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Low Back Pain and its Assessment among Commercial Fishermen in Agenebode: An Ergonomic Perspective.

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Abstract

In a research done amongst commercial fishermen in Agenebode (Lat. 7.11°N, 6.69°E), the problem low back pain is significant in the fishing business. Research information is scarce on the investigation of the ergonomic stress of professional fishing. Moreover, there is no prior analysis, which investigates the relationship between low back stress (LBS) and low back pain (LBP) in fishing activities. This paper aims to measure the LBS during the gillnet and commercial crab fishing activities as well as to verify the correlation between the low back pain occurrences and those stresses reported in study of Agenebode commercial fishermen during the period (April 2017 – July 2017). A sample of 30 commercial fishermen considered in this study were exposed to LBS and the frequency of the fishing activities was assessed using questionnaire with crab pot and gillnet fishermen. The occurrence rate ratios (RR, 95% CI) of low back pain, which interrupted fishing, exposed to the high LBS and self-reported task was modelled on the basis of the multivariate generalised Poisson regression. It was observed that increased rates of low back pain correlates with the percent of time fishermen were exposed to discomforted postures. Handling of heavy loads during the loading and unloading activities generated lifting indices and high compression values, but with little overall work time (<15%). The results establish that neither ergonomic measure nor fishing task frequency alone can accurately predict LBP. Conversely, ageing, history of the LBP and self-selection out of tasks, perhaps, are significant factors that contributes to the LBS and outcomes observed

Keywords

CABS
Ergonomic measure
Fishing activities
Low back pain
Low back stress
PATH

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1. Introduction

Farming occupation, agricultural work, construction, logging, and fishing present many challenges for researchers that strive to characterise the scenery of the work and health hazards that are present. These occupations often do not have documents or records that allow workers to be easily identified, and they are practiced in a variety of settings influenced by the natural environment. Many workers in these outdoor manual occupations are exposed to hazardous working conditions and have the highest mortality and morbidity rates. Commercial fishing is one of these occupations (Kucera *et al.,* 2009).

The business of commercial fishing is a dangerous and strenuous occupation worldwide. Research shows that fishermen work long hours, often days at a time, and, in many fishing areas, access to health care is limited (McDonald *et al.*, 2004). Commercial fishing is also associated with high morbidity from vessel losses (Jin *et al.*, 2001) and traumatic injuries from falls, slips, being hit by gear and equipment, handling catch, and maintenance activities (Jensen *et al.*, 2005). Because fishing includes exposure to heavy loads, handling fishing gear, balancing on a moving surface caused by rough water and boat motion, and exposure to elements (wind, cold, rain, etc.), musculoskeletal disorders (MSD) are common in the fishing population and therefore a concern for occupational health professionals and researchers (Lipscomb *et al.*, 2004). Current epidemiological literature on commercial fishing consists predominantly of studies of mortality associated with deep sea fishing operations in Alaska and Northern Europe (Roberts, 2002; Conway *et al.*, 2002). The business of commercial fishing has been identified world-wide among occupations with the highest mortality rates ranging from 98.2 to 143 deaths per 100,000

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worker-years (Conway *et al.*, 2002; Roberts, 2004). Knowledge of the epidemiology of morbidity related to fishing has increased in the past 15 years, but like studies of mortality, is limited primarily to deep-sea fishing operations.

The most commonly studied non-fatal outcomes of previous morbidity studies are "accidents" and traumatic injury (Jensen 2000; Jin *et al.*, 2001; Jensen *et al.*, 2005). Studies of Northern European and Alaska fishermen have shown that the most common causes of traumatic injury are falls. There are few studies of musculoskeletal disorders in commercial fishing however (Torner *et al.*, 1994; Lipscomb *et al.*, 2004; Fulmer *et al.*, 2017).

1.1 Commercial Fishing in Agenebode, Nigeria

The fishing done at Agenebode (Lat. 7.11^{o}N, 6.69^{o}E), forms a unique work environment for Edo state's commercial fishermen. The maximum depth of 9 meters with averages between 3 and 5 meters provides a rich environment for many species of finfish and shellfish. This marine and freshwater ecology is unique to Agenebode (Edo state) fishing and offers a different kind of fishing when compared to the deeper ocean fishing done in other parts of Nigeria (Africa).

Fishing is financially important to Edo people at the Agenebode axis and to the families that depend upon it for their livelihood. In year 2000, Agenebode commercial fishing catch landings peaked bringing in about 154.1 million pounds of fish and shellfish to the market docks. Current statistics show that hard crabs continue to be Agenebode's top catch, bringing in an estimated 32.1 million Naira in year 2000. Associated with high mortality and one of the ten leading industries in Nigeria, commercial fishing's unintentional fatal trauma rate, relative to all industries, was 19.2, second to logging, and its fatality rate due to environmental conditions was number one at 48.3. Fishing in Agenebode is not just an occupation; it is also a family business and a way of life in many cases. Moreover, gill nets and crab pots are the most frequently utilised fishing gear in Agenebode.

The process of fishing for finfish with gillnets and crabs with pots are described in the literature (Mirka *et al.*, 2005). Crab pots are made from sheets of plastic coated chicken wire formed around a metal bar box frame (0.6 x 0.6 x 0.5 meters) and have three outlets: one for the crabs to enter the pot, one for the bait, and one to empty the pot which is closed with an elastic bungee cord. A buoy is attached to each pot with a 1 to 2 meter rope. Pots are set individually in lines along the bottom of the river where the buoy marks the spot. As the fisherman approaches the first pot, he grabs a metal hook and catches the rope around the buoy. Pulling the buoy to the side, he either loop the rope around a hydraulic puller which pulls the pot up, or pull the rope in by hand. Then, the pot is lifted in, dumped out old bait, unhooked the bungee cord to open the pot, and shake out the crabs onto a work surface or into a box. Once emptied, the pot is hooked closed, re-baited with two to three fish, and reset (Kucera *et al.*, 2008). If working with another crewmember, one fisherman drives the boat while another empties and baits the pot so they can reach the next pot when the current pot is ready to be set. Otherwise, a fisherman working alone either circles the pot or idles the boat during this cycle. Culling (sorting by size and shell hardness to remove unlawful sized crabs) is needed by law and is carried out on the boat between pots or lines.

Gillnets are comprised of a monofilament mesh that is attached on the top and bottom to two lines. On the top, a cork float is attached while the bottom line is free so that the net sits vertical in the water column. Each end of the net is marked by a buoy and an anchor holds the net in place. Fish swimming into the net get caught in the mesh holes around their gills. Catch type determines the size of the mesh net holes, the depth the net is set, and gear used. For example, flounder swim on the bottom, so the net sits lower in the water column.

In the fishing business, fishermen utilise metal hooks to grab the rope attached to the buoy, pull the buoy to the side, unhook the buoy, and feed the rope into a hydraulic puller. Once the anchor is pulled up it is also removed. When the net appears, the line is removed from the puller and put around a net reel, a large metal drum that rotates, which pulls the net in and down a wooden chute or table. Without a net reel (puller), the fishermen perform this work by hand. The fishermen pick out the fish from the net as it is pulled aboard and toss them into boxes. Once the end of the net is reached, buoy and anchor are removed, and the net is reset in another location. Net length varies by fisherman and fishing location.

2. Review of Related Studies

2.1 Musculoskeletal Disorders and Injuries in the Workplace

A musculoskeletal disorder is a condition, which involves the nerves, muscles, tendons as well as other supporting structures of the body. Musculoskeletal injuries are the result of traumatic events causing damage or disruption to tissues. Injuries are acute in their onset and may result in a functional disorder, while disorders are generally characterised by gradual or unknown onset and may or may not be a result of disruption of tissues.

Regardless of onset, both conditions are identified by ache or loss of normal function resulting from the injury event or the disorder. Few studies have been able to determine definitively which outcomes, injury or disorder, are represented in work injury claims and therefore the estimate of the proportions, injury and disorder are unknown. Therefore, it is appropriate to address both outcomes where applicable. The advantage of considering both back pain and injuries as a mixture of conditions related to instantaneous and long-term events is that it allows the investigator to incorporate risk factors related to both types of possible etiologist in the study design.

Musculoskeletal disorders and injuries have a major impact on US workers and constitute the main constituent of the total cost of work-related injury. The Bureau of Labour Statistics reported in 1997 that a third of the entire cases involving lost days from work were as a result of over exertion or repetitive motion. The National Institute of Occupational Safety and Health (NIOSH) in its 2001 National Occupational Research Agenda (NORA) have specified low back musculoskeletal disorders as one of its priority research agenda areas. Measurements of these outcomes in epidemiologic studies are through a variety of means, including self-report, insurance claims, work injury or incident reports, and medical diagnosis. Data collected from administrative systems are deficient since not all job-related MSD are reported in the work place or compensated by insurance carriers. Diagnostic criteria for MSD are not standardised and often inconsistent from provider to provider. Therefore, self-reported symptoms are an accepted method used commonly in occupational and ergonomic epidemiology research to evaluate the presence of musculoskeletal disorders (Punnett & Wegman, 2004). For example, the Nordic Questionnaire consists of a broad-spectrum questionnaire and more detailed body part specific questionnaire about the presence of ache or discomfort (Kuorinka *et al*., 1987). Studies have reported that the best measurements for low back musculoskeletal symptoms are self-reported symptoms or pain with less than one year recall (Burdorf & Sorock, 1997).

2.2 Risk Factors for LBP and Injury

In consideration and evaluation of numerous researches, risk factors for occupational low back musculoskeletal disorders and injuries have been identified in previous literature for other occupations and industries and include bending and twisting, lifting and forceful movements, static work positions and whole body vibration (Punnett & Wegman, 2004). In addition to occupational risk factors such as years at particular jobs and years of employment, several individual risk factors have been suggested such as body mass index (BMI), age, gender, and smoking. Most studies of occupational low back disorders are cross sectional in nature, with few cohort studies, and most employ poor measures of ergonomic exposures (most qualitative and not quantitative), varied low back outcome measures, and poor control and measurement of confounders (Burdorf & Sorock, 1997). In order to evaluate the association of potentially modifiable occupational risk factors, such as work task, researchers must be able quantify them.

There are some differences in risk factors for injuries versus disorders. Injuries are attributed to an acute event and therefore experience factors such as age, lack of training or supervision as well as intense exposures, fatigue or overuse, and unfamiliar work have been identified as potential risk factors for injuries. Musculoskeletal disorders are often described by a cumulative trauma model where personal factors such as history of previous injury, disc degeneration, BMI, and aging as well as work-related factors such as frequent exposures and years at job are described as risk factors. Several risk factors have been presented in a unified model of acute and chronic injury recognising the need to consider the whole spectrum of factors in order to describe low back outcomes (Kucera *et al*., 2009).

2.3 Low Back Outcomes among Commercial Fishermen

Musculoskeletal symptoms were common among Nigerian (Agenebode) fishermen and were influenced by age, years as a fisherman, fishing type, and job tasks (Pilot study). Seventy-four percent of participating fishermen, of whom 87% had been fishing for 21-30 years, reported some type of musculoskeletal symptoms in the last 12 months. Reported symptoms varied depending on fishing types, whether net fishing or trawling, as well as whether the fisherman was a crewmember or captain. In the study of isometric lifting strength and musculoskeletal injuries, it was observed that torso lifting strength was higher in the group who never reported back pain when compared to the group who had reported LBP during the past 12 months.

Several studies have reported prevalence and incidence of low back outcomes among commercial fishermen. Norrish & Cryer (1990), using hospital discharge and health insurance claimed that two thirds of all musculoskeletal injuries of commercial deep-sea fishermen from New Zealand were back strains. Jensen (1996), in a retrospective follow-up study of Danish fishermen, found 10% of all injuries were sprains and strains while 10% of all injuries were to the back. Another study (Mirka *et al.,* 2005) found that sprains and strains were ranked fourth in length of incapacity during fishing after fractures and dislocation, contusions, infected traumas among Grimsby (UK) deep-sea fishermen.

An aspect of commercial fishing setting it apart from other non-industrial occupations is that workers perform their tasks on a moving surface, i.e. the boat. Studies of boat motion on musculoskeletal injury found that motion was responsible for increased stress on the musculoskeletal system, particularly in the lower extremity and lumbar region (Torner *et al*., 1994). A study of Agenebode's commercial fishermen described traumatic injuries self-reported at entry into the cohort (Pilot study). At baseline, 40% of commercial fishermen had a traumatic injury event in the last year. Half of the strains and sprains were to the back and 72% were caused by lifting or moving heavy objects. The results of these findings indicate that at baseline back injuries from manual material handling activities were an important outcome.

Prevalence and incidence of low back symptoms were measured in this cohort over two years. Half of fishermen at baseline reported prevalence of low back symptoms. In addition, 20% reported that low back symptoms limited work activity in the last year (Pilot study). Prevalence of back pain at baseline was elevated for fishermen age 37 to 52, male gender, fishing less than full-time, and having no other job but fishing. Of those who did not report prevalence of symptoms in the past 12 months, incidence of low back symptoms was 33.1 (95% CI: 23.1, 46.0) per 100 person-years. Reported rates of new low back symptoms that interfered with work stratified by presence and absence of baseline LBP was 13.1 (95% CI: 6.8, 22.9) and 6.4 (95% CI: 2.8, 12.6) per 100 person-years respectively (Pilot study).

2.4 Measuring Ergonomic Exposures

Ergonomics can be defined as a "systematic and rational means of fitting the work to the person." Its main objective is to improve "worker performance and safety through the study and development of general principles that govern the interaction of people and their working environment." Ergonomics is concerned with a variety of occupational factors such as lighting, noise levels, and vibration. Exposure variables in ergonomic epidemiology studies of occupational musculoskeletal disorders are motion, posture and repetition, work organisation, material handling, and external factors such as vibration.

Previous studies have used a variety of methods to measure task and job-related, or ergonomic, risk factors both qualitatively and quantitatively. Employment records and self-reports detailing the presence or absence of ergonomic risk factors in the workplace are valuable tools for determining exposure – especially past exposure – to physical strain. Job title and years on the job are other qualitative measures commonly used in epidemiology to determine exposure to ergonomic hazards, yet research has shown variation in postures and speed of work within job titles (Punnett & Wegman, 2004). Questionnaires that ask workers to describe their exposure to ergonomic hazards are also subject to errors and underestimation.

Recent reviews of the literature have found quantitative measures of ergonomic stress to be the preferable method when determining appropriate risk factors for occupational MSD and injury (Kucera & McDonald, 2010). In a review of 81 original studies, only 42% had attempted to characterise exposure to ergonomic risk factors quantitatively through any of three methods: questionnaires, observational methods, or direct measurement techniques. Questionnaires that go beyond presence or absence of risk factor and strive to assign duration and intensity of exposure are useful for epidemiology yet are still subjective in nature. Observational methods have become more popular in recent research as have direct measurement techniques (Burdorf & Sorock, 1997). Observational methods use work-sampling approaches through direct observation of the worker or video tape. Postures, loads, and activities are recorded or sampled for a period of time and provide frequencies for these ergonomic exposure variables. Direct measurement techniques focus on measuring specific biomechanical factors like spine compression or spine forces and have the highest level of precision. Direct measurement is more costly, time consuming, and is difficult to use in an epidemiological study compared to observational methods and questionnaires. These methods are useful for quantifying ergonomic stress, however unless exposure variability between and within worker is incorporated the measures are subject to exposure misclassification (Punnett & Wegman, 2004).

2.5 Measurement of Ergonomic Exposure using PATH and CABS Methods

The goal of posture, activity, tools, and handling (PATH) is to identify awkward postures (e.g. lumbar flexion greater than 20 degrees, laterally bent and twisted lumbar postures) and strenuous manual materials handling activities. Previous studies with apple harvesters indicated high physical loads to the shoulder and strain to the back (Kucera & Lipscomb, 2010).

The continuous assessment of back stress (CABS) method utilises three assessment tools well established in the field of ergonomics to directly measure spine stress. These tools are the revised NIOSH lifting equation (NIOSHLE), the three-dimensional static strength prediction program (3DSSPP) and the lumbar motion monitor (LMM). Mirka *et al.* (2000) reviewed the goals of each of these methods. Each assessment tool addresses a vital aspect in the risk of low back injury and disorder. When combined with time values from work tasks summed over the work day, CABS provides estimates of level and duration of stress. NIOSHLE was developed for measuring static postures and two-handed lifts at fixed speeds over an eight-hour workday. Considering the nature of commercial fishing, this method alone will not adequately characterise the biomechanical stress. LMM was developed for repetitive jobs without rotation and often high-risk activities are missed. 3DSSPP is better suited for acute trauma risks and limited for cumulative trauma. The combination of the three methods, in hybridised form, enables researchers to better represent work with variable tasks.

The three components of the CABS method (NIOSHLE, LMM, and 3DSSPP) and two risk factor checklists (comparable to the PATH method) were compared in a study of 178 autoworkers from 93 randomly selected production jobs at an auto metal fabricating plant to see if their primary variables were similar. Correlations between methods ranged between 0.21 and 0.80 (Lavender *et al.*, 1999). A study of 28 male and female construction workers showed that these workers activities required an evaluation method that could account for different stresses to the low back in a probabilistic manner (Mirka *et al.*, 2000). This direct measurement method allows researchers to estimate stress to the low back and relate that with each task and ultimately a job. Other previous intervention work using CABS has been with furniture manufacturing and carpentry. Both of these methods are well suited for studying the occupational stress involved in commercial fishing and can be employed in a multivariate model. Measures from the PATH method in the current epidemiological study of risk factors for low back outcomes included the duration exposed to postures, forces or loads, and tasks. Measures from the CABS method included the percent of the work day exposed to a range of low back stress levels expressed as NIOSHLE Lifting Indices (0 to 10), LMM probability of high risk low back disorder group (1- 100%), and 3DSSPP spine compression measures 0 to 6600+Newtons). These measures and how they were operationalised are discussed in more detail in section 3.

3. Methods

Due to a video-taped document at Agenebode fishermen as they performed fishing tasks in order to identify activities that were particularly strenuous for the musculoskeletal system and target possible areas for intervention. Two well established ergonomic assessment methods originally developed for the construction industry were used in this study.

The PATH methodology is an observational ergonomic evaluation technique used to describe the postures and tasks associated in occupations with varied work activities. It describes the frequencies of tasks and represents the variability of work tasks between workers and within workers. Previous studies using PATH have been in construction, orchard harvesting work, and fishing (Buchholz *et al.*, 1996; Fulmer and Buchholz, 2002; Kucera & Lipscomb, 2010). This methodology is based on the Ovako work posture analysing system (OWAS), which categorises postures for the whole body in four classes ranging from normal posture to "the load of the posture is extremely harmful." PATH utilises OWAS posture categories in conjunction with descriptions of activities, tools used during the activity, and materials handled.

The CABS methodology is an ergonomic assessment technique for occupations with varied tasks and generates a distribution that represents the range of total biomechanical stress experienced by each worker in a day of work. It uses three assessment tools (NIOSHLE, 3DSSPP and LMM) well established in the field of ergonomics to directly measure spine stress. When combined with time values from work tasks summed over the work day, CABS provides estimates of level and duration of stress.

3.1 Ergonomics in Commercial Fishing

The OWAS system was employed to analyse working postures and loads from video tape and results were reported for a small-scale coastal fishery done on small, open boats with up to two workers. For the 30 minutes of time observed, fishermen spent 3% of time with back flexed >20 degrees, 24% of time with back bent to the side or twisted, and 1% of time bent and twisted. Eighty-eight percent of the time their upper arms were lifted out from trunk and 100% of time they handled loads less than 10 kilograms (kg) (<100N).

Pilot work on Agenebode three-man and two-man crab potting crews was conducted using the CABS methodology. Results identified 28 different crab potting subtasks. Sixty-five percent of the workday was spent without weight in upright tasks, such as driving the boat and working with the catch, and 14% of the day engaged in manual materials handling activities, such as loading and moving. Distribution of low back stress differed between three and two man crews and between job titles. The captain spent the most time upright in a neutral spine position driving the boat and hooking the buoy. The mate was engaged in the highest risk activities for acute injury: loading, unloading, lifting pots from side of the boat, and repeated shaking to dislodge crabs.

The third man maintained discomforted forward flexed positions for extended periods of time in sorting and culling catch on the boat (Pilot study). These studies helped identify factors that are related to musculoskeletal stress and that describe the fishing process. The aim was to establish the correlation between self-reported low back pain and exposure to ergonomic low back stress in the context of commercial fishing. Fishermen are especially vulnerable to low back musculoskeletal disorders and injuries because of the dynamic nature of their work. Research in this area is important because many do not have health insurance and a lost day of work means they will not have income for that day. Furthermore, commercial fishing has not been fully evaluated in an ergonomic context. Characterising the way fishermen perform their tasks and identifying quantitatively the ergonomic stresses associated with those tasks that act on the musculoskeletal system will provide a more thorough understanding of why low back pain and injuries occur in fishing and ultimately how they can be reduced.

3.2 Cohort Follow-up Study

From over 7000 licensed commercial fishermen Agenebode, Nigeria, a group of commercial fishermen was initially assembled between April 2008 and November 2010. The aim was to study "possible estuary-associated symptoms (Pilot study)." The population used included 217 individuals 18-65 years, who worked on estuaries or the river for at least 20 hours weekly for at least six months of the year. Participants were recruited through several means. Information about the study was mailed to licensed commercial fishermen and followed up by phone calls. In addition, researchers disseminated information via radio, television, and newspaper as well as distributed brochures at trade shows, association meetings and fish houses.

The Nordic musculoskeletal questionnaire was employed to evaluate the presence of musculoskeletal disorders in this population (Kuorinka *et al.,* 1987). As described previously, the Nordic questionnaire assesses presence of pain, discomfort, or ache in areas of the body. The Nordic questionnaire was administered to the Agenebode commercial fishing study nurses to participants in the clinic at baseline and a modification of the questionnaire was administered at each follow-up visit. The information collected in the clinic by study nurses is made up of 12-month prevalence of LBP at baseline and in follow-up visits, the occurrence of low back pain since last visit. Fishing exposure and traumatic injury information was collected in weekly (March to November) and biweekly (November to March) phone interviews. Fishermen were asked about their work activities for the week including: type of fishing done and gear used; boat size; days and hours on the water; and days and hours off the water. The participants were asked if they had an injury event that week and to describe details about their injury event.

3.3 Ethnographic Interview Study

Another component of the parent study includes the ethnographic interviewing methods to obtain detailed, first-hand information on the work of 34 fishermen. Information was gathered on a wide range of topics to supplement the information from the clinic and phone interviews. Pilot ergonomic measures using CABS methodology were obtained for a subset of this group of fishermen. Information from ethnographic sources was used to inform our ergonomic data collection procedures.

3.4 Supplemental Questionnaire Assessment

From April to October 2009 members of the cohort follow-up study and the ethnographic interview group were interviewed by telephone about their history as a commercial fisherman, the tasks they performed for different types of fishing, and other non-fishing related job exposures. At the end of the interview fishermen were asked if they would allow a researcher to observe and record (photograph and video tape) them while they worked. The 81% (176/217) of cohort members and 94% (32/34) ethnographic study participants that were available for telephone interview, 60% (105/217) and 41% (13/34) completed the questionnaire.

4. Results and Discussion

Based on the field data collection, it was observed that the participants were mostly male (89%) and white, non-Hispanic (91%). It was observed that 162 people-hours of fishing work by 25 (20 crab pot; 5 gillnet) fishermen on 16 crews (4 gillnet; 12 crab pot) of which 108 people-hours were observed on the video. The observations of two fishermen and two fish house employees who helped with loading, unloading, and sorting tasks (n=4) were included. For crab potting, the time to pull, empty, and reset one crab pot averaged 76 seconds (range 46 to 117) for the four 1-man crews, 41 seconds (range 30 to 47) for the five 2-man crews, and 35 seconds (range 34 to 36) for the two 3-man crews. One-man crews pulled on average 169 pots per day (range 84 to 321), 2-man crews averaged 310 pots per day (range 188 to 478), and 3-man crews averaged 645 pots per day (range 637 to 653).

4.1 Posture, Activity, Tools, and Handling (PATH)

Over 108 people-hours of video recording of 29 fishermen, 3079 observations were coded simulated real-time using the PATH method. As coded by PATH, by far, the most frequent activities for either fishing type are pulling in and setting nets or pots (80%) followed by travelling to fishing grounds (7%), loading and unloading (6%), sorting catch (4%), with the residual time spent cleaning (3%), casting off and docking (2%), and other tasks (5%). The most frequent activities carried out while pulling or setting fishing gear are handling/operating nets or pots (26%), operation controls to the net reel or boat (18%), and guiding/handling lines (15%) as shown in Figure 1.

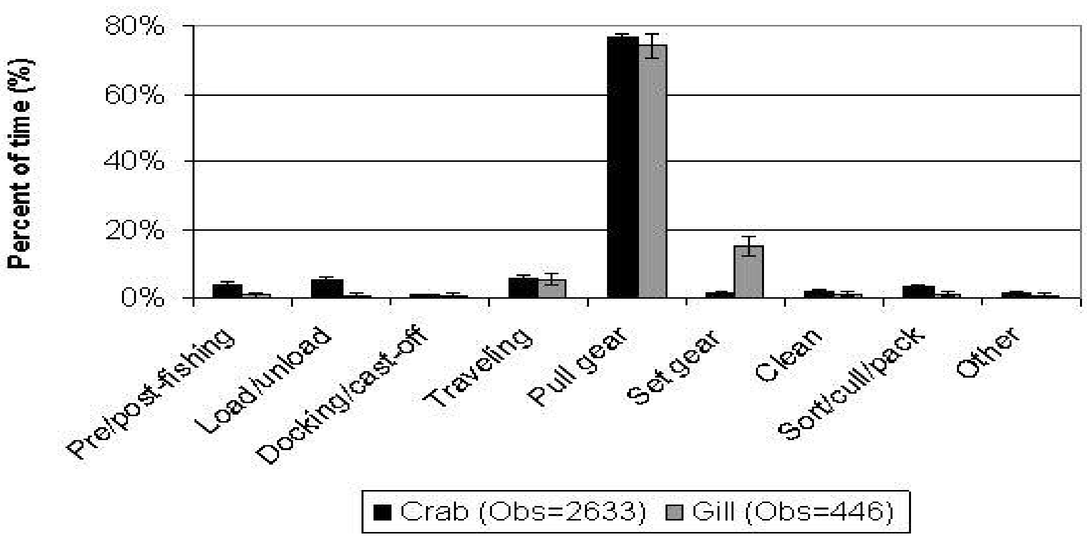

Figure 1: Percent of time observation in commercial fishing tasks by gillnet (n=5) and crab pot (n=20) fishermen using PATH method

The percent of time spent in setting or pulling fishing gear varied by fishing type. For crab potting operations, fishermen spent more time in operation control (33% crab pot vs. 4% gillnet), but in gillnetting, fishermen spent more time in handling the lines (22% gillnet vs. 7% crab pot), handling gears (36% gillnet vs. 19% crab pot), and picking the nets (33%). Extra distinctions were observed by the work title within and between fishing types as shown in Figure 2.

Crab pot's captain spent half the time in operation controls versus gillnets captains that guided the lines for a majority of time. Compared to captains, mates spent more time handling gears. Gillnet mates spent more of the time (81%) in handling gears compared to crab pot mates (41%). The 3rd man for crab potting spent 42% of time sorting catch. The 3rd man spent more time (52%) in non-neutral trunk postures compared to the time in severe flexion (32%), whereas mates and captains spent 30% and 19% of the time in no neutral trunk postures, and only 10% and 4% in severe flexion. The real-time PATH observations were collected for 13 of 25 fishermen (7 of 16 crews). When two crewmen were working on the boat, the captain was under sampled in simulated real-time (43% real-time vs. 53% simulated real-time) compared to the mate (59% real-time vs. 49% simulated real-time). Otherwise, results for fishing activities, postures, and forces were consistent except for time travelling to and from fishing grounds (14% real-time vs. 9% simulated real-time).

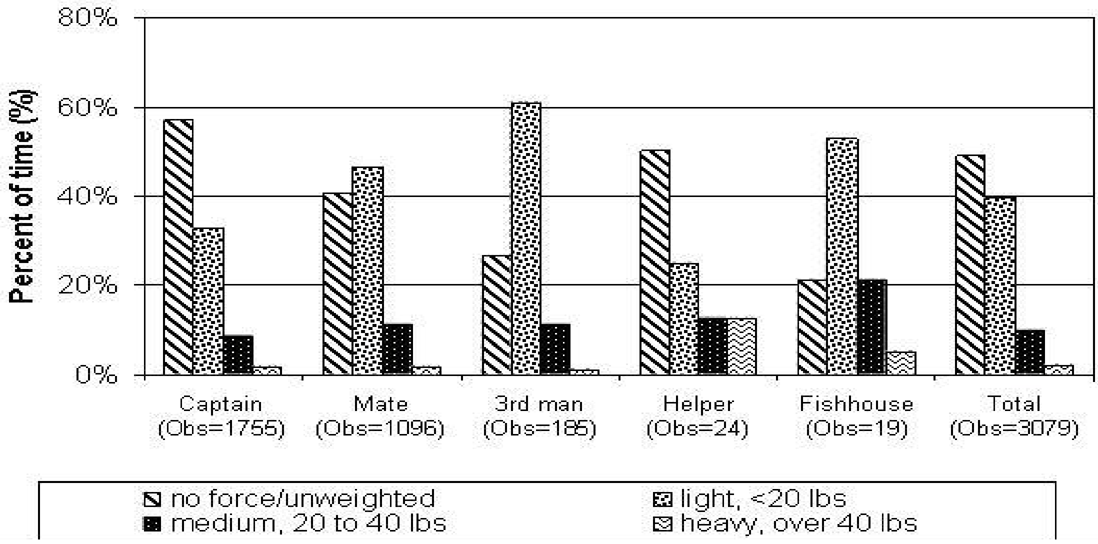

Figure 2: Percent of time observed handling loads or forces stratified by job title, captain (n=15), mate (n=8), 3rd man (n=2), helper (n=2), or fish house employee (n=2), for crab pot and gillnet fishing combined using PATH method

4.2 Continuous Assessment of Back Stress (CABS)

Analyses of the 108 people-hours of video recording by 27 fishermen acknowledged 43 subtasks for gillnet and crab pot fishing. The other subtasks were either weight dependent or required slightly different positions. However, compression and lifting index range are shown for selected CABS subtasks. In general, spine compression varied by fishing type. The LMM modelling illustrated the repetitive nature of both fishing types with range from 41% to 100%. Half of the crab potting crew workday was spent in 0 to 680N compression values, whereas 51% of the gillnetting workdays were at 680-1360 N of spine compression as shown in Figure 3.

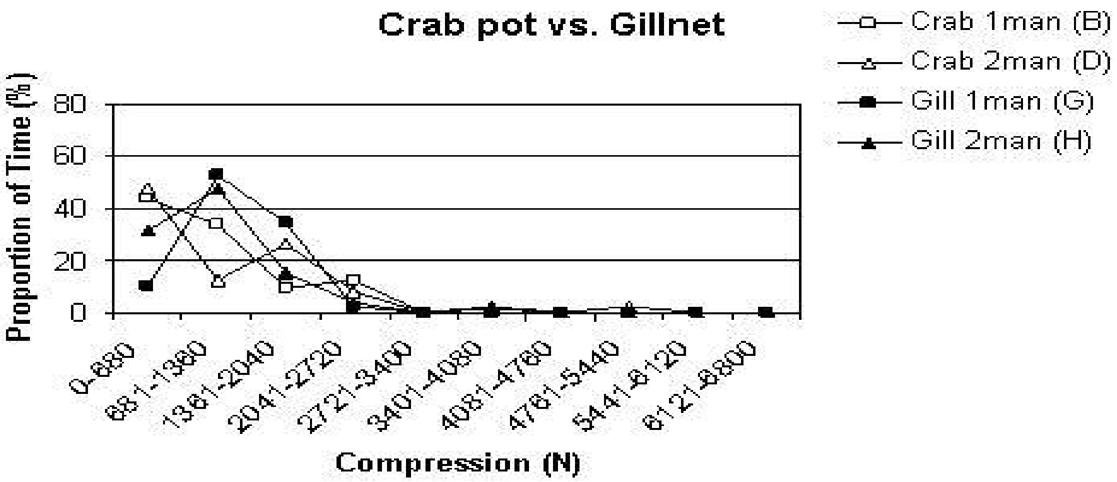

Figure 3: Comparing crab pot and gillnet commercial fishing crews using CABS method

4.3 Compression and lifting index distributions varied by job type.

Gillnet and crab pot's captains within dissimilar crew sizes had the largest variability. For the crab pot fishing, the three-man crew crab pot captains and one 2-man crew captain spent most of the time (78%, 91%, and 89%) from 0-680 N compression compared to both 1-man captains (45% and 52%) and the other 2-man captain (60%). Likewise, gillnet crewmembers' stresses differed between jobs, the greatest experienced by the 2- man crew mate whose main task was pulling and picking fish from the net as shown in Figure 4.

Sensitivity of modelling subtasks: Hooking the buoy two ways showed differences in three CABS measures while feeding the pot puller two ways showed variability in only the compression measure. When retrieving the buoy from the water, the use of a metal hook decreased the overall compression value but made no difference in the lifting index. The use of the pot puller made a difference in all three measures.

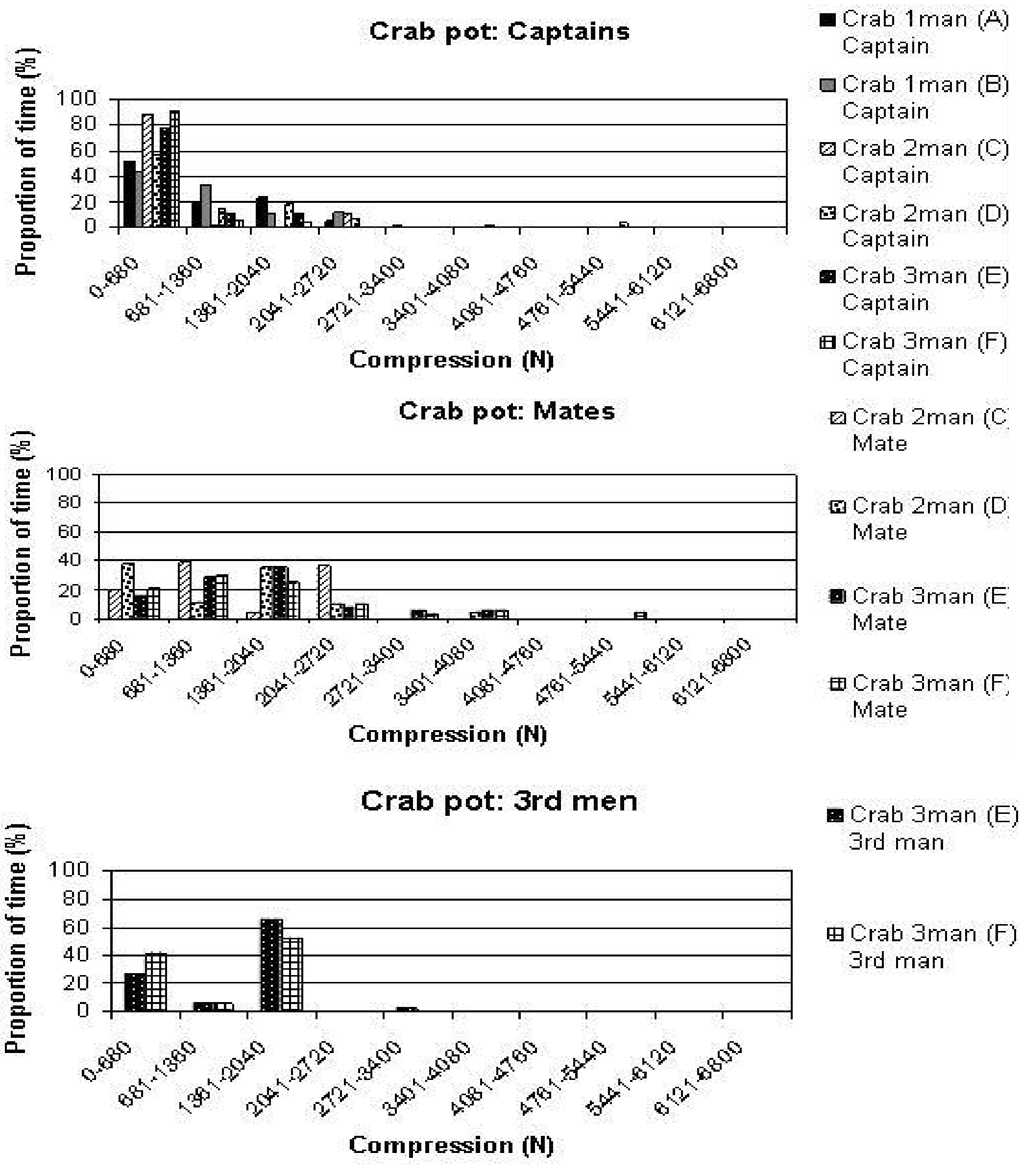

Figure 4: Histogram of 3DSSPP lumbar spine compression (N) for crab pot fishing captain, mate, and 3rd man across different crew sizes using CABS method

4.4 Variability of CABS and PATH exposures by fish type, crew size, work, and worker

Fish type results for the most of variability in all PATH and two CABS low back stress exposures (range 94.4% to 50.3%) when accounting for crew size and job (captain, mate, and 3rd man). On the other hand, most of the variability in percentage of work time in compression (>3400N) and lifting index (>3.0) was accounted for by work type (64.6% and 47.0%) followed by fishing type (17.7% and 25.3%).

5. Conclusion

This paper investigates the prevalence of the problem LBP in the fishing business. The aim was to measure the LBS during the gillnet and commercial crab fishing activities as well as to verify the correlation between the low back pain using data collected during the period (April 2017 – July 2017) from Agenebode (Nigeria) on the basis of two widely-accepted techniques (PATH and CABS). The results showed that, all material handling tasks were identified by PATH and at least one CABS hybrid measure as higher risk for low back stress. For fishing specific activities, PATH identified pulling in and handling gear and handling catch as higher risk, while only CABS identified those tasks as high risk. Combining task and time information for each fisherman, the overall percent of the workday exposed to LBS measured by PATH and CABS was poorly correlated (Pearson r range 0.03 to 0.52) except for percent of day at lifting index >1.0 and handling materials (Pearson r = 0.79).

Conflict of Interests

The author declares that there is no conflict of interests regarding the publication of this paper.

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