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Assessment of Risk Factors of Upper-Limb Musculoskeletal Disorders in a Fish Processing Industry

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ABSTRACT

The aim of this study was to evaluate the risks in relation to the workers' repetitive upper-limb movements, as well as analyze the effects of a reduced work pace on the risk levels in a fish processing industry. The study was conducted in a Brazilian fish processing industry with 1,900 workers, who were divided into two work shifts. The OCRA checklist was used to assess 10% of the total workforce during work tasks. The 13 main work tasks (homogeneous groups) of the productive sector were analyzed. The occupational repetitive actions performed by workers were 81.5 ± 19.2 per minute, representing 10 points on the OCRA scale (0-to-10-point scale). The average OCRA checklist score was 18.4 ± 2.9 (moderate risk). The scores for the right upper limb (18.3 ± 2.8 - moderate risk) were significantly higher than the contralateral limb (16.0 ± 4.2 - moderate risk) ($p = 0.014$). Considering the five risk categories proposed by the OCRA method, 12 tasks were deemed moderate risk (92%) and 1 low risk level (8%). Due to the predominance of the highly repetitive upper-limb movements in fish processing work, and previous studies suggesting a reduced work pace to prevent UL-WMSDs, simulations of a pace with very low risk levels were carried out utilizing the OCRA checklist. By conducting these simulated interventions, it was possible to reduce the UL-WMSD risk to very low levels in all tasks by only decreasing the work pace (-42.8 ± 17.7%). These results suggest that most of the tasks that workers performed were classified as moderate risk, predisposing workers to a greater probability of developing UL-WMSDs (10.8 to 21.5%) than the population that was not exposed. Simulations of a reduced work pace showed the effectiveness of this organizational measure in lowering the risk of UL-WMSDs.

Keywords: Risk assessment, Ergonomics, Work pace, Fish processing, OCRA

INTRODUCTION

Brazil was once considered the country with the greatest potential for the development of fisheries and aquaculture. Today, it ranks only 13th in aquaculture fish production, and 8th in freshwater fish production (FAO, 2020). According to the Food and Agriculture Organization of the United Nations (FAO, 2020), there have not been any official fishery statistics in Brazil since 2014, and the data has been obtained from surveys carried out by the institution as well as its partners.

Fish processing is a chain that involves all the important management of fish and fishery products. This chain starts from the moment the fish

is harvested until it is delivered to the consumer (Olaoye et al., 2015). Physical, chemical, ergonomic and biological hazards are the categories of occupational risks and dangers to which fish processors are often exposed (Olaoye et al., 2015). Common physical hazards in processing facilities are trips, slips, falls and exposure to loud noises; as for chemical hazards, common risks and vulnerabilities include accidents with vapors, acids, solvents, fumes, and carbon monoxide. Ergonomic hazards are caused by physical factors that affect the musculoskeletal system, while parasitic infections, bacteria or viruses, animal injuries, such as shark or crocodile bites, are responsible for biological hazards (Olaoye et al., 2015).

In most fish processing industries around the world, a great deal of emphasis is placed on the quality aspects of fish, especially slaughtering techniques, organoleptic characteristics, improved equipment, and increased production with little attention given to the workers' quality of life (Guertler et al., 2016). The nature of the work itself, the job setting and the environment in various fish processing facilities are the main occupational etiological factors of WMSDs among their employees (Gundmi et al., 2021). They demand prolonged periods of static or uncomfortable body positions, high physical loads, and repetitive movements in inadequate working conditions (Gundmi et al., 2021).

The OCRA Checklist was developed to analyze workers' exposure to tasks featuring various upper-limb injury risk factors (awkward postures and movements, lack of recovery periods, repetitiveness, force, and others, defined as "additional" risk factors) (Colombini and Occhipinti, 2016). This method is a Consensus Document, drafted and published by the International Ergonomics Association - Technical Committee on Musculoskeletal Disorders, along with the endorsement of the International Commission on Occupational Health (Colombini et al., 2001).

Considering the scarcity of studies on WMSD risks in fish processing, the aim of this study was to evaluate the risks in relation to the workers' repetitive upper-limb movements, as well as analyze the effects of a reduced work pace on the risk levels in a fish processing industry.

METHOD

The local Human Research Ethics Committee approved the procedures for this study, in accordance with the Declaration of Helsinki.

The study was conducted in a Brazilian fish processing industry with 1,900 workers, who were divided into two work shifts. In order to evaluate the risks associated with repetitive upper-limb movements, 10% of the workforce was evaluated while carrying out their work tasks, using the checklist proposed by the OCRA method (Colombini and Occhipinti, 2016). The evaluated tasks were considered individually, regardless of whether they were part of job rotation schemes. A sampling of 10 cycles for each task was recorded with a Sony® HDR-XR160 digital camcorder camera.

Based on the data resulting from the application of the OCRA checklist, simulated interventions were implemented in order to reach borderline risk levels by reducing the work pace for each of the analyzed tasks. The scores

for all examined risk factors on the checklist were weighted in proportion to the proposed work pace reductions.

Descriptive statistics were used (mean, standard deviation and percentage), as well as the Student's t-test (SPSS 17.0), in order to compare the risks of both sides of the worker's body, adopting $p \leq 0.05$.

RESULTS AND DISCUSSION

The 13 main work tasks (homogeneous groups) of the productive sector were analyzed (see Table 1).

Considering that the total duration of the work shift was 08 h 48 min with six rest breaks of 10 min each, the net duration of the repetitive work was classified in the range of 421 to 480 min ("duration" multiplier 1). For the risk factor "recovery", the multiplier 1.05 was used. The scores of the other risk factors evaluated by the OCRA method (posture with stereotyped movements, frequency of technical actions, force, and additional factors) were assigned according to the particularities of each task and the operative mode of each worker.

The occupational repetitive actions performed by workers were 81.5 ± 19.2 per minute (10/10 points on the OCRA scale). Kilbom (1994) suggests that workers ought to not exceed 25–33 actions/min to prevent tendon disorders, since higher rates provide insufficient pauses for the recovery of fatigue between contractions (micropauses). No other studies were found that quantified the repetitiveness of upper-limb movements in fish processing workers. However, Chiang et al. (1993) studied workers in a fish processing industry in Taiwan and found more prevalent symptoms in the upper limbs among those with jobs involving high repetitiveness or forceful movement, as compared to those in the same factories who had jobs with low repetitiveness and low forceful movement. According to Silverstein et al. (1986), highly repetitive jobs are those with a cycle time of less than 30 s, or more than 50% of the cycle time involved performing the same type of fundamental cycles.

The average OCRA checklist score was 18.4 ± 2.9 (moderate risk). Considering the five risk categories proposed by the OCRA method, 12 tasks were deemed moderate risk (92%) and 1 low risk level (8%). Despite the lack of studies evaluating fish processing tasks with the OCRA checklist, a number of studies found similar results in the processing of other types of animal protein, with a predominance of moderate risk tasks in poultry (Reis et al., 2015, 2017, 2019, 2020, 2021) and pig (Reis et al., 2018, 2019b) slaughterhouses. Exposed to risk levels similar to those found in the present study (an average of 20 points on the OCRA Checklist), 22.4% of workers at a chicken slaughterhouse in Italy were diagnosed with WMSDs (established by clinical evaluations and complementary medical examinations) (Colombini and Occhipinti, 2016). Based on this type of study, the authors of the OCRA method used statistical procedures (regression analysis) to define hypotheses for the prevalence of WMSDs according to the occupational conditions (Colombini and Occhipinti, 2016). Specific percentages were determined for each level of the WMSD incidence. In this way, most of the workers evaluated

Table 1. Results of the risk assessment from the OCRA checklist and simulations to decrease the risk by reducing the work pace.

Tasks	Current situation				Simulations for risk reduction			
	Units/min	TA/min	OCRA score	Risk level	Units/min	TA/min	OCRA score	Risk level
Fueling tuna canner	23.1	92.3	22.1	4	9.2	36.9	11.0	2
Cleaning tuna	*	99.0	21.5	4	*	37.1	11.0	2
Tuna evisceration	11.1	66.7	21.0	4	6.1	36.7	11.0	2
Fueling sardine head cutting machine	60.0	120.0	20.0	4	23.1	46.2	11.0	2
Aligning sardines on the head cutting machine	85.7	85.7	20.0	4	46.2	46.2	11.0	2
Cleaning sardine fillet	8.6	94.3	20.0	4	3.8	41.3	11.0	2
Checking shredded tuna package	10.0	100.0	18.9	4	4.0	40.0	11.0	2
Packaging shredded tuna	7.5	75.0	18.9	4	4.0	40.0	11.0	2
Canning sardine	16.7	83.3	17.9	4	10.3	51.7	11.0	2
Placing tuna in the cage - evisceration	3.1	61.5	16.8	4	2.6	52.2	11.0	2
Sealing shredded tuna package	2.1	60.0	14.7	4	1.5	43.5	11.0	2
Checking sardine weight	5.5	60.0	14.2	4	4.3	47.1	11.0	2
Canning small sardine	2.4	61.4	13.1	3	2.0	51.8	11.0	2
Average	18.2	81.5	18.4	4.0	9.0	43.9	11.0	2.0
Standard-deviation	25.6	19.2	2.9	0.3	12.6	5.7	0.0	0.0

Risk level: 5-high; 4-medium; 3-low; 2-very low; 1-acceptable; TA-technical actions; *Task with variable work pace.

in the present study had a probability of developing WMSDs between 10.8 and 21.5% (moderate-risk tasks).

The OCRA checklist requires an analysis to be performed on both sides of the body, but the final score for each task considers the side of the body that presents the greatest risk (Colombini and Occhipinti, 2016). It was found that the OCRA checklist score for the right upper limb (18.3 ± 2.8 - moderate risk) was significantly higher than the contralateral limb (16.0 ± 4.2 - moderate risk) ($p = 0.014$). Reis et al. (2015, 2017, 2019) also found higher risk levels for the right upper limb in poultry slaughterhouse workers. Corroborating these results, Tirloni et al. [15] interviewed 312 workers at a poultry slaughterhouse and found that 71.2% reported body discomfort, with a predominance of complaints on the right side of the body.

Due to the prevalence of the highly repetitive upper-limb movements in fish processing work, and previous studies suggesting a reduced work pace to prevent UL-WMSDs (Reis et al., 2015, 2017, 2018, 2019, 2019b, 2020,

2021), simulations of a pace with very low risk levels were carried out utilizing the OCRA checklist. By conducting these simulated interventions, it was possible to reduce the risk of UL-WMSDs to very low levels in all tasks by only decreasing the work pace (-42.8 ± 17.7%). Previous studies found that a reduced work pace, similar to those verified in the present study (-42.1 ± 14.5%; -44.9 ± 13.7%; -48.5 ± 11.8%; -38.8 ± 4.8% and -39.8 ± 16.8%, respectively), were necessary to adjust the risk level in poultry slaughterhouses (Reis et al., 2015, 2017, 2019, 2020, 2021).

CONCLUSION

Based on the results of this study, it is possible to conclude the following:

- Most of the tasks carried out by workers were classified as moderate risk, predisposing workers to a greater probability of developing UL-WMSDs (10.8 to 21.5%) than the population that was not exposed;
- The risk of developing UL-WMSDs was higher for the right side of the body;
- Simulated interventions and a reduced work pace demonstrated the effectiveness of this organizational measure in lowering the risk of UL-WMSDs;
- Future studies are necessary to verify if the results of the present study can be generalized to other fish processing industries.

Finally, to reduce the UL-WMSD risk in fish processing industries, it is recommended to perform a series of organizational measures, highlighting: an improved workplace organization, which includes the formation of joint health and safety committees, a reduced work pace, the adoption of an efficient job rotation (between tasks with different biomechanical requirements), rest breaks every hour, an expanded workforce for each task, the maintenance of sharp knives (avoiding unnecessary effort), and constant risk level monitoring of work tasks using objective tools, such as the OCRA checklist.

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