Check for updates

EVALUATION OF AN ERGONOMIC INTERVENTION DEMONSTRATES REDUCED LOW BACK LOADS ASSOCIATED WITH COMMERCIAL DUNGENESS CRAB HARVESTING

Kiana Kia[1], Laurel Kincl[2], Jay Kim[1,2]
[1]School of Mechanical, Industrial, and Manufacturing Engineering, Oregon State University, Corvallis, OR, USA;
[2]School of Biological and Population Health Sciences, Oregon State University, Corvallis, OR, USA.

Copyright 2022 by Human Factors and Ergonomics Society. All rights reserved. 10.1177/1071181322661041

The West Coast Dungeness crab fleet is considered one of the highest-risk commercial fishing fleets in the US due to high injury rates (Case et al., 2015). The majority of limiting nonfatal injuries were associated with handling, hauling, and setting crab pots (72%), which can pose forceful exertions, awkward postures, and repetitive motions (Bovbjerg et al., 2018). In a conventional set up for crab pot handling, fishermen "bang" the pot on the top of the sorting table, which can create substantial torso flexion and therefore increase biomechanical load in the low back. During our previous work with this commercial fishing fleet, we identified an ergonomic intervention (banger bar) developed by Dungeness crab fishermen (Pillai et al., 2019). The banger bar is attached to the top of crab sorting table to help dump the crabs from the pot. Therefore, they would not have to bend their backs as much compared to crab pot handling with a conventional set up. However, this fishermen-developed intervention has never been biomechanically evaluated; thus, its effectiveness and potential hazards are unknown. To address this current research gap, this study evaluated the use of a banger bar in reducing biomechanical load in the low back during simulated crab pot handling tasks.

Ten healthy male adults participated in a repeated-measures laboratory study. The mean and standard deviation of age, height, and mass of the participants were 26.9 (7.9) years, 181.8 (3.7) cm, and 84.3 (9.3) kg. Each participant performed a manual crab pot handling task in two different conditions: with and without a fishermen-designed control (banger bar). The task consisted of grabbing the pot with both hands, then tilting the pot to bang it against the banger bar or surface of the table, depending on the condition. During the experiment, joint moment and muscle activity in the low back were measured. To measure joint moment, a top-down approach was used for the L5/S1 joint torque calculation based on the 3-D external hand force collected by two six-degree-of-freedom load cells (PY6; Bertec; Columbus, OH), estimated body segment inertial parameters, and their respective moment arm estimated from kinematic data collected by a motion capturing system (Flex 13; Optitrack; Natural Point, OR). Muscle activity in the low back (right and left erector spinae muscles) was collected using an electromyography (EMG) system (Trigno Avanti; Delsys; Natick, MA). A mixed model in JMP (Pro 15; SAS Institute Inc.; Cary, SC, USA) was used to determine the effects of using the banger bar on the low back joint moment and muscle activity measures ($\alpha = 0.05$). The intervention (with and without banger bar) was the fixed effect; the participant effect was included as the random effect.

The results showed that the banger bar reduced lower L5/S1 joint moment with respect to the Y-axis (roll) (37-48%) and Z-axis (yaw) (7-28%) as compared to no banger bar condition with different degrees of statistical significance ($p < 0.16$). When using the banger bar, the participants were able to bang the crab pot against the bar without the substantial lateral flexion (roll) and axial rotation (yaw) of the back. Such lower lateral flexion and axial rotation of the back may have resulted in lower L5/S1 joint moment with respect to the Y- and Z-axis. These lower moment measures with the banger bar were consistent with the significantly lower (33-41%) low back muscle activity measures with the banger bar compared to no banger bar ($p < 0.007$). As the erector spinae is a primary muscle for lateral flexion, the disproportionally large reduction in the joint moment with respect to the Y-axis may explain the significant reduction in the muscle activity. The EMG data also showed that erector spinae muscle activity was higher on the right side compared to the left. This is likely explained by the fact that the simulated task had the participants tilt and bang the bar to their left. This task created asymmetric axial rotations (twisting), which can cause asymmetrical muscle activation of the erector spinae muscles. To avoid unbalanced overuse of the low back muscles, it may be beneficial for deckands to switch sides of the sorting table during harvesting if feasible.

In conclusion, this study indicated that the banger bar may effectively reduce biomechanical load in the low back, and therefore overall fatigue and the risk of overuse during manual crab pot handling.

Acknowledgement: This research was supported by a research grant from the National Institute for Occupational Safety and Health (NIOSH: 1U01OH011927-01). The content is solely the responsibility of the authors and does not necessarily represent the official views of NIOSH. The authors would like to thank the Dungeness crab fishermen and a local fabricator who gave their time to provide us with their expert opinions.

REFRENCES

1. Bovbjerg, V., Kincl, L, Jacobson, K., Vaughan, A., Pillai, S., & Lucas, D. (2018). Injury and injury treatment in US West Coast Dungeness crab fishing. International Fishing Meeting.
2. Case, S., Bovbjerg, V., Lucas, D., Syron, L., & Kincl, L. (2015). Reported traumatic injuries among West Coast Dungeness crab fishermen, 2002-2014. International Maritime Health, 66(4), 207-210.
3. Pillai, S., Bovbjerg, V. E., Vaughan, A., Jacobson, K. R., Syron, L. N., & Kincl, L. D. (2019). Dungeness crab fishermen perceptions of injury causation and factors in staying safe. *Int Marit Health, 70*(1), 55-60.