ORIGINAL ARTICLE

Ergonomic Hazard Identification, Risk Assessment, and Control in Fish Landing Operations in Kuantan, Pahang, Malaysia

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ABSTRACT

Background: The Malaysian fishing industry is worth approximately RM11.5 billion annually and employs over 153,461 workforces. Despite its significant contribution to local livelihood and national economic growth, working in this industry is considered high-risk due to the physically demanding nature of the work, heavy workload, and long working hours, which contribute to a high incidence of occupational injuries and illnesses reported globally. To date, the role of ergonomics in addressing these safety and health issues among workers on fishing vessels has been well documented. However, there is still limited data on ergonomic issues available at the fish landing jetty, particularly in Malaysia. Hence, this study aimed to identify the ergonomic hazards associated with fish landing operations and evaluate their risks and control measures at the Fisheries Development Authority of Malaysia (LKIM) Kuantan Complex, Pahang. **Methods:** A systematic Hazard Identification, Risk Assessment, and Risk Control (HIRARC) analysis of fish landing operations was conducted based on the Department of Occupational Safety and Health (DOSH) guidelines. Walk-through observation, face-to-face interviews with workers and employers, and consultations with experts were conducted to gain insights into ergonomic issues faced by the target population. **Results:** A total of 25 ergonomic hazards were identified, of which 56% were classified as high risk with high priority for intervention. The packing catch was identified as the most ergonomically hazardous task within fish landing operations, attributed to extensive lifting, pushing, and pulling of heavy loads. Although ergonomic controls were in place, they were inadequate. **Conclusion:** The findings suggest ergonomic risks are prevalent among the fish landing workers. Therefore, a task-specific ergonomic risk assessment is necessary before improving control measures.

INTRODUCTION

The fishing industry is complex and highly diverse, encompassing small-scale traditional to large-scale commercial fishing operations. Similarly, the workforce is equally varied, which includes artisanal and commercial fishers, fish processing and fish landing workers, and boat or fishing vessel owners. Despite its significant contribution to local livelihood and national economic growth of many countries, working in this industry is considered high-risk. It is widely recognised as one of the most hazardous sectors, contributing to a high incidence of occupational injuries and illnesses reported globally (Frantzeskou et al., 2016; Eckert et al., 2018; Olapade et al., 2021; Barrow et al., 2022; Shrestha et al., 2022; Halder et al., 2024; Venugopal et al., 2024).

Previous studies have reported that fisheries workers are exposed to various types of hazards, such as slips, trips, and falls on wet and slippery surfaces, which can lead to common injuries, including sprains, strains, bruises, fractures, cuts, and lacerations (Zytoon & Basahel, 2017). Other than physical hazards, the workers are also exposed to ergonomic hazards due to the physically demanding nature of the work, heavy workload, and long working hours (Falcão et al., 2015; Berg-Beckhoff et al., 2016). Fatigue, sleep disorders and work-related musculoskeletal disorders (WMSDs) are some of the outcomes from prolonged work under unfavourable ergonomic settings (Dabholkar et al., 2014; Laraqui et al., 2022; Eckert et al., 2018; Olapade et al., 2021; Laraqui et al., 2022; Fulmer et al., 2017; Mohammed Emran et al., 2023; Halder et al., 2024).

An ergonomic hazard is any workplace condition that can cause harm to the musculoskeletal system. Ergonomic risk refers to the likelihood that exposure to such hazards will result in injury, depending on the intensity, frequency, and duration of exposure (DOSH, 2017; Centers for Disease Control and Prevention, 2024). Several ergonomic risk factors (ERFs) are widely recognised as contributors to WMSDs, including awkward and static postures, forceful exertions, repetitive movements, and vibration. The presence of multiple risk factors simultaneously can

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increase the probability and severity of injury (DOSH, 2017; Centers for Disease Control and Prevention, 2024). For instance, among traditional fishermen, professional fishers, and crew vessels, it has been determined that the main factors contributing to the high prevalence of WMSD are monotonous work operations, repetitive tasks, excessive force, and poor ergonomic postures (Fulmer et al., 2017; Sandsund et al., 2019; Emran et al., 2023).

To date, the role of ergonomics in addressing these safety and health issues among workers on fishing vessels has been well documented. However, there is still limited data on ergonomic issues available at the fish landing jetty, particularly in Malaysia. Considering the significant contribution of the fishing industry to job opportunities, the national economy, and food security, occupational safety and health issues are a growing concern that warrants urgent attention and targeted interventions. Hence, this study aims to identify the ergonomic hazards associated with fish landing operations and evaluate their risks and control measures at the LKIM Kuantan Complex, Pahang.

MATERIALS AND METHODS

Study Design

A semi-quantitative research design was employed, incorporating a walk-through risk assessment and supplementary interviews to contextualize findings. This study has received ethical approval from the Kulliyyah Postgraduate and Research Committee (KAHS 45/24) and IIUM Research Ethics Committee (IREC) (IREC 2024-196).

Study Area and Population

This study was conducted at the LKIM Kuantan Complex in Pahang, Malaysia, which serves as a primary landing site for commercial fishing vessels around Kuantan. Approximately 400workers, including fishermen, jetty workers, and fishing vessel owners, were involved in the fish landing operations at this jetty.

Instrumentation and Assessors

The HIRARC followed the Guidelines for Hazard Identification, Risk Assessment, and Risk Control (2008) established by the Department of Occupational Safety and Health (DOSH), Malaysia. The DOSH HIRARC form was adopted with minor modifications. Two trained assessors conducted the HIRARC, following guidance from supervisors and a HIRARC-trained trainer, who had also observed the job tasks on site. A pilot study was conducted to ensure the reliability of the risk rating between assessors prior to commencing the primary study.

Data Collection and Analysis

Step 1: Classification of job task

A job task was defined as a specific activity carried out by fish landing jetty workers, starting from the arrival until the departure of the fishing vessels. Through the walkthrough observation, all main and sub-tasks of the jetty operations were recorded. Additional information about the tasks was obtained through direct interviews with the workers. The recorded sub-tasks were then classified based on phases in the work process and the regularity of job tasks (i.e. routine, non-routine, and ad hoc).

Step 2: Hazards identification

For each routine sub-task, all ergonomic hazards that could pose risks to the safety and health of fish landing workers were systematically identified through site observations, photographs, and field notes. Additional explanations and clarification were obtained through face-to-face interviews with employers and workers during on-site inspections to ensure a comprehensive understanding of these hazards.

Step 3: Risk assessment

For each hazard, ergonomic exposures (i.e. awkward postures, forceful exertions, repetitive motions, static/sustained postures, and vibration) and their potential injuries were identified. Risk levels were determined based on: (1) Likelihood of a hazardous exposure, and (2) Severity of potential health impacts from exposure. The relative risk (R) scores were then calculated by multiplying the “Likelihood” (L) and “Severity” (S) indexes. A risk matrix was used to estimate the outcome risk level and to determine the appropriate action plan (Figure 1). In this matrix, green indicates a non-significant risk with no priority, yellow indicates a significant risk with medium priority, and red represents a significant risk with high priority for intervention.

Step 4: Risk controls

The existing controls for each identified hazard were recorded, and their efficiencies were evaluated based on previous experience, consultations with experts, and insights from relevant literature. Recommended controls were suggested according to the hierarchy of controls.

Likelihood / Severity	1 (Negligible)	2 (Minor)	3 (Major)	4 (Fatality/Catastrophic)
4 (Very likely)	4	8	12	16
3 (Likely)	3	6	9	12
2 (Unlikely)	2	4	6	8
1 (Highly unlikely)	1	2	3	4

Figure 1: Risk matrix

Statistical Analysis

Inter-rater reliability for pilot study risk ratings was assessed using Cohen's kappa coefficient in SPSS version 29. The analysis followed McHugh's (2012) benchmarks, with a Cohen's kappa (κ) value of 0.80 or above considered the acceptable inter-rater reliability. For categorical data, descriptive analysis was performed to summarize ergonomic risk levels across fish landing tasks.

RESULTS

Inter-Rater Reliability Analysis

The pilot study demonstrated strong inter-rater reliability (Cohen's κ = 0.87). According to McHugh (2012), this value indicated *'almost perfect'* agreement, confirming high reliability and consistency of the assessment methodology for the subsequent analyses.

Description of Main and Sub-Tasks

Fish landing operations at the LKIM Kuantan Complex in Pahang were classified into five main tasks, each comprising several sub-tasks (Figure 2). The operation commenced with the transfer of catches from the vessel to the jetty, involving four sub-tasks. This was followed by the sorting of catches, which comprised three sub-tasks, and subsequently, the weighing procedure, which consisted of four sub-tasks. Once weighing was completed, the operation proceeded to the packing process, encompassing nine sub-tasks, the highest number among all stages. The final stage of the operation was the transportation of catches from the packing to the distribution area, involving five sub-tasks.

Relative Risk Level Across Main Tasks

Overall, a total of 25 hazards related to ergonomic risk were identified (Figure 3). Of these, 56% (n = 14) were categorised as high risk and 44% (n = 11) as medium risk. Across the identified main tasks, packing catch was reported as the most hazardous during fish landing operations, accounting for the highest percentage of ergonomic hazards with high R (n = 5, 20%), which requires high priority for intervention. This was followed by sorting and weighing tasks. In contrast, transferring and transporting catches had a higher number of medium (n = 3, 12%) than high (transferring: n = 1, 4%; transporting: n = 2, 8%) R hazards with medium priority for intervention.

Figure 2: The flow of main tasks of the fish landing operations at LKIM Kuantan Complex

Further details of the HIRARC results for each main task are presented in the subsequent sections.

Task 1 - Transferring catches

Four hazards were identified during the transfer of catches from the fishing vessel to the jetty (Table 1). Controlling the rope to transfer the baskets onto the jetty posed the highest relative risk (R = 9) despite using a power-assisted manual hoist. This is because this task involved repetitive pulling of the hoist rope in awkward postures for at least two hours cumulatively. Prolonged and repeated forceful exertion increases the risk of WMSDs, particularly affecting the back, shoulders, arms, and wrists. To mitigate this, a manual rope should be replaced with a mechanical winch to eliminate risk exposure.

Task 2 - Sorting catches

The sorting catches had the fewest identified hazards (n = 3, 12%) compared to other main tasks (Figure 3). Despite the low number of hazards, this task presented high ergonomic risks (R = 9) with high priority for intervention due to the inadequacy of the existing controls (Table 2). For instance, using a rope as an extended handle can minimise excessive bending when transferring heavy baskets to the sorting table. However, pulling the baskets, especially those without wheels, requires backward arm extension and high-forceful exertion, increasing the physical strain compared to pushing. In addition, the absence of mechanical aids caused the workers to manually lift baskets exceeding 60 kg from the floor to the shoulder-height sorting table. Other than engineering controls, proper lifting/pushing techniques, task rotation, and breaks during the sorting catches may reduce physical strain and fatigue among the workers.

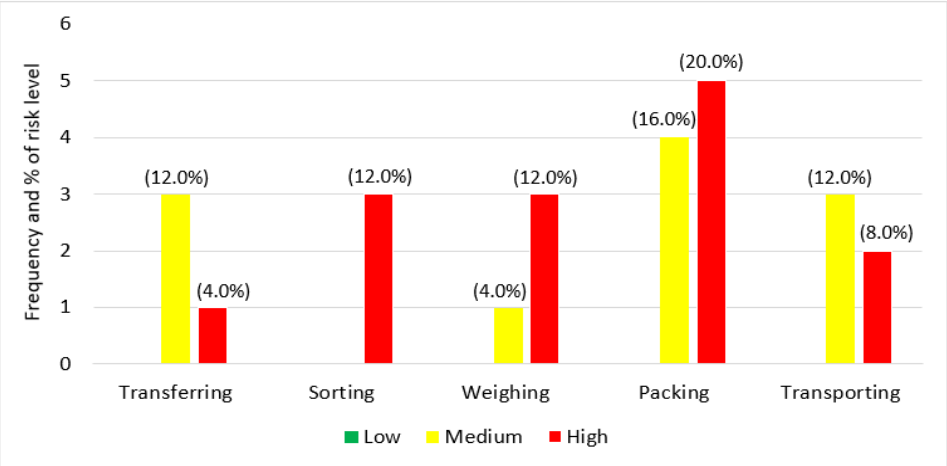

Figure 3: Overall relative risk across tasks at the LKIM Kuantan Complex

Table 1: HIRARC of transferring catches

Hazard Identification	**Risk Assessment**						**Risk Control**
Sub Task	**Ergonomic Exposure**	**Potential Health Impact**	**Existing Control**	**L**	**S**	**R**	**Recommended Control**
Transfer drums from storage room to deck	• AP • FE	Back/shoulder discomfort	Power-assisted manual hoist	3	2	6	• **Administrative:** When pushing hoist-supported drum, keep feet/shoulders aligned with push direction to prevent body twisting • **PPE:** Anti-slip gloves
Push drums to spill catches into baskets	• AP • FE • RM	Back/shoulder discomfort	Team pushing (2 workers)	3	2	6	• **Engineering:** Use hoist-assisted pouring • **Administrative:** Two-person push: face direction with straight back, coordinate with "1-2-3-push" command
Attach hoist hook to baskets	• AP	Lower back discomfort	None	3	1	3	• **Engineering:** Use an extended hook • **Administrative:** Squat (knees bent, back straight) to attach hook
Control hoist rope to transfer baskets onto jetty	• AP • FE • RM	Back/shoulder /arm/wrist strain/fatigue	Power-assisted manual hoist	3	3	9	• **Engineering:** Replace manual rope with mechanical winch • **Administrative:** Rotate operators every 15 mins

AP: Awkward Postures; FE: Forceful Exertions; RM: Repetitive Motions; L: Likelihood; S: Severity; R: Relative Risk (L×S)

Table 2: HIRARC of sorting catches

Hazard Identification	Risk Assessment						Risk Control
Sub Task	**Ergonomic Exposure**	**Potential Health Impact**	**Existing Control**	**L**	**S**	**R**	**Recommended Control**
Pull baskets from jetty to sorting area (<20 m)	• AP • FE • RM	Back/shoulder /arm/wrist strain	Rope	3	3	9	• **Engineering:** Install wheeled basket trolley with ergonomic handle • **Administrative:** Two-person push: face direction with straight back, coordinate with "1-2-3-push" command
Lift and tilt baskets from floor onto sorting table	• AP • FE • RM	Back/shoulder /arm/wrist strain	Team lifting (2 workers)	3	3	9	• **Engineering:** Use hydraulic lifter • **Administrative:** Two-person lift: squat with straight back, coordinate with "1-2-3-lift" command
Sort catches into basket while standing (>2 hrs continuously)	• AP • RM • SSP	Neck/back/ feet strain/ fatigue	None	3	3	9	• **Engineering:** Install height-adjustable sorting table • **Administrative:** Mandatory 5-min breaks every 30 mins; Task rotation hourly

AP: Awkward Postures; FE: Forceful Exertions; RM: Repetitive Motions; SSP: Static/Sustained Postures; L: Likelihood; S: Severity; R: Relative Risk (L×S)

Task 3 - Weighing catches

Table 3 summarises the HIRARC findings of the weighing catches, identifying four ergonomic hazards related to lifting, pushing, and pulling full-load baskets. Lifting baskets weighing up to 68 kg onto a weighing scale or trolley posed a high relative risk (R = 9), which was higher than arranging (pulling) the baskets (R = 6). Although both sub-tasks were performed by teams of two workers, the lifting task performed exceeded the recommended weight limit, increasing the risk of injury. To reduce risks, a wheeled basket trolley with ergonomic handles, hydraulic lifter, can promote proper team manual handling.

Table 3: HIRARC of weighing catches

Hazard Identification	Risk Assessment						Risk Control
Sub Task	**Ergonomic Exposure**	**Potential Health Impact**	**Existing Control**	**L**	**S**	**R**	**Recommended Control**
Pull baskets from sorting area to weighing area	• AP • FE • RM	Back/shoulder /arm/wrist strain	Hook	3	3	9	• **Engineering:** Install wheeled basket trolley with ergonomic handle • **Administrative:** Two-person push: face direction with straight back, coordinate with "1-2-3-push" command
Lift baskets onto weighing scale	• AP • FE • RM	Back/shoulder /arm/wrist strain	Team lifting (2 workers)	3	3	9	• **Engineering:** Use hydraulic lifter • **Administrative:** Two-person lift: squat with straight back, coordinate with "1-2-3-lift" command
Arrange baskets at designated area	• AP • FE • RM	Back/shoulder /arm/wrist discomfort	Hook, team pulling (2 workers)	3	2	6	• **Engineering:** Install wheeled basket trolley with ergonomic handle • **Administrative:** Two-person push: face direction with straight back, coordinate with "1-2-3-push" command
Lift baskets onto trolley	• AP • FE • RM	Back/shoulder /arm/wrist strain	Team lifting (2 workers)	3	3	9	• **Engineering:** Use hydraulic lifter • **Administrative:** Two-person lift: squat with straight back, coordinate with "1-2-3-lift" command

AP: Awkward Postures; FE: Forceful Exertions; RM: Repetitive Motions; L: Likelihood; S: Severity; R: Relative Risk (L×S)

Task 4 - Packing catches

Packing catches recorded the highest number of ergonomic hazards across various sub-tasks analysed (Table 4). Over half of the hazards posed high ergonomic risks (R = 9), indicating this task is complex and labour-intensive. Like other main tasks, packing catches workers posed ergonomic risks such as prolonged awkward postures, excessive forceful exertions, and repetitive lifting. These risks were more substantial, as the packing workers must manually lift and lower full-loaded iceboxes weighing up to 140 kg. Using a forklift reduces the relative risk of transferring iceboxes from the shredded ice collecting area to the packing area (R = 3). However, it potentially introduces whole-body vibration, possibly contributing to WMSDs if not correctly managed. In addition, considering the weight, the current practice of a team lifting a 140 kg icebox, is unsafe and must be prohibited to protect workers' health and safety. The use of a hydraulic lifter or forklift, along with proper training, is strongly recommended.

Table 4: HIRARC of packing catches

Hazard Identification	Risk Assessment						Risk Control
Sub Task	**Ergonomic Exposure**	**Potential Health Impact**	**Existing Control**	**L**	**S**	**R**	**Recommended Control**
Transfer baskets to packing area	• AP • FE	Back/shoulder /arm/wrist strain	Trolley	3	3	9	• **Engineering:** Maintain trolley wheels regularly • **Administrative:** Two-person push: face direction with straight back, coordinate with "1-2-3-push" command; Ensure loads within safe weight limits
Unload baskets from trolley onto floor	• AP • FE • RM	Back/shoulder /arm/wrist strain	Team lifting (2 workers)	3	3	9	• **Engineering:** Use hydraulic lifter • **Administrative:** Two-person lift: squat with straight back, coordinate with "1-2-3-lift" command; Tilt-and-slide techniques
Transfer iceboxes from ice area to packing area	• AP • FE	Back/shoulder /arm/wrist strain	Trolley	3	3	9	• **Engineering:** Use forklift • **Administrative:** Two-person push: face direction with straight back, coordinate with "1-2-3-push" command; Ensure loads within safe weight limits
Transfer iceboxes from ice area to packing area	• WBV	Back/buttocks /hips discomfort	Forklift	3	1	3	• **Administrative:** Designate smooth transport pathways; OSHA-certified forklift training
Unload iceboxes from trolley onto floor	• AP • FE • RM	Back/shoulder /arm/wrist strain	None	3	3	9	• **Engineering:** Use hydraulic lifter • **Administrative:** Prohibit manual lifting; Tilt-and-slide techniques
Prepare plastic wrappers	• AP	Back discomfort	2 workers	3	1	3	• **Administrative:** Squat with straight back to avoid bending
Fill ice/salt solution into iceboxes using bucket	• AP • FE • RM	Back/shoulder /arm/wrist discomfort	None	3	2	6	• **Administrative:** Reposition bucket at waist height, use two-handed pouring; Mandatory 5-min breaks every 30 mins
Transfer catches from baskets into iceboxes	• AP • FE • RM	Back/shoulder /arm/wrist strain	Team lifting (2 workers)	3	3	9	• **Engineering:** Use hydraulic lifter • **Administrative:** Two-person lift: squat with straight back, coordinate with "1-2-3-lift" command
Tie plastic wrappers and cover iceboxes	• AP • RM	Back discomfort	None	3	1	3	• **Administrative:** Mandatory 5-min breaks every 30 mins

AP: Awkward Postures; FE: Forceful Exertions; RM: Repetitive Motions; WBV: Whole-Body Vibration; L: Likelihood; S: Severity; R: Relative Risk (L×S)

Task 5 - Transporting catches

Five ergonomic hazards were identified during the transport of catches from the packing area to the distributing area (Table 5). Manually lifting iceboxes onto the trolley and transferring them to the truck posed significant ergonomic risks (R = 9) due to awkward postures, forceful exertions, and repetitive movements. Consistent with findings from the packing task, manual handling of fully loaded iceboxes should be considered only as a last resort, even when performed by teams. Using a hydraulic lifter or forklift is highly recommended to eliminate manual handling risks. Additional controls include minimising repetitive push/pull motions and utilising anti-slip gloves to reduce strain and secure grip.

Table 5: HIRARC of transporting catches

Hazard Identification	Risk Assessment						Risk Control
Sub Task	**Ergonomic Exposure**	**Potential Health Impact**	**Existing Control**	**L**	**S**	**R**	**Recommended Control**
Lift iceboxes onto trolley	• AP • FE • RM	Back/shoulder /arm/wrist strain	Team lifting (2 workers)	3	3	9	• **Engineering:** Use hydraulic lifter/ forklift • **Administrative:** Prohibit manual lifting
Transfer iceboxes from packing area to truck	• AP • FE	Back/shoulder /arm/wrist strain	Trolley	3	3	9	• **Engineering:** Use forklift • **Administrative:** Two-person push: face direction with straight back, coordinate with "1-2-3-push" command; Ensure loads within safe weight limits
Transfer iceboxes from packing area to truck	• WBV	Back/buttocks /hips discomfort	Forklift	3	1	3	• **Administrative:** Designate smooth transport pathways; OSHA-certified forklift training
Control hoist rope to transfer iceboxes onto truck	• AP	Shoulder/arm /wrist discomfort	Overhead hoist crane	3	1	3	• **Administrative:** Communicate clearly with crane operator via hand signals (no direct hand contact)
Arrange the iceboxes on the truck	• AP • FE • RM	Back/shoulder /arm/wrist discomfort	None	3	2	6	• **Administrative:** Two-person push: face direction with straight back, coordinate with "1-2-3-push" command; Mandatory 5-min breaks every 30 mins • **PPE:** Anti-slip gloves

AP: Awkward Postures; FE: Forceful Exertions; RM: Repetitive Motions; WBV: Whole-Body Vibration; L: Likelihood; S: Severity; R: Relative Risk (L×S)

DISCUSSION

Ergonomic Hazards and Health Impacts

The fish landing operation at the LKIM Kuantan Complex, involved five main tasks, each comprising varying number of sub-tasks, ranging from as few as three (i.e. sorting) to as many as nine (i.e. packing). This variation reflects the complexity and diversity of activities involved in each stage of the fish landing operation, highlighting the need for a task-specific assessment and targeted control strategies.

Previous HIRARC studies in Malaysia found that fishermen were highly exposed to ergonomic hazards compared to other types of hazards (i.e. physical, chemical, and biological hazards) (Saiful et al., 2020; Saadon et al., 2023). The present study further supports these findings in which most of the identified ergonomic hazards were classified as high- and medium-risk. These risks are primarily attributed to manual handling activities such as lifting, pushing, and pulling loads from the arrival to the catch distributing areas, which similarly impose extensive physical demands on fishermen in India, Norway, and Bangladesh (Dabholkar et al., 2014; Sandsund et al., 2019; Halder et al., 2024).

The present study identified packing catches as the most hazardous task in fish landing operations, with the highest percentage of identified ergonomic hazards with high relative risks. Based on the present review of the literature, this study is the first to highlight this issue in Malaysia, which can be attributed to several key factors Firstly, the packing process involves multiple labour-intensive steps, from preparing iceboxes with shredded ice to transferring fully loaded iceboxes to the distributing areas. These activities are not only physically demanding but also involve a heavy workload to complete. Based on the interviews, workers typically start work as early as 2.30 AM and finish by late morning or afternoon on a typical workday. However, during the peak season, when multiple fishing vessels land with large marine catches, workers extended their shifts until evening or even late at night. The number of iceboxes packed daily varied depending on the company/fishing vessel size and was significantly higher during peak seasons. Previous studies have reported that high work demands, long working hours, or a combination of both are well-established risk factors for increased fatigue (Dabholkar et al., 2014), musculoskeletal disorders (MSDs) (Falcão et al., 2015; Berg-Beckhoff et al., 2016; Eckert et al., 2018; Mohammed Emran et al., 2023), osteoarticular pathologies (Mansi et al., 2019), and sleep disorders (Eckert et al., 2018; Olapade et al., 2021; Laraqui et al., 2022) among the fishing industry workers.

Secondly, packing catches involves a significant number of lifting and/or lowering tasks of different types (i.e. baskets, buckets, and iceboxes) and weights (i.e. 15 – 140 kg) of containers. Similar to most of the other main tasks, lifting occurs at low working heights (i.e. between mid-lower leg to elbow) and is often carried out by a team of two workers. Due to constrained working spaces caused by stacked iceboxes, baskets, and unattended trolleys, packing workers often lift and/or lower loads with bent and twisted body postures. Repetitive exposure to such awkward body posture during lifting and/or lowering imposes excessive strain, especially on the lower back and upper limbs, which can eventually lead to development of WMSDs among fishery workers (Dabholkar et al., 2014; Fulmer et al., 2017; Sandsund et al., 2019; Mohammed Emran et al., 2023; Patel & Ghosh, 2023; Halder et al., 2024).

In addition to body posture, the weight of the loads is a key factor contributing to the high relative risk of lifting and/or lowering activities during fish landing operations. For example, during the packing task, a full basket of catches, approximately 68 kg, is lifted from mid-lower leg to elbow height and poured into an icebox. Each packing process typically requires transferring two baskets and takes around five to ten minutes per icebox to complete. This sub-task is performed repeatedly at a frequency of two lifts every five minutes (about 24 lifts per hour) by two workers under postural constraints. Packing more than 30 iceboxes per day is common, resulting in approximately 60 heavy lifting tasks daily. This sub-task clearly exceeds safe manual lifting limits despite workers always working in pairs.

The guidelines by DOSH (2017) and the International Organization for Standardization (2021) do not specify a single weight limit for two persons in general, but they set a 25 kg limit for individual men, provided the load is lifted between knuckle and elbow height and kept close to the body. According to the Manual Handling Assessment Charts (MAC) tool, lifting a load of less than 35 kg is considered safe for two persons. Regular lifting of loads over 50 kg every five minutes (12 lifts per hour) presents a very high level of risk, requiring immediate interventions (DOSH, 2017). Furthermore, this sub-task often includes body twisting and sideways bending, further increasing musculoskeletal injuries and lower back pain (LBP). The prevalence of LBP among fishing communities is high (Müller et al., 2022; Mohammed Emran et al., 2023) and is significantly associated with age, educational status, work experience, and body mass index (BMI) (Dienye et al., 2016; Mohammed Emran et al., 2023). Back pain primarily arises from various mechanical factors, including poor postural conditions (Patrick et al., 2014; Casiano et al., 2023), which can be managed by lifting with a straight back or using a squat technique (Nolan et al., 2018, 2020).

Thirdly, pushing and/or pulling activities during packing involve various types of loads (i.e. 60 - 400 kg), methods (i.e. with or without a trolley or forklift), and distances (i.e. 1 - 100 m). These activities can sometimes be more hazardous than the pushing and/or pulling required in other main tasks due to improper techniques and excessive weight limits. For example, during the packing task, a full-loaded trolley (i.e. stacked with baskets or iceboxes) weighing over 300 kg is commonly pushed and/or pulled by a single worker over distances exceeding 20 meters in constrained spaces. These sub-tasks are carried out repeatedly to transfer catches to the packing area and refill shredded ice from the ice crusher machine.

Although the trolleys are generally well-maintained, workers often need to overextend their arms and apply excessive force to move the heavy loads, increasing the risk of LBP and upper limb strain. According to Argubi-Wollesen et al. (2017), the cart or trolley weight is the most influential factor in reducing strain during pushing and/or pulling tasks, provided the wheels are well-maintained, as poor wheel conditions create additional resistance and increased risk of musculoskeletal injuries (Zhang et al., 2021). In addition, the handle positions should ideally range between hip to shoulder height, and the task should be performed using proper pushing and/or pulling techniques (Argubi-Wollesen et al., 2017).

High ergonomic risk related to pushing and/or pulling activities is not limited to fish landing operations. During fishing activities, fishermen frequently engage in the repetitive pulling and throwing of heavy fishing nets or pots (Dabholkar et al., 2014; Frantzeskou et al., 2016; Mohammed Emran et al., 2023). Sometimes, they must maintain their hands and body posture under physically demanding conditions on the unstable platform of fishing vessels. Working in this poor ergonomic condition can increase the risk of injury and musculoskeletal disorders, particularly in the lower back, shoulders, knees, hands, and wrists (Dabholkar et al., 2014; Mohammed Emran et al., 2023).

Recommendations for Controls

In general, the present study found that various types of controls were applied during fish landing operations, including engineering controls (e.g. hoists, forklifts), administrative controls (e.g. task rotation, irregular breaks), and personal protective equipment (PPE) (e.g. gloves, boots). Nevertheless, these controls were often inadequate, with their effectiveness influenced by two main factors: (1) Type and design of the control measures, and (2) Worker involvement and behaviour.

The availability and quality of engineering controls depend strongly on company size and resources. Larger companies can invest more in mechanical aids like forklifts, eliminating ergonomic risks associated with lifting, carrying, pushing, and lowering heavy loads. In contrast, smaller companies typically lack such equipment, exposing workers to higher musculoskeletal strain. Cart handling can also be improved through the use of ergonomically designed carts with well-maintained wheels (Argubi-Wollesen et al., 2017) and workspace improvements such as lowering ramp slopes, removing obstacles, and maintaining open spaces (Zhang et al., 2021).

Worker behaviour is also crucial in controlling effectiveness. Observations and interviews revealed inconsistent use of PPE and awareness of safe handling techniques. Improper team lifting frequently leads to instability and violations of weight regulations (Visser et al., 2014). Thus, administrative interventions are necessary, particularly regular ergonomic training. (Argubi-Wollesen et al., 2017; Zhang et al., 2021), as increasing awareness through targeted safety training has been shown to significantly improve compliance with safety practices among fishery workers (Diani Laksono et al., 2025). Promoting a strong safety culture and ensuring compliance with occupational safety standards are essential to align with Sustainable Development Goal 8, which advocates for safe and secure working environments for all.

Limitations of the Study

Firstly, this study was limited to the LKIM Kuantan Complex, which may not fully represent other fish landing sites with different layouts, equipment, or operational practices.

Secondly, this study employed a modified DOSH HIRARC form that uses a 4-point Likert scale, in contrast to the 5-point scale used in the standard DOSH version. While the exact rationale behind this modification is beyond the scope of this study, a reasonable interpretation can be made based on an understanding of HIRARC principles. For **Likelihood**, the revised matrix merges the “Remote” and “Inconceivable” categories, acknowledging that all hazards carry some probability of occurrence even if highly unlikely. For **Severity**, the revised matrix emphasizes fatal and catastrophic incidents by classifying them into a single highest category. This reflects the principle that every life is invaluable, assigning even a single fatality the maximum severity level. The use of a 4-point scale, instead of the 5-point version, simplifies assessment and improve consistency, particularly in field settings. However, it may reduce sensitivity to subtle risk differences. As a result, risk levels reported in this study may appear lower than those using the standard DOSH form, and comparisons should consider this scale adjustment.

Thirdly, this study utilized HIRARC as the primary risk assessment tool to screen for potential ergonomic hazards, serving as a preliminary step for the subsequent analysis of ergonomic risk factors and controls. Nevertheless, it is worth noting that HIRARC, while widely used in Malaysia, often functions more as a checklist-based tool rather than a detailed analytical method. While effective for general hazard identification, it lacks the quantitative precision of established ergonomic tools such as the NIOSH lifting equation, RULA and REBA. This may limit its sensitivity in identifying specific biomechanical risks, particularly in manual handling tasks. Consequently, reliance solely on HIRARC may underestimate actual ergonomic risks, potentially limiting the accuracy of the findings.

CONCLUSION

In conclusion, packing catches is considered the most hazardous task in fish landing operations. This is primarily due to its labour-intensive nature, which has the highest number of identified ergonomics hazards with high relative risks. The high ergonomic risks in packing catches originate from the sub-tasks related to lifting, lowering, pushing, and pulling loads, which are frequently performed in awkward body postures and exceeding the recommended weight limit. Although ergonomic controls are in place, they are inadequate. Previous studies have reported that poor ergonomics significantly increase the likelihood of developing WMSDs among the fisheries community. Therefore, conducting an ergonomic risk assessment of this task is necessary prior to making further improvements in task design and control strategies.

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