5	10	20
Elbows	15	5	0	5
wrists/hands	45	15	5	15
Lower back	55	30	15	30
Hips/thighs	20	15	5	10
Knees	10	5	0	15
Ankles/feet	15	5	0	15

The examination of Nordic Musculoskeletal Questionnaire (NMQ) data, categorized across 14 distinct job categories, unveiled a notable trend among workers engaged in tasks such as Shoveling Works, Sweeping, and Clearing Metal Scraps. These workers reported higher incidences of lower back pain

symptoms compared to their counterparts in other job categories. This observation aligns with the REBA scores, which also demonstrated higher score levels for individuals undertaking these tasks. Such findings underscore the prevalence of awkward postures adopted by these workers during their activities, particularly contributing to lower back discomfort.

Conclusions

This study investigated musculoskeletal disorders (MSDs) among SkyTrain construction workers in Bangkok. The findings reveal a high prevalence of MSDs, particularly lower back pain (55% of workers). While these symptoms may not always impede daily activities, they represent a potential health concern impacting worker well-being and productivity. Furthermore, the low rate of healthcare consultation suggests a need for increased education and awareness regarding MSD prevention and treatment options.

The analysis of Nordic Musculoskeletal Questionnaire (NMQ) data and Rapid Entire Body Assessment (REBA) scores pinpointed higher incidences of back pain among workers engaged in tasks such as shoveling, sweeping, and metal scrap clearing, attributed to the adoption of awkward postures during these activities. To address these findings and mitigate the risk of musculoskeletal disorders among workers, immediate interventions are recommended. Recommendations include Specific Recommendations for High-Risk Tasks:

Shoveling Works (Excavation): Provide ergonomic shovels with adjustable handles to accommodate different heights. Train workers on proper lifting techniques and encourage them to keep their backs straight while shoveling. Rotate workers frequently to avoid prolonged periods of shoveling. Use mechanical aids such as wheelbarrows or mini-excavators for moving heavier loads.

Sweeping and Clearing Metal Scraps: Use ergonomic brooms with adjustable handles to promote a more neutral wrist position. Implement a rotation schedule to alternate between sweeping and other less physically demanding tasks. Provide knee pads or kneeling mats for workers who need to kneel frequently during cleaning tasks. Install anti-fatigue mats to reduce strain on workers' legs and feet.

Grinding Operation: Provide ergonomic portable grinding equipment with proper grips. Implement job rotation to vary tasks and reduce prolonged exposure to vibration from the grinding equipment.

By prioritizing these interventions, construction companies can foster a safer and healthier work environment for their employees, ultimately enhancing both worker well-being and overall productivity on the construction site. It is crucial for stakeholders to recognize the significance of proactive measures in addressing musculoskeletal health concerns and to commit to the implementation of these recommendations to safeguard the welfare of their workforce.

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Ethical Declaration:

This research proposal and tool got approval from the institutional research board of St Teresa International University. A coding scheme was used for data collection, and every document relating to the participants, such as the questionnaire, was destroyed upon completion of the research.

Support Resources: The authors received no financial support for the research.

Conflict of Interest: The authors declare no conflict of interest.

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