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Research Article

Ergonomic Risk Assessment of Warehouse Workers in the Courier Service Industry: A Case Study from Kuantan, Malaysia

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ABSTRACT

The global surge in demand for courier services has introduced both benefits and challenges. Courier workers face immense pressure to handle large volumes of orders, leading to increasing cases of health and occupational injuries. The lack of ergonomic interventions in their work highlights the urgent need for ergonomic assessments in the courier industry. In Malaysia, current ergonomic risk assessments for warehouse courier workers are insufficient, making it essential to identify prevalent musculoskeletal disorders (MSDs) and determine the associated risk factors and levels posed by their daily tasks. This study aimed to address this gap by conducting ergonomic risk assessments among 35 warehouse workers using the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ), the Initial Ergonomic Risk Assessment (ERA) Checklist, and Rapid Entire Body Assessment (REBA). Three different work tasks were observed: scanning and sorting, tiered storage and stacking, and load unloading. The findings revealed that lower back pain was the most common ailment (14.5%), followed by hip pain (8.39%) and neck pain (7.89%). The tiered stacking storage activity posed the highest ergonomic risk, with identified risk factors including awkward postures, static and sustained activity, and repetitive tasks. The REBA analysis indicated a very high-level risk for tiered stacking storage, necessitating immediate ergonomic interventions. These findings contribute to the field of ergonomics and provide valuable insights for safety practitioners, ergonomists, researchers, and academicians in occupational safety and health and the courier service industries.

Keywords: manual handling, ergonomic risk assessment, musculoskeletal disorders, courier service, warehouse activities

INTRODUCTION

E-commerce has become the choice of consumers because of its convenience and ease of access due to digital growth. Since the COVID-19 pandemic outbreak, e-commerce has become a necessity for online shopping communities [1]. The growth of e-commerce has created a spike in demand for courier services worldwide. Statistics provided by The Services Producer Price Index (SSPI) show that transportation of courier service activities increased from 1.4% to 1.9% in the second quarter of 2020, marking a 0.5% increase from the previous year [2]. In 2022, the National Occupational Accident and Disease Statistics revealed a considerable rise in Occupational Musculoskeletal Disease cases, increasing by roughly 35.5% from 2021 to 2022 [2]. The manufacturing and service sectors reported the highest number of occupational diseases, especially in jobs requiring workers to perform manual tasks repeatedly over long periods, resulting in multiple health issues and injuries [3]-[5]. In Malaysia, the incidence of occupational diseases among service workers, including those in the courier industry, notably increased in mid-2020. This spike was linked to a substantial 60% rise in parcel volume during the festive season, which led to overworked courier service workers [2]. Research by Abu Hanifah et al. [5] highlights that ergonomic risk factors such as awkward postures, repetitive motions, and forceful exertions significantly contribute to the occurrence of musculoskeletal disorders (MSDs),

adversely affecting workers' health in manual handling activities. These findings stress the urgent need for ergonomic interventions to mitigate these risks and improve working conditions in these sectors.

Warehousing activities are a crucial component of the courier service industry, alongside receiving, sorting, and delivery sectors [6]. Industrial observations and reviews from various sources indicate that tasks such as scanning, tiered stacking storage, and loading packages are predominantly conducted in the courier warehouse sector. Research indicates that warehouse workers have a high likelihood of experiencing MSDs due to these conditions [3], [4], [6]. During scanning activities, for example, workers need to scan packages to categorize them before placing them on the racking system, all of which are performed manually. A notable difference exists between regional and main warehouses. Regional warehouses, typically smaller and equipped only with conveyers, differ from the main warehouses, which have more machinery to assist workers [5], [6]. This disparity means that workers in regional warehouses often handle more packages manually. As a result, various sources report that workers who repeatedly perform manual tasks such as sorting, tiered stacking, and loading over extended periods experience significant discomfort, issues, and injuries [5]-[7]. Several studies have found that courier workers frequently suffer from MSDs, especially in the lower back, neck, and shoulders, due to the physically demanding nature of their work [5], [7]-[9]. Additionally, Chen et al. [10] have shown that courier workers are exposed to significant safety and health risks due to the increasing intensity of labor. During the COVID-19 pandemic, it was revealed that 37% of courier workers reported suffering from musculoskeletal issues such as aches and pains [8].

Silve et al. [11] undertaken in Brazil during the pandemic confirms that postal service workers were among the most affected by work-related illnesses or incidents. Using motion capture, they observed the most affected body part was the shoulder, cervical, and lower back. Similar findings in a study back in 2015, researcher used Nordic Musculoskeletal Questionnaire and found that the worker's lower back had the highest prevalence of MSDs [5]. In a similar work condition of sorting, tiered stacking and loading activities in a warehouse industry, their findings also demonstrated similar ergonomic issue of musculoskeletal discomfort and MSDs was prevalent among warehouse workers due to increased workload and repetitive manual handling [3], [4], [11]-[13].

MSDs injuries would require recovery periods for a person to fully healed and back to work, depending on the scale of the injury as well as the body healing process. For an example, the recovery period for a spinal disc injury varies depending on the severity and treatment 14]. Generally, conservative treatments like rest, physiotherapy, and pain management may take several weeks to months for a noticeable improvement. Diving deeper from the tip of the iceberg, a spinal disc injury can significantly affect a person's life since it may limit a person's mobility, causing chronic pain, generally affects their daily activities. Impacts on the physiology was also proven by multiple studies, where anxiety and depression are a common condition among patients with back injuries due to physical limitations and changes in their lifestyle [14], [15]. Over the last decade, health-related studies on individuals with spinal cord injuries had been proved that the ability for the individuals to engage in daily participatory practices and decision-making are diminished due to the physical constraints, as well as their psychological, social and environmental constrains, leading to a rising trend of post-traumatic stress symptoms and depression [15].

In the effort to implement ergonomic interventions to reduce and prevent courier workers from MSDs and other injuries, ergonomic assessments need to be conducted to highlight the presence of ergonomic risk factors and its risk level. Ergonomic risk factors are a commonly known concepts that can define the number of injuries and incidents that is caused by a certain exposure. Jaffar et al., [16] stated that the primary ergonomic risk factors are repetition, awkward posture, forceful exertions, static and sustained work posture, and environments of the area. Observations by multiple researchers proved that exposure to these risk factors could be taken as an early warning of increasing problems – physical signs and symptoms which can lead to serious injuries if left unnoticed [16], [17]. Identified ergonomic risk factors from the assessments can reduce the probability of musculoskeletal injuries if diagnosed early. However, if the symptoms were ignored and workers were kept exposed to those risks, the pain or ache accumulated will form an obstacle to a fully functioning human capabilities, meaning that the body will be unable to perform its capabilities, reducing the quality of life of a person for a long time [17].

In Malaysia, the Department of Safety and Health (DOSH) published the Guidelines of Ergonomic Risk Assessment at Workplace in 2017, which outlines various ergonomic assessment tools and methods suitable for specific risk

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factors [18]. Recent enforcement by DOSH mandates that every organization in Malaysia must comply with the Guideline of Occupational Safety and Health on Ergonomic Risk Assessment 2017. This includes the mandatory Initial ERA (Ergonomic Risk Assessment) checklist analysis. The Initial ERA process involves identifying pain or discomfort through self-assessment questionnaires, such as the Nordic Musculoskeletal Questionnaire (NMQ) and the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ), depending on the suitability of the assessment. Following the self-assessment, the initial ERA includes an observational analysis based on nine risk factors: awkward posture, static and sustained posture, forceful exertions, repetitive motions, vibration, temperature, lighting, noise, and environment. Each analyzed and scored risk factor is summarized in a standardized checklist table [18].

Despite the enforcement of these guidelines, previous literature in similar working populations has yet to utilize the Initial ERA tool developed by DOSH Malaysia to assess ergonomic risks in the workplace. This gap is particularly evident in the courier service industry, which still lacks comprehensive studies in ergonomic assessments. The absence of ergonomic risk assessments among courier workers in Malaysia underscores the need for such studies. Therefore, this study is essential to contribute to the courier service industry in Malaysia by identifying ergonomic risk factors among warehouse workers and ensuring compliance with legal requirements in the current economy. Therefore, this study aimed to investigate the ergonomic risk factors, assess the prevalence of musculoskeletal disorders and the ergonomic risk level among warehouse workers in the courier service industry.

To highlight the presence of risk factors among warehouse courier workers, this study proposes a comprehensive ergonomic assessment. The assessment begins with reviewing existing workplace data, such as injury reports, absenteeism records, and other documentation of unwanted events. From these reviews, high-risk work activities will be identified, enabling a focused ergonomic intervention to reduce the likelihood of musculoskeletal disorders (MSDs). By conducting a comprehensive ergonomic assessment, this study will identify specific risk factors faced by warehouse workers, providing a foundation for data-driven interventions. This detailed identification will help understand the root causes of MSDs and develop proper intervention to reduce MSDs. By aligning with the Guidelines of Ergonomic Risk Assessment at Workplace 2017 published by DOSH, the outcomes of this study are expected to aid courier service organizations in complying with legal requirements.

METHODS

Study Design

The data for this study was collected during the ongoing COVID-19 pandemic. In early April 2022, Malaysia began transitioning to an endemic phase after several phases of Movement Control Order (MCO) to control the rise in COVID-19 cases. With the assistance of courier authorities, warehouse workers aged between 18 and 60, involved in warehousing activities, with over a year in the industry and no past medical conditions, were identified to address potential biases. Before the survey commenced, participants were briefed on the study's purpose and the necessity of the survey. They were then given consent forms to sign, confirming their agreement to participate. The questionnaire was distributed to all selected participants, resulting in a 100% response rate. Ethical approval for the methodology was obtained from the university's ethics committee, which operates in accordance with the Declaration of Helsinki (reference no. IIUM/504/14/11/2/IREC 2022-212).

Field observations and surveys were conducted at a courier service industry facility in Kuantan, Pahang (East Coast Malaysia). Information related to musculoskeletal disorder (MSD) symptoms in nine body parts (neck, shoulders, elbows, wrists/hands, upper and lower back, hips, knees, and ankles/feet) was collected using the self-assessed Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) [19]. Through observation analysis, the Initial ERA checklist from the guidelines on Ergonomics Risk Assessment at Workplace 18] was used to identify the ergonomic risk factors associated with each work task in the courier warehouse.

The Rapid Entire Body Assessment (REBA) was employed in this study to evaluate the ergonomic risk level among 35 warehouse workers [20]. REBA is a well-established observational method that systematically identifies potential ergonomic issues and prioritizes actions to mitigate the risk of work-related musculoskeletal disorders (MSDs). This method assesses both upper and lower extremities simultaneously, providing a comprehensive view of ergonomic

risks in the workplace. The selection criteria ensured that all 35 warehouse workers had no reported history of work-related medical conditions. This precaution aimed to eliminate potential confounding variables and enable a clearer assessment of how the current work environment impacts the prevalence of MSDs. By utilizing REBA and maintaining strict inclusion criteria regarding workers' medical histories, this study aimed to provide accurate insights into ergonomic risks and their impact on warehouse workers' health in the context of their daily tasks. These methods and criteria enhance the study's validity and reliability, contributing to a more robust understanding of ergonomic challenges in the courier service industry.

Tasks Description

A The selection of tasks for this study was guided by the Guideline on Occupational Safety and Health in the Courier Service Industry in Malaysia [6], combined with field observations aimed at identifying prevalent musculoskeletal disorder (MSD) symptoms and ergonomic risk levels reported by warehouse operators. Before participating in the survey and during observations, interviews were conducted with the operators to gather insights. Based on this information, three specific tasks were chosen: scanning and sorting items, tiered storage and stacking, and loading and unloading to and from courier vehicles.

To capture a detailed understanding of these tasks, video cameras were used to record the activities in real-time. This method allowed for precise observation and analysis of ergonomic factors such as posture, repetitive motions, and force exertion during each task. By integrating guidelines, field observations, operator interviews, and video recordings, the study aimed to comprehensively assess the ergonomic risks associated with these critical warehouse activities in the courier service industry.

According to the Guidelines of Occupational Safety and Health in the Courier Service Industry [6], the workflow for courier service activities begins with customer pickup and concludes with delivery. This industry, characterized by its labor-intensive nature, necessitates a substantial workforce to manage the meticulous tasks involved. These activities predominantly entail manual handling, including lifting, carrying, pushing, pulling, and handling items of varying weights and sizes, thereby requiring force exertion in virtually every movement. These conditions are widely recognized as the primary contributors to work-related musculoskeletal disorders (MSDs) and injuries [20]-[22]. The repetitive and physically demanding nature of these tasks places significant strain on workers' musculoskeletal systems, particularly in the upper limbs, shoulders, and lower back. The Guidelines highlight the importance of ergonomic interventions to mitigate these risks, emphasizing the need for proper training, ergonomic equipment, and adherence to safe lifting techniques to protect workers' health and safety in the courier service industry.

Work Task A – Scanning and Sorting

The sorting department plays a crucial role in the operations of courier service industry warehouses. Warehouse operators engage in activities where they scan package barcodes before arranging them on the racking system, a process known as palletizing. These packages are sorted based on location, customer, type of items, and storage duration [6]. Figure 1 illustrates the scanning and sorting activities involved in work task A, requiring workers to predominantly stand with statically positioned legs while moving their upper bodies to twist and bend down to reach items. This task necessitates frequent bending as workers scan items, organize them into rack trolleys, and twist their bodies accordingly.

The duration of this activity is directly proportional to the number of items scanned and sorted into rack trolleys, with more items translating to longer working hours spent on this task. Such repetitive movements and static postures are recognized contributors to musculoskeletal disorders (MSDs) among workers in similar industries [20], [21]. Therefore, understanding and mitigating ergonomic risks associated with these tasks are essential to safeguarding the health and well-being of warehouse operators in the courier service industry.

Work Task B – Tiered Storage and Stacking

Figure 2 illustrates the execution of work task B within the courier service industry warehouse setting. This task involves arranging loose items and packages onto a tiered storage pallet, following precise schedules and locations

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Figure 1. Work Task A – Scanning and Sorting

for subsequent distribution [6]. According to the Malaysian Occupational Safety and Health (OSH) Guideline on the Courier Service Industry, warehouse workers are recommended to utilize lifting equipment such as forklifts, reach trucks, and stackers to facilitate the handling and arrangement of packages efficiently. However, in practice, manual handling and heavy lifting by manpower are predominant for this task.

During this activity, warehouse operators bend their backs to access lower platforms at mid-lower leg and knuckle heights, using a hugging motion to hold and maneuver items into the stacking storage. This manual handling process involves significant ergonomic risks, particularly due to the handling of large, fragile, and heavy items [6], [20]. Such tasks are known to increase the likelihood of musculoskeletal disorders (MSDs) among workers, emphasizing the critical need for ergonomic assessments and interventions to minimize injury risks associated with these manual handling activities in the courier service industry.

Work Task C – Loading and Unloading

Loading and unloading activities represent pivotal processes within the warehouse department, as depicted in Figure 3. This essential task involves unloading parcels or packages from collection vans or lorries. Both drivers and warehouse operators are responsible for this task, requiring them to unload packages from vehicles, stack them onto racking trolleys, and deliver them to the conveyor system. Throughout this cycle, workers repetitively bend their bodies to access packages within vehicles, lift and carry items at chest level for stacking, a task associated with documented complaints of back pain due to repetitive loading on their backs [6].

Figure 2. Work Task B – Tiered Storage and Stacking

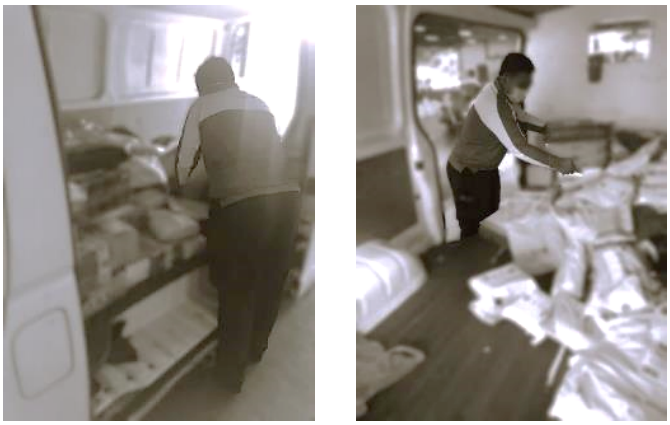

Figure 3. Work Task C – Loading and Unloading

Following sorting based on customer requirements, the packages are loaded onto lorries for delivery by transportation workers assigned to regional service areas. Interviews and observations conducted with both warehouse operators and delivery personnel provide insights into their tasks and ergonomic challenges [6]. This comprehensive approach allows for a thorough understanding of the ergonomic risks associated with loading and unloading activities in the courier service industry. Identifying these risks is crucial for implementing targeted ergonomic interventions aimed at reducing musculoskeletal disorders and improving workplace safety and efficiency.

Data Collection Instruments

Cornell Musculoskeletal Discomfort Questionnaire (CMDQ)

The survey employed in this study included socio-demographic segments and a 54-item self-administered questionnaire designed to assess musculoskeletal discomfort among participants [19]. This questionnaire included a body-map diagram and inquiries regarding the prevalence of pain, ache, or discomfort across twenty different body regions experienced during the previous working week.

To quantify musculoskeletal discomfort, the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) scoring guideline was utilized [19]. Respondents reported the frequency of discomfort on an ordinal scale: 'Never' (scored as 0), '1 or 2 times/week' (scored as 1.5), '3 or 4 times/week' (scored as 3.5), 'every day' (scored as 5), or 'several times every day' (scored as 10). Each frequency score was multiplied by a severity rating ('slightly uncomfortable' = 1, 'moderately uncomfortable' = 2, 'very uncomfortable' = 3) and an interference rating ('not at all' = 1, 'slightly interfered' = 2, 'substantially interfered' = 3). The resulting total discomfort score provided a weighted assessment of musculoskeletal discomfort levels experienced by participants during their work activities. This methodology allowed for a comprehensive evaluation of musculoskeletal health among warehouse workers in the courier service industry, offering insights into the prevalence and severity of discomfort across various body regions and guiding potential interventions to improve workplace ergonomics and reduce occupational health risks.

Initial Ergonomic Risk Assessment (ERA) Checklist

The Initial Ergonomic Risk Assessment (ERA) checklist, as outlined in the Guideline of Ergonomic Risk Assessment at the Workplace [18], serves as a critical tool in this study. It successfully achieves both objectives: identifying ergonomic risk factors and determining the associated risk levels. Utilizing established ERA principles and procedures, the Initial ERA was conducted following numerous complaints received from respondents during interviews and through the CMDQ self-assessment survey. Observations focused on three specific tasks, with checklists completed based on these observations. Subsequently, the Initial ERA results were analyzed to determine which tasks required further assessment through the Advanced ERA, as advised in the Malaysian ERA guidelines [18]. According to these guidelines, specific minimum scores indicate when an Advanced ERA is necessary:

- Awkward posture: Score of six and above

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- Static and sustained work posture: Score of one and above
- Forceful exertion: Score of one and above
- Repetitive motion: Score of one and above
- Vibration: Score of one and above
- Lighting, temperature, ventilation: Score of one and above
- Noise: Score of one and above

These criteria ensure that tasks exhibiting significant ergonomic risks are subjected to a more detailed assessment to refine workplace interventions and enhance ergonomic conditions for warehouse workers in the courier service industry.

Rapid Entire Body Assessment (REBA)

The Rapid Entire Body Assessment (REBA) is a well-established ergonomic tool designed to assess worker posture across various body regions, including the neck, back, arms, wrists, and feet [23]. It systematically evaluates static postures, repetitive movements, external forces, and duration of work to identify potential musculoskeletal issues [23], [24]. This observational method combines individual body region scores to calculate Scores A (trunk, neck, and leg scores plus load/force) and Scores B (upper and lower arm and wrist scores plus coupling factors). The final REBA score, incorporating activity factors, determines the overall risk level associated with the assessed posture.

The REBA scores are categorized into five risk levels:

- Scores 1: Minimal risk (Negligible)
- Scores 2-3: Low risk (Changes may be required)
- Scores 4-7: Moderate risk (Investigate further)
- Scores 8-10: High risk (Investigate and implement changes)
- Scores 11 and above: Very high risk (Immediate change required)

This method provides a comprehensive framework for assessing and prioritizing interventions to mitigate work-related musculoskeletal problems in various workplace settings, including the courier service industry. By identifying and addressing high-risk postures, organizations can proactively improve ergonomic conditions, thereby enhancing worker health, safety, and productivity.

RESULT AND DISCUSSION

Demographic Data

Table 1 presents the 35 respondents, who were comprised of 35 people of different ages, body mass index values (BMI), work activities, past occupational disease histories and work experience. Based on Table 1, the respondents fell into four age ranges: 20-30 years old, 31-40 years old, 41-50 years old, and over 51 years old. The highest percentages were in the 21-30 and 31-40 age ranges, both of which contained 40% of the respondents. The third most common age range was 41-50 years old, which comprised 17.14%. The smallest group of respondents was those aged 51 years old and above, who comprised 2.86% of the respondents.

The BMI values were divided into four categories: underweight (<18.5), normal (18.5 < 25), overweight (25.0 < 30), and obese (>30.0). According to Table 1, most respondents (47.5%) had normal BMI values. The second largest BMI range was overweight, which made up 34.29% of the respondents, and only a few respondents (2.86%) were underweight. The tasks carried out by most respondents (54.3%) were loading and unloading activities. About 37.1% of the respondents performed scanning and sorting tasks, while 8.6% performed tiered storage and stacking. Of the 35 respondents, 31.4% had a past medical history of work-related issues, and the other 68.6% had no related medical history. Lastly, the warehouse operators' years of work experience in the industry were divided into five categories: 1-5 years, 6 - 10 years, 11- 15 years, 16 - 20 years and more than 21 years. Table 1 shows that the largest work experience category was '1 to 5 years', which applied to 42.86% of the respondents, followed by the '6 to 10 years'

Table 1 Demographic data of 35 Respondents from the Warehouse Department

Characteristics	Frequency (n)	Percentage (%)
Age (years)		
20-30	14	40
31-40	14	40
41-50	6	17.1
50 and above	1	2.9
Gender		
Male	35	100
Female	0	0
Body mass index (kgs/m²)		
Underweight (<18.5)	1	2.9
Normal (18.5 < 25)	16	45.7
Overweight (25 < 30)	12	34.3
Obesity (>30.0)	6	17.1
Work experience (years)		
1-5	15	42.9
>5 - 10	9	25.7
>10 - 15	3	8.6
>15 - 20	7	20.0
Medical History (Y/N)		
Yes	11	68.6
No	24	31.4
Main Task		
Scanning and sorting	13	37.1
Tiered storage and stacking	3	8.6
Loading and unloading	19	54.3

category, which only takes about 25.7%. Meanwhile, the third largest category was the work experience range of 11 to 15 years, which comprised 20% of the respondents.

The warehouse population were predominantly in the "20 – 40 years old" group (80%), followed by those in the "41 – 50 years old" group. Previous studies have highlighted that age significantly influences the severity of musculoskeletal disorders, where human functional capacity begins to decline with age, primarily affecting physical abilities notably, this decline becomes more pronounced after the age of 45 [25]-[27]. It was proved that workers aged 40 to 60 would experience 20% reduction in their work capacity [28]. This age-related decrease in work capacity forces workers to operate closer to their maximum limits, placing them to higher risk of developing musculoskeletal disorders.

Body Mass Index (BMI) is a critical factor influencing MSD prevalence. Among the male warehouse operators, 45.7% were found to be normal in terms of body mass index (BMI), and 34.3% were overweight. In this study, normal-weight individuals had lower MSD rates compared to overweight and obese individuals, who showed a drastic increase in lower back pain prevalence. This finding is consistent with existing research indicating a higher BMI exacerbates physical strain and the risk of MSDs [27], [28]. Viestar et al., [29] proven that obesity is associated with musculoskeletal symptoms, particularly in the lower extremity, therefore supports the statement of normal weighted employees had lower risk for developing MSDs symptoms compared to obese employees.

This study has found that there are no similar patterns were identified among workers with different working period of industrial work experience. Workers with shorter tenure (one to five years) reported higher lower back

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discomfort, compared to those with longer tenure experienced discomforts. Indicating that the cumulative effect of prolonged physical workload correlate with increased MSD symptoms. Unlike the previous findings, the length of working time appears to be an important predictor in identifying MSDs, correlating of longer work experience with increased MSD symptoms [5], [30], [31]. This finding proves that work experience does not really affect MSDs prevalence, because in an increasingly demanding industry, high workload inherently poses significant physical and mental stress regardless of the duration an individual has been in the job. Since excessive physical workload can be directly linked to negative health outcomes such as MSDs, which can affect both new and experienced workers alike [32], [33].

Prevalence of MSD among Warehouse Workers

The data from Table 2, sourced from the CMDQ, provides a comprehensive view of musculoskeletal disorder (MSD) prevalence among workers. It reveals that MSDs are most prevalent in the lower back (14.06%), followed by the hip/buttocks (8.39%) and neck (7.89%). In contrast, the left thigh shows the lowest prevalence at 2.44%, with the left and right forearms at 2.01% and 2.27%, respectively. The lumbar area, crucial for supporting the body and facilitating movement, registers the highest total discomfort score percentage. This area is particularly vulnerable during work tasks A, B, and C, which involve prolonged standing and handling packages. The multifaceted functions of the lower back, including movements such as turning, twisting, and lifting during package handling, significantly increase the risk of developing musculoskeletal issues.

The high prevalence of musculoskeletal disorders (MSDs) in the lower back among warehouse workers aligns with findings from various studies, emphasizing the significant impact of manual handling tasks on lower back health [5], [9], [34]. Abu Hanifah et al. in 2015 reported that lower back pain was the most common MSD among courier workers, affecting 60.8% of the studied population [5]. The lower back's crucial role in supporting body movements and protecting tissues makes it particularly vulnerable to strain from repetitive actions such as lifting, twisting, and bending. Workers often experience discomfort and pain when they exceed their body's endurance limits, particularly during prolonged standing and high-workload tasks involving frequent turning, twisting, lifting, and bending [3],

Table 2 Total Discomfort Score of MSD

Body parts	Frequency	Discomfort	Interference	Discomfort Score	Percentage (%)
Lower back	95	63	66	395010	14.06
Hip/Buttocks	65.5	60	60	235800	8.39
Neck	65.5	58	59	224141	7.98
Right Knee	61	57	59	205143	7.30
Upper Back	65	51	55	182325	6.49
Right foot	52.5	49	55	141487.5	5.04
Left Shoulder	48.5	52	56	141232	5.03
Right Upper arm	54	46	54	134136	4.77
Left foot	49.5	48	56	133056	4.74
Left knee	46	49	56	126224	4.49
Right shoulder	44	49	57	122892	4.37
Left lower leg	39.5	47	56	103964	3.70
Left upper arm	40.5	48	53	103032	3.67
Right lower leg	38	46	57	99536	3.54
Left wrist	41	43	55	96965	3.45
Right thigh	38.5	45	53	91822.5	3.27
Right wrist	34.5	45	54	83835	2.98
Left thigh	28.5	43	56	68628	2.44
Left forearm	25.5	48	52	63648	2.27
Right forearm	23.5	48	50	56400	2.01

[4], [9], [35]. These factors significantly contribute to MSD issues, particularly in the lower extremities. This correlation is supported by a study that identified a 24% prevalence of low back pain among young warehouse workers engaged in intensive sorting tasks [35].

In An Initial ERA is required if discomfort or pain is identified on the self-assessment survey or if a probable risk exists based on the professional judgement of a trained person after they receive an MSD-related complaint from an employee or as requested by the Occupational Health Doctor (OHD) or other relevant authorities under DOSH and Social Security Organisation (SOCSO). Table 3 shows the initial ERA checklist for all task. The results reveal that in scanning and sorting tasks (Task A), three ergonomic risk factors warrant further assessment using advanced ERA tools: static and sustained working postures, forceful exertion, and repetitive motions. However, factors like awkward posture and environmental conditions did not meet the criteria for advanced ERA evaluation. Workers reported discomfort in their necks, lower backs, and hips/buttocks due to these identified risks. For Tiered Stacking and Storage (Task B), four risk factors require advanced ERA assessment: awkward posture, static and sustained working postures, forceful exertion, and repetitive motions. These factors are particularly prevalent in tasks involving repetitive lifting and carrying of large or heavy items. Conversely, factors such as vibration and environmental risks did not meet the threshold for advanced assessment. Workers in Task B reported discomfort and pain in their necks, shoulders, lower backs, and hips/buttocks areas due to these identified risks. For Loading and Unloading (Task C), three risk factors were identified for advanced ERA: static and sustained work posture, forceful exertion, and repetitive motion, as their score has met the minimum requirement for an advanced ERA. Conversely, other risk factors, such as awkward posture, vibration, and environmental risks, scored below the threshold for further assessment. The workers' discomfort at the neck, lower back, and knees can be attributed to the risk factors revealed in the MSD assessment, emphasising the importance of addressing these ergonomic concerns to enhance workplace conditions.

The analysis from the Initial Ergonomic Risk Assessment (ERA) highlighted significant musculoskeletal disorder (MSD) risks associated with specific tasks in the warehouse courier industry. During scanning and sorting tasks, workers often assume bending postures, known to contribute to neck and shoulder issues. This corresponds with research linking bending and twisting movements to lower back pain (LBP) due to strain on the lumbar region [9], [11]. Tasks involving tiered storage and stacking exhibited the highest risk factors, including awkward postures, repetitive motions, and forceful exertions. These factors are widely recognized contributors to MSDs in environments where manual material handling is prevalent [5], [34], [36]. The repetitive actions of lifting and bending in these tasks place significant strain on both the lower and upper back, leading to fatigue and potential injury when workers surpass their physical capabilities [11], [13], [37]. These findings are consistent with studies across various professions, such as warehouse roles, where workers face similar MSD risks due to the physical demands of repetitive lifting and handling [3], [4]. This consistency underscores the critical need for ergonomic interventions to mitigate these risks effectively.

Table 3. Initial ERA Checklist for Warehouse Work Tasks

Risk Factor	Minimum requirements for Advance ERA	Result of Initial ERA (Need Advance ERA if "YES")		
		Task A	Task B	Task C
Awkward posture	≥ 6	3	6 (YES)	3
Static and sustained work posture	≥ 1	2 (YES)	1 (YES)	1 (YES)
Forceful exertion	1	1 (YES)	2 (YES)	1 (YES)
Repetitive motion	≥ 1	2 (YES)	3 (YES)	2 (YES)
Vibration	≥ 1	0	0	0
Lighting	1	0	0	0
Temperature	1	0	0	0
Ventilation	1	0	0	0
Noise	≥ 1	0	0	0

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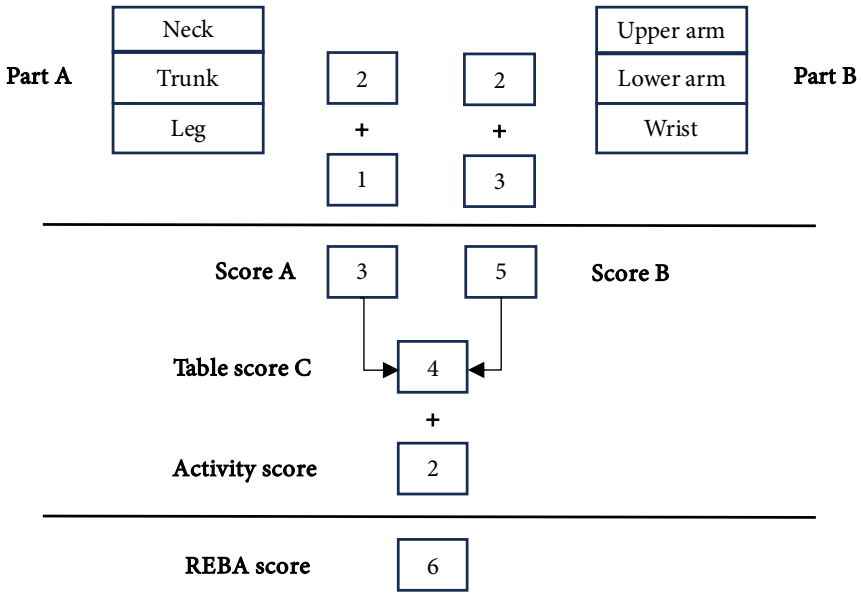
Figure 4. The worker's posture in Work Task B

Figure 4 illustrates the work posture for tiered storage and stacking (Task B), and Figure 5 provides the REBA scoring sheet analysis. According to the REBA worksheet, the neck position scores 2 points due to flexion greater than 20°. The trunk position scores 3 points for a 50° flexion, with an additional point for a slight bend, totaling 4 points. The legs' position scores 1 point, with the knees bent between 30° and 60°, adding another point for a total of 2. Additionally, the worker is handling a load exceeding 10 kg, resulting in a load/force score of 2. This score is then combined with the Group A score, which includes the neck, trunk, and legs' scores, leading to the final Score A calculation.

Group B analyzes the upper arms, lower arms, and wrists. The worker's upper arm is flexed between 45° and 90°, earning 3 points. The lower arms score 1 point as they are flexed between 80° and 100°. The wrist is extended and



Group A		Group B	
1. Neck position score	: 2	1. Score of the upper arms motion	: 3
2. Trunk position score	: 4	2. Score of the lower arms motion	: 1
3. Legs/feet position score	: 2	3. Score of the wrist motion	: 2
4. Load/force score	: 2	4. Coupling score	: 3

Figure 5. REBA score sheet

flexed at 15° from the midline, adding 1 point. The object carried by the workers in Figure 4 lacks handles, making it unsafe to hold, which adds a coupling score of 3 points to Score B. Combining these factors, Score C totals 10. This includes the activity score, which accounts for the rapid changes in posture shown in Figure 4, with some body parts held in position for more than 1 minute, adding another 2 points. The resulting REBA score is 12, indicating an action level of 4, which signifies a very high risk of injury and necessitates immediate change.

Although similar ergonomic issues have been identified for other tasks, however, workers involved in tiered stacking storage tasks face the most significant ergonomic risks which further highlighted the severity of these risks. The current study found that the overall REBA score for task B, tiered stacking storage, was 12, indicating an Action level of 4, which necessitates immediate intervention. The main contributors to the very high-risk levels among workers involved in task B were manual handling activities, such as lifting and carrying items. These tasks require workers to bend their backs to lift items from below knee level, putting the lower back at high risk [38]. Previous research has found similar results, with assessments in the warehouse department of a manufacturing industry also indicating a very high-level risk of injury [13]. This consistency across studies underscores the urgent need for ergonomic interventions in tiered stacking storage tasks.

CONCLUSION

This study revealed that the most affected body parts among the workers were the lower back, hip area, and upper neck, with a particularly high prevalence of MSDs in the lower back. Consequently, the study objectives were achieved, confirming the lower back as the most prevalent MSD among warehouse courier workers. The Initial ERA analysis identified several risk factors across all warehousing tasks, including static and sustained work postures, repetitive motion, and forceful exertion. Additionally, tiered stacking storage tasks also presented an awkward posture risk factor. The checklist score from the Initial ERA indicated the necessity for an Advanced ERA for tiered stacking storage activities. The REBA analysis for Task B classified the warehouse workers' posture as very high-risk. These findings underscore the urgent need for immediate interventions and changes. The courier service industry should improve warehouse working conditions, especially in anticipation of increased demand leading to more repetitive lifting and bending. The insights from this study can help mitigate possible risk factors in the warehouse sector and assist courier service organizations in complying with the legal requirements of DOSH Malaysia. This study effectively identifies the most affected body parts among warehouse workers, emphasizing the need for advanced ergonomic risk assessment. While the findings provide crucial insights for warehouse courier workers, they also have broader implications for warehouse safety and health. The results highlight the pressing need for interventions to improve working posture and reduce ergonomic-related injuries. Future research should focus on evaluating the effectiveness of these interventions and exploring additional strategies for mitigating ergonomic risks in similar work environments. By addressing these areas, organizations can enhance working conditions, design, and management practices, ultimately ensuring the safety, health, and welfare of employees across various industries.

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CONFLICT OF INTEREST

The author declares that there are no conflicts of interest regarding the authorship or publication of this research.

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