

Prevalence of musculoskeletal disorders among female workers in the fish processing industry in Odisha, India

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ABSTRACT

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Introduction: The fish processing industry in India has experienced significant growth in the recent years, contributing substantially to the national economy. Several tasks involved in processing are dependent on manual handling which lead to development of work related musculoskeletal disorders (wMSDs). The aim of study was to assess the prevalence of wMSDs among the female fish processing workers.

Methods: Two hundred female workers were randomly selected from three fish processing units of Mancheswar of Khurda district of Odisha. A descriptive study design was chosen, and it involved assessment of physical and demographic parameters work organization and work stress of the female workers. A modified Nordic Questionnaire was used for the assessment of pain and discomfort among the workers. The study also included posture analysis by using Rapid Upper Limb Assessment (REBA) tool. The study was carried out for ten months from February 2024 to November 2024.

Results: The female fish processing workers reported experiencing discomfort in various parts of their bodies. The risk estimates also indicated that workers performing sorting were at 3.2 times (95% CI 2.0-5.1) at higher risk of developing pain and discomfort in the upper back, 10.2 times (95% CI 4.0-26.1) in the wrist and 3.8 times (95% CI 2.1-6.7) in the finger. The RULA score for the posture practiced during sorting indicated a medium risk of MSD injury occurrence. Awkward posture increased the risk of MSD injury occurrence by 9.5 times (95% CI 2.2-11.3).

Conclusion: Female workers in the fish processing industry experience pain and discomfort. Prolonged working in static, awkward, and standing postures, along with performing repetitive jobs, increases the risk of developing work-related MSDs.

Keywords: Awkward Posture, Ergonomic risk factors, Female fish processing workers, Repetitive job, Work-related Musculoskeletal Disorders

Introduction

The fisheries and aquaculture sectors are vital drivers of global employment, and India's seafood

industry plays a significant role in this landscape. Odisha, with its extensive 480 km coastline, stands

out as a leading contributor to India's thriving seafood processing sector.¹ The division of labor typically follows gender lines, with men primarily engaged in seafood harvesting, while women are involved mainly in processing-related tasks.² The processing sector is heavily reliant on women, with over 90% of the workforce involved in shrimp peeling and 70% in the processing of other fish products being comprised of women.³ The female workers are outnumbering men in the work associated with fish processing. The majority of manual material handling tasks performed by men involve carrying fish in cartoons, thoroughly washing them in chlorine water, putting them in boxes, and using a cart to move them to cold storage.⁴ Processing involves a variety of processes, but the most common in the processing sector are freezing (71%), cutting (63%), and degutting (58%).⁵ Women in aquaculture play a crucial role in holding major activities such as processing and marketing of fish products. However, the socio-economic conditions of the workers in such factories are below International standards.⁶ Increased levels of production and processing of seafood and physical exposures differences make them victims of occupational health problems, among which Musculoskeletal disorders are a notable one, resulting in increased incompetency to work in female workers. A study highlighted a significant proportion of workers reported musculoskeletal discomfort in various body regions. Specific tasks within the industry showed varying levels of risk for WRMSDs.⁸ For instance, workers engaged in material handling tasks reported high rates of discomfort in the elbows, wrists, and hands (71.4%), along with significant neck symptoms (57.1%), indicating a higher likelihood of developing musculoskeletal disorders.⁹ One-third of all lost workday illnesses is caused by the high prevalence of Work-related musculoskeletal disorders (WMSDs). Among which WMSDs predominantly affecting the hand and wrist are associated with longer durations of work absences, resulting in a more substantial impact on productivity and wages compared to disorders in

other anatomical regions.¹⁰ The development of musculoskeletal pain is the detrimental result of poor posture adoption and repetitive strain.¹¹ A research indicated a high incidence of lower back pain, upper back pain, and hand injuries among the workers, attributing these to prolonged standing, repetitive motions, and inadequate workstation design.¹² Prolonged static postures without adequate rest intervals have been associated with increased musculoskeletal discomfort and heightened pain perception, particularly affecting the lower back, cervical and thoracic regions, as well as the wrists and fingers.¹³ The present study aimed to assess the prevalence of work-related musculoskeletal disorders and to identify the ergonomics risk factors leading to the development of MSDs among the female workers of the fish processing industry in Odisha.

Methods

Two hundred female fish processing workers were randomly selected from three fish processing industries in Mancheswar, Khurda District, Odisha. The study participants belonged to the 18-45 age group and had a minimum of one year of experience working in the fish processing industry. The data were collected over a 10-month period, from February 2024 to November 2024. Written consent was obtained from the workers before the commencement of the study. Workers with any prior non-occupational history (accident) and history of non-occupational musculoskeletal disorders (congenital conditions, age-related degeneration) were excluded from the study. The height and weight of the female workers were recorded using the Martin's Anthropometer rod and the OMRON weighing machine. The BMI of the study participants was calculated using the collected data by applying a standardized equation. A modified Nordic questionnaire was used to assess work-related discomfort and pain in various body parts.¹⁴ If the participants experience any discomfort, it would be in regions including neck, shoulders, elbows, wrists, hands, upper and lower back, hips, knees, and ankles,

along with any other related disabilities. The questionnaire was used to assess the likelihood of developing musculoskeletal disorders (MSDs) in the study participants. The questionnaire was administered in one-on-one interviews with the study participants. The Rapid Upper Limb Assessment (RULA) tool was utilized to evaluate postural discomfort among female fish processing workers in Odisha. The assessment process was conducted using digital videography, which enabled the capture of working postures. Subsequently, stick diagrams were developed based on still images extracted from the video footage. These diagrams were analyzed using Ergo Fellow 3.0, an ergonomics software developed by FBF Sistemas, Brazil. A chi-square test of independence at the chosen significance level of $p < 0.05$ was conducted to determine the

association between ergonomics risk factors, selected demographic characteristics, and work tasks and the occurrence of MSDs among female workers. The odds ratio was used to analyze the risk associated with the development of MSDs. For each task (e.g., sorting, grading, peeling, packaging), odds ratios (ORs) were calculated by comparing the odds of pain among workers engaged in the specific task to those not involved in that task. Thus, for each work task, the reference group consisted of all participants not performing that particular task. Data analysis was performed using SPSS software version 29. The ethical approval for the present study was received from the Institutional Ethical Committee (IEC) of Sri Sri University.

Results

Demographic variables related to the study population, primarily including age, height, weight, and BMI, are presented in Table 1. The

mean BMI of the female fish processing workers, as shown in the table, indicates a standard range of physiological characteristics.

Table 1: Demographics of the female Fish Processing Workers (n=200)

| Variables | Female fish processing workers (M±SD) |
|-------------------------------------|---------------------------------------|
| Age (years) | 31.57 ±4.51 |
| Height (Cm) | 170.08 ±3.27 |
| Weight (kg) | 55.37 ±1.04 |
| BMI (kg/m ²) | 19.1 ±2.45 |
| Duration of work per day (in hours) | 10±0.50 |
| Duration of rest per day (in hours) | 1 |
| No. of working days in a week | 6 |

Notes: BMI is Body Mass Index, M±SD, Mean and Standard Deviation

The fish processing workers had a poor educational background, which significantly increased the risk of MSD injury ($p=0.05$). Twenty percent of the study participants had more than 9 years of experience, as shown in Table 2. Work

experience of the female workers ($p=0.01$) has a significant effect on the occurrence of MSD injury, leading to an indication that the female workers with higher work experience are at increased risk of MSD injury.

The majority of the workers (71%) also reported repetitive motion of the body segments, particularly of hands, which increased the risk of MSD injury by 12.9 times ($p=0.02$, 95% CI 6.9-24.3). The awareness about PPE use among workers was

found to be poor (35%), which increased the MSD injury risk by 18.6 times ($p=0.01$, 95% CI 11.5-27.9). The female workers need to stand for a prolonged period, which increased the risk of MSD injury by 11 times ($p=0.0004$, 95% CI 1.9-22.0).

Table 3: Association of selected demographic factors, ergonomic risk factors with occurrence of MSD injury

| SL No. | Parameters | Category | Frequency Distribution | OR | 95% CI | P value |
|--------|--|-------------------------|------------------------|------|-----------|---------|
| 1. | Age | 18-29 | 67(34%) | - | - | 0.05* |
| | | 30-39 | 92(49%) | | | |
| | | 40-45 | 41(27%) | | | |
| 2. | Education | Primary school | 66(33%) | - | - | 0.002* |
| | | Secondary School | 56(28%) | | | |
| | | Higher secondary school | 30(15%) | | | |
| | | Illiterate | 48(24%) | | | |
| 3. | Marital Status | Married | 105(65%) | 3.5 | 2.1-7.5 | 0.03* |
| | | Unmarried | 95(35%) | | | |
| 4. | Working Experience | 1-4 years | 58(29%) | - | - | 0.01* |
| | | 5-9 years | 102(51%) | | | |
| | | >9 years | 40(20%) | | | |
| 5. | Rigidity in work methods and procedure | Yes | 140(70%) | 13.8 | 8.6-23.1 | 0.03* |
| | | No | 60(30%) | | | |
| | Work demand targets specific productivity | Yes | 160(80%) | 0.5 | 0.1-1.3 | 0.22 |
| | | No | 40 (20%) | | | |
| 6. | Use of PPE | No | 128 (64%) | 3.3 | 1.1-9.5 | 0.01* |
| | | Yes | 72(36%) | | | |
| 7. | Job demands repetitive motion of body segments | Yes | 142(71%) | 12.9 | 6.9-24.3 | 0.02* |
| | | No | 58(29%) | | | |
| 8. | Awareness about Personal Protective Devices | Yes | 70(35%) | 18.6 | 11.5-27.9 | 0.003* |
| | | No | 130(65%) | | | |
| 9. | Prolong Standing | Yes | 200(100%) | 11.0 | 1.9-22.0 | 0.0004* |
| | | No | - | | | |
| 10. | Awkward posture | Yes | 146 (78%) | 9.5 | 2.2-11.3 | 0.04* |
| | | No | 54 (22%) | | | |
| | | No | 54 (22%) | | | |

*significant at 0.05 level of significance, OR-Odds Ratio, χ^2 -Chi-Square value

According to the questionnaire, musculoskeletal discomfort was prevalent among female workers

in the fish processing industry. The majority of workers (61%) reported experiencing pain in their

lower back. The pain in the upper back was also prevalent among the female workers by 50%, neck (34%), shoulder (31%), forearm (20%), wrist (32%).

They also experienced pain in the leg region (42%) due to prolonged standing during work, as shown in Figure 1.

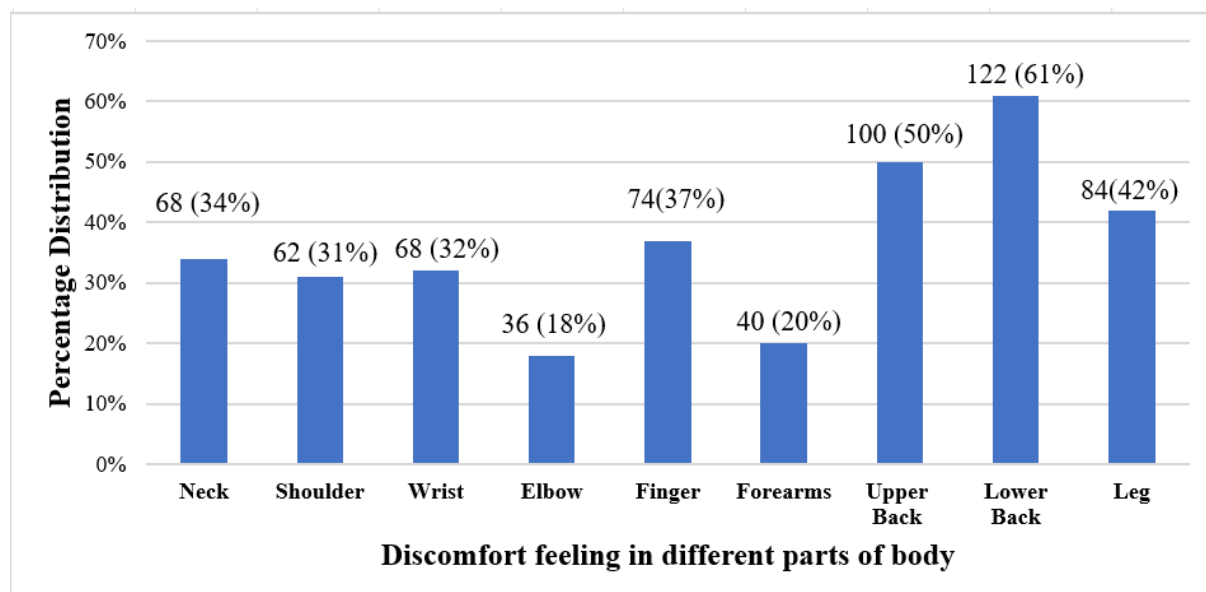








Figure 1: Discomfort feelings of female fish processing workers at different body parts (n=200)

The working posture of the female workers in their different job tasks was analyzed using the RULA method, as shown in Table 3. It was found that the medium risk of MSD was found to be in peeling, grading, sorting, beheading, and washing of fish with a RULA score of 5. The analysis of the

posture required further investigation and changes as soon as possible. This also leads to an indication that female workers adopted poor and awkward posture for a prolonged period at their working place.

Table 3: Analysis of working posture of the female fish processing workers (By RULA method)

| SL No. | Job Task | Posture | RULA Score | Action Level |
|--------|-----------|---|------------|--|
| 1. | Peeling |  | 5 | Medium risk, further investigation, changes soon |
| 2. | Beheading |  | 5 | Medium risk, further investigation, changes soon |

| | | | | |
|----|-----------|---|---|--|
| 3. | Grading |  | 5 | Medium risk, further investigation, changes soon |
| 4. | Sorting |  | 5 | Medium risk, further investigation, changes soon |
| 5. | Washing |  | 5 | Medium risk, further investigation, changes soon |
| 6. | Packaging |  | 4 | Low risk, changes may be needed |

*RULA Method: Rapid Upper Limb Assessment method

Female workers are involved in various job tasks. Approximately 71% are involved in sorting fish. The study participants were engaged in peeling

(62%), grading (55%), packaging (52%), and a combination of these tasks (26%). The percentage distribution of various job tasks in the fish processing industry is illustrated in Figure 2.

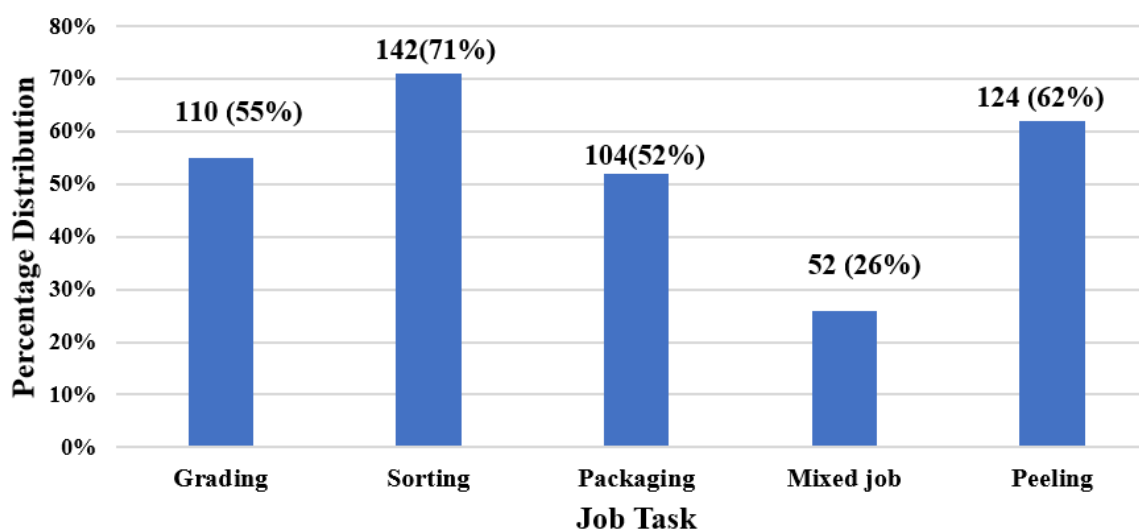


Figure 2: Work Tasks Involved in the Fish Processing Industry

The test of significance of the relative risk estimates was made for four major job task variables (sorting, grading, packaging, and

peeling) against MSDs in different regions of the body (upper back, lower back, shoulder, neck, leg, wrist, and finger), and their statistical association

is shown in Table 4. The analysis of the results showed a significant association between discomfort and pain in the upper back, lower back, neck, legs, wrists, and fingers, respectively. The risk estimates also indicated that workers performing sorting were at 3.2 times (95% CI 2.0-5.1) at higher risk of developing pain and discomfort in the upper back, 10.2 times (95% CI 4.0-26.1) in the wrist, and 3.8 times (95% CI 2.1-6.7) in the fingers. However, the female workers

performing grading were at 9.4 times higher risk of developing pain (95% CI 3.7-17.8) in the upper back, 2.3 times (95% CI 1.0-3.3) in the lower back, and 3.7 times (95% CI 2.0-3.3) in the wrist. Workers performing peeling were at high risk of developing musculoskeletal pain, with a 2.1 times (95% CI 2.7-4.4) increased risk in the shoulder and a 3.4 times (95% CI 1.6-4.7) increased risk in the neck, respectively.

Table 4: Association of job tasks and ergonomic risk factors with occurrence of MSDs

| Work Task | Pain region | OR | 95% CI | P value |
|-----------|-------------|------|----------|---------|
| Sorting | Upper back | 3.2 | 2.0-5.1 | 0.03* |
| | Lower back | 3.0 | 1.9-4.8 | 0.05* |
| | Shoulder | 1.8 | 1.2-2.8 | 0.04* |
| | Neck | 0.9 | 0.2-1.5 | 0.2 |
| | Leg | 1.8 | 1.2-2.8 | 0.04* |
| | Wrist | 10.2 | 4.0-26.1 | 0.001* |
| | Finger | 3.81 | 2.1-6.7 | 0.01* |
| Grading | Upper back | 9.4 | 3.7-17.8 | 0.02* |
| | Lower back | 2.3 | 1.0-3.3 | 0.05* |
| | Shoulder | 1.9 | 1.9-2.1 | 0.07 |
| | Neck | 0.7 | 0.5-1.7 | 0.4 |
| | Leg | 1.5 | 1.0-1.7 | 0.05* |
| | Wrist | 1.7 | 1.0-3.3 | 0.03* |
| | Finger | 1.6 | 1.2-2.9 | 0.04* |
| Peeling | Upper back | 1.0 | 0.5-1.8 | 0.7 |
| | Lower back | 0.5 | 0.1-1.1 | 0.3 |
| | Shoulder | 2.1 | 2.7-4.4 | 0.04* |
| | Neck | 3.4 | 1.6-4.7 | 0.001* |
| | Leg | 1.3 | 0.4-1.8 | 0.1 |
| | Wrist | 3.8 | 2.2-7.8 | 0.01* |
| | Finger | 7.2 | 3.5-17.2 | 0.001* |
| Packaging | Upper back | 1.9 | 1.2-3.0 | 0.004* |
| | Lower back | 0.9 | 0.6-1.4 | 0.8 |
| | Shoulder | 1.1 | 0.7-1.6 | 0.5 |
| | Neck | 1.9 | 1.1-3.2 | 0.01* |
| | Leg | 1.0 | 0.6-1.3 | 0.7 |
| | Wrist | 1.9 | 1.1-3.1 | 0.01* |
| | Finger | 1.6 | 1.0-2.5 | 0.03* |

*significant at 0.05 level of significance, OR - Odds Ratio, χ^2 -Chi Square value

Discussion

Approximately 71% of workers reported that their processing job required frequent repetitive motion of body segments, and all female workers reported prolonged standing as the primary form

of work in the processing industry, which may lead to the development of pain in various body regions. This statement is supported by Rathore et al. (2020), who highlighted that highly repetitive, labor-intensive, and prolonged standing lead to

the development of musculoskeletal disorders.¹⁵ The analysis of posture from Table 3 showed that most of the postures that were practiced by the workers while carrying out their job tasks, mainly beheading, peeling, Grading, sorting, washing, and packaging, required rectification as soon as possible, as indicated by the RULA analysis. The workers were found to adopt an awkward posture, which may lead them to suffer from musculoskeletal problems. From the investigation, it can be said that female workers are exposed to various risk factors, among which a predominant one is repetitive tasks that they perform in awkward postures. It is observed that the work in the fish processing industry is too short-cycled and carried out without any pauses. This leads to increased work strain and muscle tension, which results in an increased risk of developing musculoskeletal pain in different regions of the body. This observation of the researcher has been supported by a larger number of workers experiencing musculoskeletal discomfort in different body parts. 90% of the female fish processing workers complained of having discomfort in different parts of their bodies as represented in Figure 1. Das (2020) also found that the sawmill workers suffered from musculoskeletal disorders resulting from the development of poor working postures.¹⁶ However, these workers were found to work in a constrained, awkward posture for a prolonged period of time, which leads to the amplification of discomfort feelings. About 70% of the workers responded that the fish processing task involved rigidity in work methods and procedure, while 80% responded that work demanded target-specific productivity, and 65% of the workers did not have awareness about the correct use of PPE. These can be referred to as work stress factors and lead to the development of MSD problems among the female processing workers. A significant association was found between multiple work factors, such as job repetition ($p>0.05$), awareness about PPE ($p>0.05$), prolonged standing ($p>0.05$), rigidity in work ($p>0.05$), and occurrence of musculoskeletal injury (Table 2). The risk estimates indicated that the

workers performing job repetition were 12.9 times more likely to develop MSD injury, and workers performing their task in an awkward posture were 9.5 times more likely to develop MSD injury. Similar results were found by Das (2020) in their study on railway track maintainers, where workers with repetitive hand movement were at 16.25 times (OR 16.25, 95%CI 8.100–32.622) and workers with awkward posture were 311.40 times (OR 311.40, 95% CI 89.18–1087.34) at higher risk of developing MSD.¹⁷ Education is crucial for raising awareness and comprehension of occupational risks and hazards among workers. The present study showed a significant association, indicating that higher education is associated with decreased risk of MSD injury. This statement was supported by Percin et al. (2012), who found that higher degrees of education were associated with increased awareness and reduced the risk of occupational hazards compared to lower levels of education ($\chi^2=7.84, p<0.001$) among fishermen.¹⁸ Marital status was found to show a significant association with developing MSD injury, indicating married women were more prone to the risk of MSD ($p<0.05$). However, Saha A et al. (2006) did not find a significant association between marital status and injury occurrence.¹⁹ The employment of females in large numbers in India has been a notable characteristic of the fish processing industry, and a majority of them have a limited educational background and live in low socio-economic conditions. There is a higher tendency for women aged 25–26 years to quit their jobs, with marriage being the major reason. The significant association in the present study may be due to mental stress, which can also be a result of staying away from families for married women, increasing their vulnerability and contributing to the increased risk of injury among female workers. The present study demonstrated that work experience has a significant effect ($p < 0.05$) on the occurrence of occupational injuries. The workers with higher job experience have a greater risk of occurrence of MSD injury due to prolonged exposure to work stress factors. The statement is buttressed by a study that showed an increase in

the prevalence rate of MSD with increased years of working experience, using correlation ($r = 0.8$, $p = 0.001$) among dentists.²⁰ Age had a significant effect on MSD injury occurrence, indicating that older individuals are at a higher risk of developing MSD injury than younger individuals. This stated varied by the study of Breslin et al. (2007) who showed that younger workers were at 1.2 times higher risk of developing occupational risk in comparison to older ones on account of their ignorance and underestimation of health and safety.²¹ It was found that the female workers were engaged in different job tasks majorly sorting (55%), grading (71%), packaging (44%), and peeling (62%) which required the repetitive movement of various body parts leading to the occurrence of MSD injury. The risk estimates in the present study indicated that workers performing sorting, grading, and packaging were at a higher risk of developing pain in the upper back. In addition to it, workers performing sorting were at relatively higher risk of developing MSD pain in the wrist and fingers, respectively. The findings coincided with the studies of Nag A et al. (2012), who showed workers in fish processing who were involved in mixed jobs were 13.8 times and in ring cutting were 18.3 times at higher risk of developing discomfort and pain in the knee and upper back, respectively.²²

Limitations

One of the limitations of this study was the restricted accessibility to participants due to limited permission from the competent authorities of the fish processing units. This limits the scope of data collection, preventing a more in-depth exploration of several important personal and occupational characteristics of the study participants.

Conclusion

From the comprehensive investigation, it can be said that female workers in the fish processing

industry are highly susceptible to musculoskeletal disorders (MSDs) due to their repetitive tasks and awkward postures. The RULA analysis indicated that the majority of postures during critical tasks such as receiving materials, beheading, grading, sorting, peeling, and packaging are detrimental and require immediate correction. Work-related stressors, including rigid work methods, target-specific productivity demands, and the necessity for frequent body segment rotation, as well as awkward posture, were identified as significant contributors to the development of MSDs. The prevalence of musculoskeletal discomfort and these stressors was found to be strongly correlated by the study, with a substantial portion of workers reporting prolonged standing and lack of awareness about proper personal protective equipment (PPE) usage as exacerbating factors leading to the development of MSDs. It can be said that the result findings call for immediate and sustained efforts to implement ergonomic interventions to promote better postures, introducing regular breaks to reduce muscle strain, and provide comprehensive training and education to the workforce which includes ergonomic practices, such as the correct use of PPE (personal protective equipment), proper lifting techniques, as well as body mechanics, will lead to reduce their vulnerability. The use of PPE, such as cut-resistant latex gloves, waterproof aprons, and non-slip aprons, will help enhance hygiene and safety in the fish processing industry. However, looking into these issues is not only crucial for the well-being of workers but also for the sustainable development and productivity of the fish processing industry.

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