

Relationship Between Musculoskeletal Load and Weight of Manual Fish Handling Via 2D Simulation

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ABSTRACT

Fisherman experienced work-related musculoskeletal disorders (WMSDs) due to manual handling. Especially, manual handling for heavy fish makes physical load for fisherman. To prevent these WMSDs, fisherman should know the limit of weight in manual fish handling. Thus, the objective of this study was to find the relationship between the musculoskeletal load and weight of manual fish handling. This investigation was performed by the 2D musculoskeletal simulation. Posture of fishermen during manual fish handling on the commercial fishing boat was obtained from the Fishnet Open Images Database. Compression force of L5-S1 and joint torque of elbow, shoulder, knee, and ankle as musculoskeletal load were calculated by BlessPro2 software. The weight values of bigeye tuna, yellowfin tuna, and albacore tuna were used for this simulation. The results showed that compression force of L5-S1 and joint torque were increased with fish weight. In addition, the compression forces of L5-S1 during manual handling for bigeye tuna and yellowfin tuna were much larger than 3400 N as injury threshold of the National Institute of Occupational Safety and Health (NIOSH). These results indicate that fishermen should avoid heavy fish such as bigeye tuna and yellowfin tuna in manual fish handling for preventing WMSDs.

Keywords: Fishing industry; Manual fish handling; Compression force of L5-S1; Joint torque; Weight.

INTRODUCTION

Fishermen experienced work-related musculoskeletal disorders (WMSDs) due to manual handling [1,2]. Dogelio-Naga et al. reported that manual handling with 30 kgf caused subjective loads for arm, finger, shoulder, and lower back of fisherman [1]. Dabholkar et al. found that fisherman have lower back pain due to heavy manual handling in fishing industry [2]. From this background, it is considered that fisherman should know the limit of weight in manual handling. To prevent WMSDs, Álvarez-Casado et al. investigated awkward posture of fisherman by computational simulation using digital human [3]. In addition, assistive device to support fish handling was developed [1]. Furthermore, current study investigated risk factors for musculoskeletal disorder of upper limb in fishing industry [4]. However, these studies did not consider the relationship between weight of fish handling and musculoskeletal load. According to the National Institute of Occupational Safety and Health (NIOSH), compression force of L5-S1 during manual handling should be less than 3400 N for preventing lower back pain [5]. It is considered that relationship between fish weight and compression force of L5-S1 will be

effective to prevention of lower back pain using NIOSH's injury threshold. In addition, joint torque of full body is known as useful parameter to evaluate physical loads [6–10]. Therefore, the objective of this study was to find the relationship between the fish weight during manual handling and musculoskeletal load such as compression force of L5-S1 and joint torque.

METHOD

The relationship between the fish weight during manual handling and musculoskeletal load was investigated via 2D musculoskeletal simulation. Figure 1 shows the process of 2D musculoskeletal simulation. Posture of fishermen during manual fish handling on the commercial fishing boat was obtained from the [11,12]. This database provides images captured on the commercial ship of longline tuna in the western and central pacific oceans [12]. In this study, image of fisherman in manual fish handling on the ship was extracted for musculoskeletal simulation. The BlessPro2 software was used as 2D musculoskeletal simulation to calculate musculoskeletal load [13]. Specification of musculoskeletal model (male, 25 years, 170 cm, 60kg) was default values of the BlessPro2. Posture image of manual fish handling was input data of the BlessPro2. In addition, fish weight of bigeye tuna, yellowfin tuna, and albacore tuna were input as weight of fish handling in this simulation. These fish weight values were defined by previous study [14].

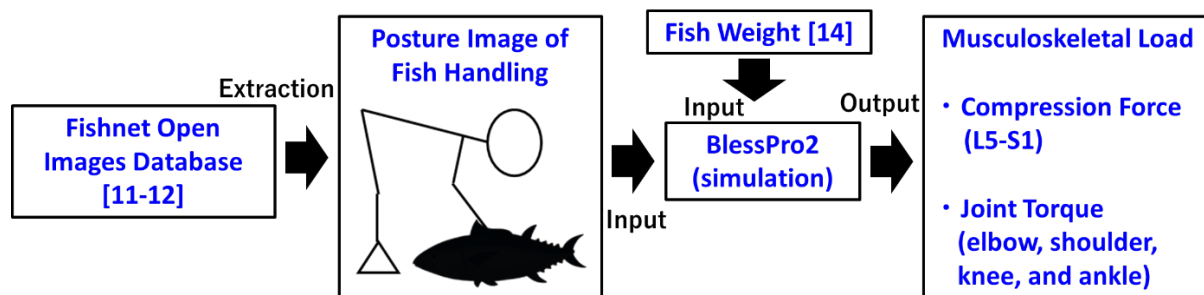


Figure 1. Process of 2D Musculoskeletal Simulation

RESULTS AND DISCUSSION

Table1 shows musculoskeletal load in manual fish handling. The results showed that compression force of L5-S1 and joint torque were increased with fish weight. In addition, the compression forces of L5-S1 during manual handling for bigeye tuna and yellowfin tuna were much larger than 3400 N as injury threshold of the National Institute of Occupational Safety and Health (NIOSH) [5].

These results indicate that fishermen should avoid heavy fish such as bigeye tuna and yellowfin tuna in manual fish handling for preventing WMSDs. When it is necessary to manipulate heavy fish such as bigeye tuna or yellowfin, multiple people or assistive device are required. These findings and recommendations can be applied to prevention of WMSDs among fisherman.

The limitation of this study was that musculoskeletal simulation applied only one male model. Future works, various parameters for gender, body height, or body weight of musculoskeletal models should be considered. In addition, other tasks of fisherman such as pulling or pushing should be investigated. Furthermore, various musculoskeletal load such as shear force [15,16] of L5-S1 will be investigated by 3D musculoskeletal simulation.

Table 1. Musculoskeletal Load in Manual Fish Handling

Fish [14]			Musculoskeletal Load in Manual Fish Handling				
			Compressive Force of L5/S1 [N]	Joint Torque in Sagittal Plane [Nm]			
Area	Species	Weight [kgf]		Elbow	Shoulder	Knee	Ankle
Atlantic	Bigeye Tuna	36.55	4955	75.70	36.90	295.4	324.9
	Yellowfin Tuna	45.31	5719	93.20	46.00	341.6	373.9
	Albacore Tuna	23.99	3859	50.60	23.80	229.2	254.7
Indian Ocean	Bigeye Tuna	45.20	5709	93.00	45.90	341.0	373.3
	Yellowfin Tuna	32.27	4581	67.10	32.50	272.8	301.0
	Albacore Tuna	24.05	3864	50.70	23.90	229.5	255.0
Eastern Pacific	Bigeye Tuna	41.72	5406	86.00	42.30	322.7	353.8
	Yellowfin Tuna	33.21	4663	69.00	33.40	277.8	306.3
	Albacore Tuna	18.85	3411	40.30	18.50	202.1	225.9

CONCLUSION

In this study, the relationship between the musculoskeletal load and fish weight of manual fish handling was investigated via 2D musculoskeletal simulation. The results showed that compression force of L5-S1 and joint torque were increased with fish weight. In addition, the compression forces of L5-S1 during manual handling for bigeye tuna and yellowfin tuna were much larger than 3400 N as injury threshold of the National Institute of Occupational Safety and Health (NIOSH). These results indicate that fishermen should avoid heavy fish such as bigeye tuna and yellowfin tuna in manual fish handling for preventing WMSDs. These findings will contribute to prevention of WMSDs among fisherman.

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