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Ergonomic Analysis of Working Postures Using OWAS In Scaffold Activities and Recommendations at Refinery Construction

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Abstract: Workers involved in scaffolding erection and dismantling activities are exposed to various physical risk factors. However, no existing study indicates that awkward working postures in scaffolding activities lead to musculoskeletal system disorders (MSDs). This study explores the ergonomic risks intrinsic to scaffolding tasks in refinery construction using the Ovako Working Posture Analysing System (OWAS). In the refinery, the utilized scaffolding encompasses an area of 319674 square meters and a volumetric extent of 603294 cubic meters. Observations were conducted on the postures of 500 scaffolding group workers across 5210 locations within the site, culminating in capturing 2000 photographic records. The mass of each scaffolding component was meticulously determined. After three months of observation, medical records were consulted for further insights. A statistical analysis employing the Pearson correlation technique was conducted to scrutinize the relationship between the ages of the scaffolding workers and the incidence of MSDs, alongside patterns of absenteeism. This analysis elucidated a robust and statistically significant correlation between the age of the workers and the prevalence of MSD associated with their occupational activities. As a result of the results of the OWAS ergonomic risk assessment, a number of regulatory changes were made to the scaffolding workforce, and then medical records were looked over again. This re-evaluation revealed a marked reduction in MSDs. The OWAS method's reliance on simple observational techniques holds substantial merit for its application within construction environments. Our research underscores the exposure of workers engaged in scaffolding tasks within continuous projects, such as refinery construction, to substantial ergonomic risks.

Keywords: OWAS; scaffolding; ergonomic risk; MSDs; Pearson correlation

1. Introduction

Strains and discomfort can have an impact on the musculoskeletal system, which consists of muscles, fibers, ligaments, nerves, discs, and blood vessels. The pain that arises from MSDs can exhibit a wide array of characteristics and complexities [1]. Those employed in the construction industry, particularly in scaffolding, face a heightened risk of MSDs because of their consistent exposure to uncomfortable postures and physical activities, such as lifting, bending, and twisting, frequently over prolonged periods [2]. The five principal ergonomic construction issues are maintaining a single position for extended durations, awkwardly bending, or twisting the back, operating in constrained or uncomfortable positions, continuing to work while injured or in pain, and managing heavy materials or equipment [3]. Awkward work postures significantly contribute to the risk of developing MSDs [4]. Research indicates that the onset of MSDs is associated with considerable occupational risk elements, encompassing physical factors [5], psychosocial and organizational factors [6], as well as individual characteristics [7]. When you use the results of one or more combined ergonomic risk assessment methodologies to help guide your improvement and corrective actions, you can reduce the number of MSDs that happen. Employees' postures and actions can be evaluated ergonomically using various techniques, such as RULA, OWAS, REBA, QEC, PLIBEL, and ManTRA [8].

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As construction projects grow intricately and time and cost pressures intensify, the industry increasingly worries about professional burnout [9]. Construction employees perform various tasks with long cycles that vary in duration and content [10], and they engage in manual material handling operations that are highly variable [11]. Scaffolders primarily undertake three primary duties: erecting a scaffold, disassembling a scaffold, and transporting scaffold parts horizontally or vertically. Generally, construction consumes nearly half of their working hours, while dismantlement and transport each take up approximately a fifth of the work time. The remaining time is allocated for preparation and breaks. Manual material handling remains the most prevalent activity throughout all three primary tasks [12]. Among construction industry workers, scaffolders face particularly elevated risks for lower back disorders [13–15]. Despite scaffolders possessing considerable isometric strength, there are still perceived risks of overexertion associated with several of their lifting postures [16]. Scaffolders experience significant mechanical stress on their shoulders, elbows, and hips [17]. An epidemiological study among scaffolders confirmed that exposure to manual material handling was linked to instances of lower back pain experienced in the past 12 months [18]. Ergonomic interventions can reduce the exposure to manual material handling in the scaffolding profession [13].

This study evaluated workers' postures while assembling eight different scaffold parts at a refinery construction site using the Ovako Working Posture Analysing System (OWAS).

2. Literature Survey of the Application of Owas

OWAS, originating from the Finnish steel industry in the 1970s, is a practical approach for ergonomically examining and assessing various work postures [19]. Despite a simplified sampling method, it consistently yields dependable and valid results [20].

In 2023, Joshi M. and Deshpande V. did a study called "An Investigative Sensitivity Study of Ovako Working Posture Analysing System (OWAS)" to find the body variable that had the most significant effect and how it helped predict the OWAS action category [21]. Bachmid Z. A. and Andesta D. (2023), in their study titled "Analysis of Improvement of Employee Work Posture Using the OWAS Method (Case study at PT. XYZ)," applied the OWAS method to analyze worker postures. Their findings revealed that cutting, marking, fitting up, and packing tasks were associated with a risk level 2 [22]. In their 2022 study called "Evaluation of Ergonomic Risks in the Construction Sector and an Application," Zorlutuna, A., and Kılıc, H. S. used the Rapid Entire Body Assessment (REBA), Rapid Upper Limb Assessment (RULA), and Rapid Exposure Assessment (REA) methods to find out how dangerous the work was. Their investigation delved into mortar preparation, bricklaying, mortar mixing, rebar tying, foundation wrapping, formwork nailing, liquid plaster preparation, plaster application, and mesh pulling [23]. Satapathy S. (2022), in his "Workplace Discomfort and Risk Factors for Construction Site Workers" study, employed the OWAS method in Ergo Fellow 3.0 to conduct an ergonomic analysis. The analysis sought to ascertain the level of discomfort that workers at a construction site were experiencing [24]. Iqbal et al., 2021, in their research titled "Working Posture Analysis of Wall Building Activities in Construction Works Using the OWAS Method," evaluated several tasks. These included the construction of a brick wall, wall plastering, and casting a concrete column using the OWAS methodology for their assessments [25]. In their 2020 study called "Evaluation of Employee Postures in Building Construction with Different Ergonomic Risk Assessment Methods," Zengin M. A. and Asal O. looked at 39 different tasks using three different ergonomic risk assessment methods: REBA, QEC, and OWAS [26]. In their 2019 study called "Personalized method for self-management of trunk postural ergonomic hazards in construction rebar ironwork," Yan X. et al. discovered that when personalized recommendations were used, posture scores on the OWAS went down by a lot [27]. Joshi M. and Deshpande V. (2019), in their study titled "A systematic review of comparative studies on ergonomic assessment techniques," used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology for a comparative analysis of various ergonomic assessment techniques, including REBA, RULA, QEC, OCRA, SI, OWAS and others [28]. Kong et al. (2018) chose 196 working positions from real farm work tasks to test ALLA, a tool for evaluating lower limb body posture. Their study was called

"Comparisons of ergonomic evaluation tools (ALLA, RULA, REBA, and OWAS) for farm work." A group of 16 ergonomic experts subsequently evaluated these postures compared to the RULA, REBA, and OWAS methods [29]. A study by Brandl C. et al. (2017), called "Effect of sampling interval on the reliability of ergonomic analysis using the Ovako working posture analysing system (OWAS)," looked into what effect the sampling interval had on the reliability of the OWAS system for ergonomic analysis of working postures [30]. Gomez-Galan M. et al. (2017) conducted a comprehensive literature review, examining the application of the OWAS method across various sectors between 1900 and 2017. Their analysis identified 166 studies published in the "Web of Science"[31]. Lee J. et al. (2016), in their study titled "Working Posture Analysis Using the OWAS Method of Core Wall Construction in High-rise Buildings," evaluated the postures of workers engaged in wall construction tasks in a high-rise building [32]. In their study titled "Analysis of Working Postures at a Construction Site Using the OWAS Method," Lee, T.H., Han, C.S. (2013) evaluated postures by tying beams with steel bars, assembling column templates, and cement grouting of the ground with OWAS [34]. Buchholz B. et al. (1996), in their paper titled "PATH: A work sampling-based approach to ergonomic job analysis for construction and other non-repetitive work," reported that the posture codes in the PATH method are derived from the Ovako Work Posture Analysing System (OWAS). Additionally, they included other codes for describing worker activity, tool use, loads handled, and type of grasp [35]. Schneider, S. and Susi, P. (1994), in their study titled "Ergonomics and Construction: A Review of Potential Hazards in New Construction," reviewed potential ergonomic hazards in new construction work. Their study summarized findings from published literature and a 15-month investigation of health hazards on a new construction site in suburban Washington, D.C [36]. Mattila M. et al. (1993), in their study titled "Analysis of working postures in hammering tasks on building construction sites using the computerized OWAS method," conducted observations and evaluations of various tasks such as roof boarding, concrete form preparation, clamping support braces, assembling roof frames, roof joisting, shelter form preparation, and fixing fork clamps using the OWAS method [37]. Kivi P. and Mattila M. (1991), in their study titled "Analysis and improvement of work postures in the building industry: application of the computerized OWAS method," demonstrated that physical work affects workers' health in 46% of jobs in new building construction. Their research examined the use of the OWAS method to analyze work postures in building construction [38]. Examples of studies conducted with OWAS are shown in Table 1.

Table 1. A summary of studies utilizing the Ovako Working Posture Analyzing System (OWAS).

No	Study	Field of Activity
1	Joshi M., Deshpande V.,2023.	An examination of the sensitivity in the OWAS.
2	Bachmid Z. A., Andesta D.,2023.	Processes of cutting marking, fit up, and packing.
3	Zorlutuna, A., Kılıç, H. S.,2022.	Mortar preparation, bricklaying, mortar mixing, rebar tying, foundation wrapping, formwork nailing, liquid plaster preparation, plaster application, and mesh pulling.
4	Satapathy S., 2022.	Using OWAS in Ergo Fellow 3.0 to ascertain the level of discomfort at a construction site.
5	Iqbal et al.,2021.	Construction of a brick wall, wall plastering and the casting of a concrete column.
6	Zengin M. A., Asal Ö.,2020.	Evaluation of employee postures in building construction with REBA, QEC, and OWAS.
7	Yan X. et al., 2019.	Described OWAS posture scores decreased when personalized recommendations were applied.

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8	Joshi M., Deshpande V.,2019.	Comparisons of REBA, RULA, QEC, OKRA, SI, OWAS and other ergonomic risk assessment methodologies.
9	Kong et al., 2018.	Comparisons of ALLA, RULA, REBA, and OWAS.
10	Brandl C. et al., 2017.	Explored the reliability of ergonomic analysis of working postures using the OWAS system.
11	Gomez-Galan, M. et al., 2017.	Literature review on ‘‘web of science’’.
12	Lee J. et al.,2016.	OWAS method on wall construction
13	Lee, T.H. et al.,2013.	Evaluated postures by tying beams with steel bars, assembling column templates, and cement grouting of the ground with OWAS.
14	Buchholz B. et al.,1996.	Posture codes in the PATH method are derived from the OWAS.
15	Schneider, S. et al.,1994.	Investigation of health hazards in a new construction
16	Mattila M. et al.,1993.	Evaluations of various tasks such as roof boarding, concrete form preparation, clamping support braces, assembling roof frames, roof joisting, shelter form preparation and fixing fork clamps using the OWAS method.
17	Kivi P., Mattila M.,1991.	Use of the OWAS method to analyse work postures in building construction.

3. Materials and Methods

3.1. Data Availability

The data was gathered by observing the scaffolding activities in the "Package-2 Construction of Amur Gas Processing Plant" project. Permissions were obtained from the company, and photographs were taken of the postures of the scaffolding workers. Ten different scaffolding equipment and postures were examined in the study. According to the calculations made for the project, it is estimated that scaffolding will be erected over an area of 319674 square meters and a volume of 603294 cubic meters.

3.2. Participant Selection and Data Observations

In the project, 500 workers are employed in the scaffolding group. These workers have been observed working at 5210 different points on the refinery construction site, and 2000 photographs of their activities have been taken.

The behaviors of the scaffolding workers during the scaffolding installation were observed in various areas of the refinery site over three months. Worker postures related to the installation of the same scaffolding parts were taken as the basis. In refinery construction projects, there is a high circulation of workers. This study considered the same tasks performed by the same workers. The workers' behaviors and postures were observed from a distance without interfering with their tasks.

3.3. OWAS Analysis

Every conceivable back, arm, and leg posture adopted by workers during their tasks was investigated and standardized as 'OWAS Working Postures,' depicted in Figure 1. In back postures, 4 codes are used; in arm postures, 3 codes; and in leg postures, 7 codes are used. Also, three codes are used for loading. The final scores obtained from the table of action categories for different posture combinations assist in determining the action states in Table 2.

BACK POSTURES	Code 1  The condition where the angle between the shoulders and hips, as well as the line angle between the hip-leg and head, is less than 20 degrees.	Code 2  The forward and backward bending of the upper extremities at an angle of 20 degrees or more.	Code 3  The twisting or lateral bending of the back at an angle of 20 degrees or more.	Code 4  The bending and simultaneous rotation of the back.
ARM POSTURES	Code 1  Arms are completely below the level of the shoulders.	Code 2  Any arm being above or at the same level as the shoulders.	Code 3  Both arms are above shoulder level or at the same level.	
LEG POSTURES	Code 1  Supporting the body's weight above the hips.	Code 2  The knee angle is less than 150 degrees and the body's weight is supported on two straight legs.	Code 3  The knee angle is less than 150 degrees with weight supported on any straight leg	Code 4  The bending of both knees is less than 150 degrees with the body weight distributed on both legs due to the bending of the knees.
	Code 5	Code 6	Code 7	

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	 The knee angle is less than 150 degrees and the bending of the knee is accompanied by weight bearing on any leg.	 Kneeling on one or both knees.	 The mobility of the worker around the working environment.
LOAD	Code 1	The lifted load or required force is 10 kg or less.	
	Code 2	The load or required force is more than 10 kg but less than 20 kg.	
	Code 3	The load or required force exceeds 20 kg.	

Figure 1. Typical occupational stances utilized in the OWAS approach [39,40].

Table 2. Action Categories for Determined Different Posture Combinations [39,40].

Back	Arm	1			2			3			4			5			6			7			Leg
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	Load
1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1	
	2	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1	
	3	1	1	1	1	1	1	1	1	1	2	2	3	2	2	3	1	1	1	1	1	2	
2	1	2	2	3	2	2	3	2	2	3	3	3	3	3	3	3	2	2	2	2	3	3	
	2	2	2	3	2	2	3	2	3	3	3	4	4	3	4	4	3	3	4	2	3	4	
	3	3	3	4	2	2	3	3	3	3	3	4	4	4	4	4	4	4	4	2	3	4	
3	1	1	1	1	1	1	1	1	1	2	3	3	3	4	4	4	1	1	1	1	1	1	
	2	2	2	3	1	1	1	1	1	2	4	4	4	4	4	4	3	3	3	1	1	1	
	3	2	2	3	1	1	1	2	3	3	4	4	4	4	4	4	4	4	4	1	1	1	
4	1	2	3	3	2	2	3	2	2	3	4	4	4	4	4	4	4	4	4	2	3	4	
	2	3	3	4	2	3	4	3	3	4	4	4	4	4	4	4	4	4	4	2	3	4	
	3	4	4	4	2	3	4	3	3	4	4	4	4	4	4	4	4	4	4	2	3	4	

Corrective actions to be taken concerning the task and workplace according to the action code are shown in Table 3.

Table 3. Action States in the OWAS Methodology [39,40].

Action Code	Action State	Explanation

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AC1	Harmless normal posture for the musculoskeletal system.	No action is required.
AC2	Postures with some harmful effects on the musculoskeletal system.	Corrective actions should be taken in the near term.
AC3	Posture with harmful effects on the musculoskeletal system.	Corrective actions should be implemented promptly.
AC4	Postures with severe effects on the musculoskeletal system.	Corrective actions must be applied urgently.

4. Application of Analyses

In our study, workers' postures in scaffolding installation activities were analyzed using the OWAS method, and the distributions of MSDs were analyzed with the Pearson correlation test.

4.1. Application of OWAS

In the refinery, the team of scaffolders, one of the workers, consists of 500 skilled employees. Activities such as assembling equipment, painting, insulation work, electrical installations, and pipe engineering are conducted throughout the construction phase, necessitating, and employing various scaffolding types. This study has documented the postures of dock workers at the site using photographic techniques. Eight unique postures were assessed, as outlined in Figure 2. Activity A1 involves assembling lateral elements; Activity A2 pertains to making pier landing ladders; Activity A3 concerns the assembly of working platforms; Activity A4 entails putting together guardrails; Activity A5 includes making toe boards; Activity A6 covers the assembly of face braces; Activity A7 is about gathering base jacks; and Activity A8 involves putting together pipe clamped supports. Equipment weights are 4.37 kg for A1 equipment, 40.28 kg for A2 equipment, 13.03 kg for A3 equipment, 11.82 kg for A4 equipment, 4.08 kg for A5 equipment, 6.94 kg for A6 equipment, 4.7 kg for A7 equipment, and 2.16 kilograms of A8 equipment.

A1	A2	A3	A4
			
A5	A6	A7	A8

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Figure 2. Working Postures.

The postures of the eight activities observed and depicted in scaffolding installation activities at the refinery construction site have been evaluated using OWAS tables. 2000 pictures observed and taken on-site have been examined. It has been observed that the eight assessed activities have the same postures in scaffolding installation activities. The evaluation results are shown in Table 4.

Table 4. Scaffolding Installation Activity OWAS Evaluation Result.

Equipment	Back Score	Arm Score	Leg Score	Load Score	Action Code
A1	Code 4	Code 2	Code 6	Code 1	AC4
A2	Code 2	Code 3	Code 7	Code 3	AC4
A3	Code 4	Code 2	Code 7	Code 2	AC3
A4	Code 2	Code 1	Code 5	Code 2	AC3
A5	Code 4	Code 1	Code 6	Code 1	AC4
A6	Code 3	Code 2	Code 3	Code 1	AC1
A7	Code 2	Code 2	Code 4	Code 1	AC4
A8	Code 4	Code 2	Code 7	Code 1	AC2

4.2. Application of Pearson's Correlation Coefficient

During the observations with the OWAS method, MSDs among the workers in the scaffolding group were monitored through doctor records. The number of workers in the 18-25 age group is 125, in the 26-35 age group is 112, in the 36-45 age group, it is 136, and in the 46 and over age group, there are 127 workers. The number of workers with MSDs according to age groups and the total absenteeism days are provided in Table 5.

Table 5. Age Group and MSDs.

Age Group	Number of workers	Number of workers with MSDs	Absenteeism (days)
18-25	125	15	32
26-35	112	13	26
36-45	136	24	56
46+	127	31	58

Different correlation methods are available for the analysis of data [41]. In our study, the Pearson correlation statistical methods have been used. Pearson's correlation coefficient measures the linear

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relationship between two variables, as shown in Table 6. It is the most used method when both variables are continuous and the relationship between them is assumed to be linear [42].

Table 6. Pearson's Correlation Coefficient.

Variables	Pearson's Correlation Coefficient (r)	P Value
Age Group - MSDs	0,895	0,105
Age Group - Absenteeism (Days)	0,866	0,134
MSDs - Absenteeism (Days)	0,954	0,046

According to the values obtained for age group and MSDs, it has been observed that the number of workers experiencing MSDs tends to increase with age, and this relationship is quite strong. The correlation between age group and absenteeism (days) shows that with the increase in age groups, the number of absenteeism days also tends to increase, and this relationship is strong. There is a robust positive correlation between MSDs and absenteeism (days). This indicates a direct and substantial relationship between the increase in the number of workers with MSDs and the increase in the number of absenteeism days. This robust correlation is observed among the relationships examined and suggests a direct and strong link between MSDs and absenteeism.

5. Discussion

During scaffolding assembly, workers are exposed to various risk factors. The workers' medical records were examined, and an assessment was made according to Pearson's correlation statistical method. The evaluation, based on the reports given by the doctor, considered MSDs and absenteeism according to age. Pearson's correlation showed a significant relationship between the workers' ailments and scaffolding assembly. Consequently, in our study, the postures of the scaffolding workers were analyzed using OWAS, one of the ergonomic risk assessment methods. The evaluation results concluded that the assembly of A1, A2, A5, and A7 equipment resulted in 'postures with severe effects on the musculoskeletal system' and that 'Corrective actions must be applied urgently.' For the assembly of A3 and A4 equipment, it was found necessary to implement 'Posture with harmful effects on the musculoskeletal system' and 'Corrective actions should be implemented promptly.' The assembly of A8 equipment concluded, 'Postures with some harmful effects on the musculoskeletal system' and 'Corrective actions should be taken in the near term.' For A6 equipment, it was observed that no action was taken. According to the OWAS results, the "Scaffolding Installation Activity Action State and Explanation" is shown in Table 7.

Table 7. Scaffolding Installation Activity Action State and Explanation.

Equipment	Action Code	Action State	Explanation
A1	AC4	Postures with severe effects on the musculoskeletal system.	Corrective actions must be applied urgently.
A2	AC4	Postures with severe effects on the musculoskeletal system.	Corrective actions must be applied urgently.
A3	AC3	Posture with harmful effects on the musculoskeletal system.	Corrective actions should be implemented promptly.

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A4	AC3	Posture with harmful effects on the musculoskeletal system.	Corrective actions should be implemented promptly.
A5	AC4	Postures with severe effects on the musculoskeletal system.	Corrective actions must be applied urgently.
A6	AC1	Harmless normal posture for the musculoskeletal system	No action is required.
A7	AC4	Postures with severe effects on the musculoskeletal system.	Corrective actions must be applied urgently.
A8	AC2	Postures with some harmful effects on the musculoskeletal system.	Corrective actions should be taken in the near term.

The OWAS risk assessment results particularly indicate the necessity for improvements in the handling and assembly of equipment A1, A2, A3, A4, A5, and A7. Workers involved in scaffolding installation were observed and depicted at different points of the refinery site, and it was noted that they exhibited similar postures. Based on the evaluation results, the following regulatory and preventive improvements have been implemented in the refinery construction:

On-site scaffolding equipment handling began utilizing machinery such as cranes and tractors, significantly reducing manual transport.

*Scaffolding parts were stored closer to the assembly area, ensuring adequate space.

*The material management system was revised, and workers were trained accordingly.

*Particularly for the assembly of A1, A2, A3, A4, A5, and A7 equipment, younger workers were employed.

*Workers started receiving practical training on correct postures and ergonomics related to manual handling.

*Scaffolding materials were positioned as close to waist level as possible. Materials that needed to be placed below or above waist level were arranged to be light and easy to grasp.

*Appropriate clothing was provided for workers, supporting the weight through friction between clothing and load.

*Obstacles restricting workers' movements in the work environment were removed.

*Housekeeping and waste management plans and procedures were revised.

*Work organization was improved for rotational work and frequent rest breaks.

*Health monitoring intervals for workers were increased. MSDs among scaffolding team members began to be closely monitored.

*Adequate lighting was ensured for night work.

* Workers were ensured to perform physical exercises before starting work.

* Procedures were developed to reduce stress in the working environment.

* Suitable personal protective equipment was provided for workers.

* Manual handling tasks were assigned to workers considering criteria such as age, physical ability, and health status.

*Vulnerable groups, like workers who had suffered from herniated discs in the past, were not assigned to strenuous manual handling tasks.

*Job organizations and Job Safety Analysis (JSA) were done according to workers' skills.

* Workers' participation was ensured in decision-making related to job organization.

*More than one worker was assigned to manual handling tasks that a single person could not perform.

After the improvements were implemented, clear improvements in the workers' postures at the refinery construction site were observed. Health reports were revisited for the same three-month period. The report resulting from the preventive and corrective actions is shown in Table 8.

Table 8. Age Group and MSDs After Improvements.

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Age Group	Number of workers	Number of workers with MSDs	Absenteeism (days)
18-25	125	8	13
26-35	112	9	15
36-45	136	14	28
46+	127	19	33

As a result of the improvements, reductions were achieved in the MSDs of scaffolding workers and their periods of disability. It has been concluded from the on-site improvements that many actions, apart from corrective measures like proper posture training, should be included in the OWAS ergonomic risk assessment. The OWAS method does not consider factors such as the ages of the workers, the physical characteristics of the workers and the load, the frequency of exposure to the load, and the distances of transport.

6. Conclusion

Large projects like refinery construction, scaffolding erection, and dismantling activities are essential for continuing other processes. When examining medical records, it has been observed that there is absenteeism among scaffolding group workers due to MSDs. According to Pearson's analysis, it has been noted that as age increases, so does the number of workers experiencing MSDs, and the increase in the number of workers with MSDs is directly related to the increase in the number of absenteeism days. To find a quick solution without disrupting the process progression in refinery construction, the simple observation based OWAS method has been beneficial. Despite its shortcomings, the OWAS method has revealed that most of the activities in scaffolding erection are risky. Our ergonomic analysis of working postures in scaffold assembly using OWAS revealed that current postural loads may harm the musculoskeletal system and that corrective measures should be taken as soon as possible.

This study emphasizes the importance of ergonomic risk assessments in the construction industry, particularly for scaffolding activities in refinery construction environments. It was found that scaffolding tasks are prone to high ergonomic risks, primarily due to awkward postures, repetitive movements, and excessive force application.

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