COMMERCIAL FISHING OCCUPATIONAL SAFETY AND HEALTH IN THE GULF

AND

AGRICULTURAL OCCUPATIONAL SAFETY AND HEALTH

IN GRADUATE MEDICAL EDUCATION

A Dissertation

by

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ABSTRACT

Background–The commercial fishing work sector continues to experience one of the highest occupational fatality rates in the U.S. There are regional differences in distribution of these events relative to fishery type, geography, and other variables such as cultural factors.

Methods–Over the last decade, the Southwest Center for Agricultural Health, Injury Prevention, and Education has been exploring these factors and developing interventions through engagement of a vulnerable population of commercial fishermen in the Gulf of Mexico and forming strategic partnerships with numerous stakeholders, most notably the U.S. Coast Guard. This has involved a variety of quantitative/qualitative methods including focus groups, surveys, a community trial with quasi-experimental pretest/posttest intervention design, and development of a social media campaign to enhance adoption of personal flotation devices (PFDs).

Results–Shrimp is a major fishery in the Gulf and earlier studies showed more than 80% of these fishermen are Asian, mostly Vietnamese. Culture plays a significant role in attitudes/beliefs among Vietnamese shrimp fishermen of the Gulf, and may influence behaviors that are risk factors for fatal and non-fatal injuries. In particular, commercial fishing industry leaders are able to influence behaviors and practices among fishermen. Over the last decade, safety tip cards, interactive CD instructional tools for vessel sound signaling and Mayday calls, and signage for a variety of safety concerns have been developed and disseminated. Statistically significant changes in attitudes/beliefs have been noted. Presently, identifying and assessing barriers to use of lifesaving PFDs (including heat stress), preferences of commercial fishermen for various PFD designs, and development of a social media campaign to promote use on deck are underway.

Conclusions–Culturally appropriate training and awareness measures combined with recognizing normative influences can favorably alter attitudes, beliefs, and behavioral intent related to workplace safety in this population.

Relevance to Public Health—Environmental health science represents one of the five core disciplines or competencies in public health and includes occupational health. This doctoral dissertation focusing on the commercial fishing work subsector addresses all three areas of essential services in public health, namely, assessment, policy development, and assurance. It has also formed an integral part of workforce development in the occupational medicine arena.

DEDICATION

To my wife, Ginny Harleston, and my children, Maddie and Elliott, for their steadfast support and patience.

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CONTRIBUTORS AND FUNDING SOURCES

This work was guided by a dissertation committee consisting of Thomas J. McDonald, PhD (Professor and committee Chair), Antonio Rene PhD, MPH (Associate Professor and committee co-Chair), and Adam Pickens, PhD, MPH (committee member), all from the Department of Environmental and Occupational Health. The work was also supported by dissertation committee member and Associate Professor, Eva Shipp, PhD (Department of Epidemiology and Biostatistics and Center for Transportation Safety, TTI) as well as Mark Benden, PhD, CPE, Department Head and Associate Professor, Environmental and Occupational Health.

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CHAPTER I

INTRODUCTION:

OCCUPATIONAL INJURY EVENTS IN COMMERCIAL FISHING IN THE UNITED STATES – EXTENT OF THE PROBLEM AND ASSOCIATED FACTORS

Synopsis

Objective: The commercial fishing work sector has one of the highest occupational fatality rates in the U.S., more than 30X the national average. There are regional differences in fishery type, geography, cultural factors such as language, and safety attitudes/beliefs. The objective of this review is to examine variables that may influence occupational injuries in commercial fishing, both fatal and non-fatal.

Design: Manuscripts were identified through a search for full text articles in English via PubMed. The period from 1996-2015 was used with search phrase "commercial fishing occupational injury United States". The search produced 16 articles. Four were excluded, either because the main study population was not commercial fishermen, or an outcome measure was unspecified. Each manuscript was reviewed and summary information captured (tabular format).

Results: Progress has been slow in identifying causal factors, as well as designing interventions that might ultimately reduce the high rate of fatal and non-fatal injury events. Regarding fatalities, review of available studies (mostly cross-sectional) suggests two primary contributing factors – vessel disasters and falls overboard. Fatal on-board injuries often involve machinery. Non-fatal events include acute hand/wrist penetrating injuries or back and shoulder musculoskeletal conditions with variability associated with fishery type, gear, tasks, maintenance, and ergonomic factors like lifting, shoulder posture, tools, and handling. Primary limitations include sample size and recall bias.

Conclusion: Future work to design and trial interventions that reduce the risk and consequences of mechanical injuries and to enhance adoption of safety measures such as increased use of personal flotation devices is needed.

Introduction/Background

The commercial fishing trades are among the most dangerous jobs in the world, with decks of these vessels having become complex industrial environments.[1] In the United States (U.S.), commercial fishing is considered part of the Agriculture, Forestry, and Fishing (AFF) industrial sector. The commercial fishing work sector continues to experience one of the highest occupational fatality rates in the U.S., more than 30 times the national average.[2,3] Human factors, machinery and equipment, and the environmental elements at sea may give rise to hazards that contribute to the burden of fatal events. Less is known about non-fatal occupational injuries and risk factors, and their association with fatal events. Moreover, there appear to be regional differences in distribution of these events relative to fishery type, geography, and other variables such as cultural factors. The National Institute for Occupational Safety and Health (NIOSH) has proffered a series of recommendations for fishermen, vessel owners, and operators, predicated upon the findings of studies conducted over the last twenty years.[3] In fact, increased awareness has been brought to the level of danger and risk experienced by commercial fishermen through popular venues such the Discovery Channel program called “The Deadliest Catch” and other social media campaigns such as "Live to be Salty", promoting use of personal flotation devices (PFDs) like life jackets.[4] Nonetheless, societal demand for implementing meaningful intervention has lagged behind other industrial sectors with regard to maintaining a workplace free of serious recognized hazards. Barriers to use of safety measures like PFDs may partially be explained by perceptions of fishermen such as creation of an entanglement hazard or interference with work.[5]

Despite the attention given to this occupational health issue over the last two decades, progress has been slow in substantially reducing fatality rates for several reasons, including the identification and prioritization of factors that influence hazard types such as vessel disasters, on deck events, and falls overboard.[2] These factors vary by fishery and region. These variables also carry significant influence upon intervention design that may differ from fishery to fishery and region to region, and are often driven by cultural factors[6] as well as attitudes and behaviors related to worksite safety practices recognized to contribute to these hazards.[5] There are often barriers to adoption of safe work practices in a multitude of work settings. In this circumstance, for example, in 2010, Lincoln and Lucas pointed out that "falls overboard accounted for 31 percent of fatalities nationally during 2000–2009. Among the 155 victims who died from falling overboard, none were wearing a PFD and 53 percent of these fatal falls overboard were not witnessed."[2] Perhaps not dissimilar to automobile drivers reluctant to wear seat belts, or motorcycle riders who choose not to wear helmets in the event of an accident, there are a myriad of reasons that may explain these attitudes and behaviors beyond lack of awareness. Better understanding these reasons and trialing methods to enhance use of PFDs afford opportunities for future study. Likewise, emerging recognition of mechanical injuries and their consequences, such as winch entanglements, can lead to design and adoption of interventions like the emergency stop, described later in this paper.[7]

The objective of this review is to examine recent knowledge surrounding the variables that may influence occupational injuries in commercial fishing, both fatal and non-fatal. Such variables include machinery and equipment, the environmental elements at sea, physical and ergonomic components, fishery type, regional differences, and human factors such as attitudes and beliefs. The rationale for examining available knowledge is to help prioritize areas for intervention and to focus efforts on design of potential solutions which may significantly impact the burden of occupational injury in this work sector. This may also include exploring opportunities to enhance adoption of recognized safety measures such as PFDs.

Methods

Manuscripts were identified for this review through a search for full text articles in the English language via the National Library of Medicine PubMed. The period from 1996 thorough 2015 (two decades) was used for this purpose. In order to narrow the search to the matter of greatest interest, namely, fatal and non-fatal injury events, the term occupational injury was used to refer to the outcome measure. It was felt that this would capture predominantly physical and/or mechanical outcome events rather than more chronic medical conditions or diseases. Further, the geographic focus is the U.S. The term industry is construed as being much broader, hence, the search was further isolated to commercial fishing. Therefore, the final search phrase used was “commercial fishing occupational injury United States”. Other phrases were entertained, but the word selection was considered optimal for the aforementioned reasons to narrow and refine the citations identified. The search produced 16 articles. Of these 16, three were titled (and their abstracts confirmed) so as to suggest that the mechanism of injury was not physical or mechanical or that the main target audience of interest was not commercial fishermen.[8,9,10] These three manuscripts were excluded from the review. A fourth manuscript was excluded as an ethnographic study of safety attitudes among independent North Carolina fishermen for which there was no assessment of one or more specified outcome measures.[11] The search did not identify nor was their inclusion of inland aquaculture. The remaining 12 manuscripts were reviewed with the following rubric or elements considered[2] in preparing each of Tables 1.1 and 1.2 in the "Results" section:

Table 1.1 – Studies addressing both fatal and non-fatal occupational injuries in U.S. commercial fishing, 1996 through 2015 – Study design, U.S. region, and Fishery

- First author and year of publication
- Number of participants or events as appropriate
- Study design
- U.S. fishing region – Alaska, West coast, Northeast, Southern, North Carolina
- Fishery or species – Salmon, Dungeness crab, Scallop, Shrimp, Halibut, Cod, Salmon, Clam, Oyster, Lobster, Crab, Sole, Bering Sea crab, Urchin, Snapper/grouper, Multispecies groundfish. Each fishery type may be characterized by different vessel designs and types of fishing gear, thereby associated with unique hazards.

Table 1.2 – Major findings and limitations

- First author and year of publication

- Major type of incident/relevant outcome measures/statistic where relevant – vessel disaster (e.g., flooding, instability, collision, fire, explosion, struck by large wave), fall(s) overboard, on-board injuries
- Other contributing factors or covariates (e.g., slip/trip, struck by, entanglement, fatigue, working alone, alcohol/drug use, weather conditions, leaning over side)
- Involvement of emergency equipment – e.g., immersion suits, life rafts, emergency beacons (EPIRBS), life rings, PFDs, fire extinguishers
- Major findings
- Limitations

For purposes of this review, the studies were separated into two categories, those involving fatal as well as non-fatal occupational injuries, and those focused on non-fatal injury events as previously described. Each study is summarized as to these findings in a brief narrative with information compiled in tabular format.

Results

Studies addressing fatal/nonfatal occupational injuries in U.S. commercial fishing, 1996-2015

Six studies addressed both fatal/non-fatal occupational injuries in U.S. commercial fishing. They are reviewed here chronologically in order of publication date and a summary of design elements (Table 1.1. a.) with a corresponding summary of findings/limitations (Table 1.2. a.).

Table 1.1. a. Studies addressing both fatal and non-fatal occupational injuries in U.S. commercial fishing, 1996 through 2015 – Study design, U.S. region, and Fishery for six (6) studies.

First author, year publication date	Number of participants, events	Study design	U.S. fishing region	Fishery/species
Conway, 1999	162 commercial fishing deaths	Descriptive analysis, surveillance/mortality data	Alaska	Not specified
Lucas, 2007	71 fatalities	Descriptive analysis	Alaska	Multiple
Lincoln, 2008	67% of severe non-fatal hospitalizations	Descriptive, Prevention Through Design (engineering)	Alaska	Vessels fishing with purse-seine gear
Day, 2010	225 non-fatal injuries, 31 fatalities	Descriptive analysis	Northeast	Clams, scallops, mackerel, herring
Lucas, 2013	35 injuries	Descriptive analysis	Southern	Shrimp
Case, 2015	28 fatalities, 45 non-fatal (2002-2014)	Descriptive analysis	West coast	Dungeness crab

Table 1.1. b. Studies addressing non-fatal occupational injuries in U.S. commercial fishing, 1996 through 2015 – Study design, U.S. region, and Fishery for six (6) studies.

First author, year publication date	Number of participants, events	Study design	U.S. fishing region	Fishery/species
Fulmer, 2002	4 boats	Descriptive, observational	Northeast	Lobstering, otter trawling, gillnetting
Marshall, 2004	215	Cross-sectional	North Carolina	Finfish, crabbing
Kucera, Loomis, & Marshall, 2008	n=217, 65 cases/controls	Case-crossover	North Carolina	Finfish, crabbing
Kucera et al., 2008	n=25, 162 person-hours	Cross-sectional	North Carolina	Crab pot, gill net
Kucera et al., 2010	n=217	Prospective cohort	North Carolina	Crab, finfish
Kucera & Lipscomb, 2010	11 crews	Cross-sectional, Descriptive, observational	North Carolina	Crab pot

Table 1.2. a. Major findings and limitations of six (6) studies from Table 1.1. a.

First author, year publi-cation date	Major incident type, outcome measure, statistic	Contributing factors, covariates	Emergency equipment	Major findings	Limitations
Conway, 1999	Vessel disaster, falls overboard, fatalities, fatality rates	Gender, age	Little in-depth discussion	Decline of commercial fishing fatalities in Alaska from 1991-1998, in particular vessel event related	Absent consideration of other covariates, e.g., training, adoption of safety practices, etc.
Lucas, 2007	Falls overboard, fatalities, Chi-square	Gear type, alone on deck, heavy weather, alcohol use	PFDs, man overboard alarms	No significant decline in fatal falls overboard over time	Absence of a comparison group (non-fatal falls overboard)
Lincoln, 2008	On-board injuries, crush injuries	Not addressed	Emergency stop	Retrofit, Prevention Through Design	Cost, adoption
Day, 2010	On-board injuries, vessel disaster, falls into water, incidence rates	Not-addressed	Not addressed	High incidence rates of fatalities associated with crush between injuries and falls into water	Information bias (injury self-report)
Lucas, 2013	On-board injuries, winch entanglement, incidence rates, relative risk with CI	Age, race, experience, job position	Emergency stop	Higher relative risk involving the deck winch drum, 41% of injuries involve loose clothing	Incomplete information for race, work experience
Case, 2015	On-board, vessel disasters, falls overboard, incidence rates	Not addressed	Not addressed	Higher fatality rates for the West Coast Dungeness fleet compared with nationally for commercial fishermen	Data gaps

Table 1.2. b. Major findings and limitations of six (6) studies from Table 1.1. b.

First author, year publi-cation date	**Major incident type, outcome measure, statistic**	**Contributing factors, covariates**	**Emergency equipment**	**Major findings**	**Limitations**
Fulmer, 2002	On-board injuries, Musculoskeletal disorders	None considered	None considered	Postural deviation, increased repetition, forceful exertion, increased noise; notable differences between fisheries	Generalizability and representative sampling of vessels
Marshall, 2004	On-board injuries, sprains/strains, retrospective recall incidence proportion	Age, gender, education, length of boat, type of fishing	Hand protection (not emergency equipment)	Statistically significant incidence proportion over prior 12 months, penetrating injuries of hand and sprain/strain to back/shoulder	Recall bias
Kucera, Loomis, & Marshall, 2008	On-board injuries, acute hand/wrist injuries, OR with 95% CI	Not measured – time spent fishing, volume of catch, weather, drug & alcohol intake	Hand protection not effective	Maintenance and use of more than one type of fishing gear in a week increases risk of injury	Recall bias
Kucera et al., 2008	On-board injuries, low back measures such as NIOSH lift index and lumbar compression force estimates, ANOVA/multi-level linear model/variance	Several not considered – age, BMI, tobacco use, etc.	Not applicable except for lift equipment	Variability by type of lifting and tasks, greatest in lift index by job title and compression forces by worker	Non-generalizability to other fisheries, effect of vessel motion

Table 1.2.b. Continued

First author, year publi-cation date	Major incident type, outcome measure, statistic	Contributing factors, covariates	Emergency equipment	Major findings	Limitations
Kucera et al., 2010	On-board injuries, acute hand/wrist, back sprain/strain, Incidence rate ratios with 95% CI	Adjustment for age, season, time of work, injury at baseline	Gloves (not emergency equipment)	Association of maintenance with any injury (Adjusted IRR=2.2 with CI 1.4,3.5), also protective effect of gloves	Selection (volunteer) bias, incomplete follow-up
Kucera & Lipscomb, 2010	On-board injuries, shoulder musculo-skeletal	No specific covariates considered	Not applicable except for lift devices	Awkward posture varies by technique and boat characteristics	Small sample size, mis-classification

In 1999, Conway et al. published findings pertaining to collaborative efforts toward occupational injury fatality surveillance in Alaska, where rates of acute traumatic occupational injury fatalities were the highest in the nation.[12] The objective was to characterize these injuries for two particularly high-risk industries (helicopter logging and commercial fishing) with the rationale of monitoring intervention and surveillance program effectiveness through establishment of extensive interagency working groups. However, no other detailed comparisons were made between these two occupational groups. Through the Alaska Occupational Injury Surveillance System (AOISS) used to capture event data, combined with "available" workforce denominator data (person-years at risk), the authors were able to conduct a descriptive analysis by calculating incidence density and examining trend patterns in occupation-specific acute traumatic injury mortality rates for 1991 to 1998. For commercial fishing in particular, there were 162 fatalities over the period of 1991 to 1998 with a fatality rate of 120 deaths per 100,000 workers per year, and a steady decline in absolute fatalities following implementation of the Commercial Fishing Industry Vessel Safety Act of 1988. Of note was a decline in vessel-related event fatalities and fatality rates over the same time period. Gender was a particular covariate considered with the disproportionate number of deaths among males due to their dominance in the workforce. Limitations of the study included absent consideration or analysis of extent to which other workplace factors beyond regulatory implementation may have been more directly associated with a decline in fatality rates, e.g., training, adoption of safety practices, etc.

Lucas and Lincoln studied fatal falls overboard in Alaska and published their results in 2007.[13] Using data from AOISS, they determined that there were 71 fatal falls overboard in the 16-year time period between 1990 and 2005. Chi-square tests for trends and equal proportions were calculated in this descriptive analysis using fatal falls overboard in the numerator of rates and full-time equivalent (FTE) fishermen estimates in the denominator. The latter was calculated as fisherman-days divided by the number of regular workdays in a year. There was no significant decline over the years. However, common circumstances associated with falls overboard were identified (see Table 1.2.a.). Potential interventions including managing lines, avoiding fishing alone, wearing PFDs/man overboard alarms, and reducing alcohol use were described. A major limitation was considered to be absence of a comparison group (non-fatal falls overboard), but the latter is difficult to identify.

Lincoln et al. in 2008 recognized that two-thirds of severe non-fatal hospitalized injuries among commercial fishermen in Alaska were caused by on-deck machinery.[7] Of such injuries, several may be due to entanglement. This paper emphasizes this risk and proposes to retrofit vessels having powerful deck winches where entanglement can occur (possibly resulting in a fatality) with an emergency stop having multiple other engineering design considerations (Prevention Through Design).

In 2010, Day et al. used U.S. Coast Guard data and the Fatality Assessment Control and Evaluation system to calculate work-related non-fatal and fatal injury incidence rates for New Jersey commercial fishermen for the period 2001 to 2007.[14] In this descriptive analysis, the most frequent cause of these fatalities was crushed between objects and falls into water. The objective in calculating rates and characterizing these variables was to increase awareness and target this workgroup with injury prevention strategies. Limitations included information bias (non-fatal injury self-reports) as well as approach to calculating person-time at risk.

More recently, in 2013, Lucas et al. have brought to light the significant contribution of winch injuries to fatal and non-fatal events in the Southern shrimp fleet.[15] In this descriptive analysis, 35 such injuries were reported from 2000 to 2011, nearly a quarter of which were fatal. Injuries involving the deck winch drum had a higher relative risk compared with the winch cathead (RR=7.5, 95% CI 1.1,53.7). Fourty-one percent of the injuries involved an item of loose clothing. One limitation involved missing data for factors such as race/ethnicity and work experience, potentially introducing bias into calculations that involved these variables. Proposed interventions included separating the deckhand from the cable, installing an emergency stop, and improved training.

In 2015, Case et al. reported on traumatic work-related fatal and non-fatal injuries in the West Coast Dungeness crab fleet.[16] In their descriptive analysis spanning from 2002 to 2014, using NIOSH data for fatalities and U.S. Coast Guard investigation reports for non-fatal events, they determined rates of 209 and 3.4 per 100,000 FTE workers respectively. This fatality rate remains considerably higher than the national rate for commercial fishing. Most fatalities were due to vessel disasters.

Studies addressing nonfatal occupational injuries in U.S. commercial fishing, 1996-2015

Six studies addressed non-fatal occupational injury events in U.S. commercial fishing. They are reviewed here chronologically in order of publication date and a summary of design elements (Table 1.1. b.) with a corresponding summary of findings and limitations (Table 1.2. b.).

The study by Fulmer and Buchholz, 2002, is a descriptive observational study employing ergonomic job task analysis in order to characterize risks for musculoskeletal disorders in different types of fisheries.[17] The rationale of the study in characterizing these risks was to identify opportunities for intervening with these factors and reducing injuries. The study involved three types of fishing vessels in Massachusetts, namely, lobstering (2 boats), otter trawling (1 boat), and gillnetting (1 boat). Each process was directly observed during regular operations, videotaped/photographed, described in writing, and characterized with drawings. Postural analysis of various tasks along with cycle time measurements and tool analysis were conducted along with noise measurements. Postural deviation, repetition (frequency/time), and forceful exertions (estimated weights) involving the upper extremity and back were observed largely related to manual materials handling such as hauling of traps. Maintaining balance was another factor. In some instances, noise level monitoring exceeded 85 dBA as an 8-hour time weighted average. Qualitative feedback was also offered by vessel captains regarding sociologic workplace factors (e.g., economic) which could contribute to adverse health outcomes. There were no health event outcome measures, limiting the ability of the study to link these risk factors to morbidity. Confounders such as age and race were not considered. Due to limited size of the study sample of vessels and crew, there were no statistical analyses conducted. A major limitation of the study is one of generalizability to each of the fisheries at large or commercial fishing in general. It is unclear if the vessels selected were representative of the industry. A notable observation was the presence of distinct differences in ergonomic risk factors between fisheries and vessel types. Recommendations to reduce risk in the form of workspace modification, tool selection, and use of hoists were offered.

Marshall and colleagues reported on a cross-sectional survey of work-related injuries in small scale commercial fishing in 2004.[18] Subjects were volunteers recruited by various means from eastern North Carolina fishers working in small independent operations for at least 20 hours per week for at least six months of the year (finfishing, crabbing, shrimping, clamming, oystering). The rationale for the study was that injuries had only previously been described in large scale operations. A 12-month retrospective recall incidence proportion (n = 215 fishers; using an inclusive definition of injury) was calculated at 38.6 per 100 workers (95% CI 32.1,45.1) with the majority of events occurring while on the water (82 percent) and a high proportion being penetrating hand injuries (37 percent). Sprains and strains were largely to the back and shoulder attributed to moving heavy objects. Potential confounders considered were age, gender, education, length of boat, and type of fishing. Recall bias was considered to be a notable limitation of the study.

In 2008, Kucera et al. published a case-crossover study to explore associations between trigger activities or circumstances and hand/wrist injuries in commercial fishing.[19] The study was nested within the cohort described by Marshall and colleagues.[18] Though hand/wrist injuries had previously been determined to be common, the objective and rationale of this study were to elucidate triggers as an opportunity for prevention. For 65 eligible cases in 46/217 fishermen, a statistically significant odds ratio (OR) for hand/wrist injury of 3.1 (95% CI 1.8,5.5) was noted for performance of maintenance work (any or none). Glove use did not appear to be protective. The case crossover design helps to minimize confounding since cases and controls are one and the same separated in time. However, seasonal differences could confound the results.

Again in 2008, Kucera et al. published a study evaluating ergonomic stress on the low back in North Carolina commercial crab pot and gill net fishermen.[20] The authors observed 162 person-hours of work among 25 fishermen from 16 crews. A variety of tools and methods were used to measure/estimate six ergonomic variables including NIOSH lift index and peak spine compression forces, assessing their variability between fishing type, crew size, job title, and worker using a multi-level linear model. There was variability by type of fishing and tasks performed by the worker, with greatest variability in lift index explained by job title and of compression forces by worker. Limitations of the study included non-generalizability to other fishing types, measuring effect of vessel motion on musculoskeletal risks, and validity of measuring trunk postures and forces and their range for a given task.

A prospective cohort study by Kucera et al. in 2010 [21] recruited volunteer participants from the same target population as described by Marshall and colleagues.[18] Participants (n=217) were followed prospectively by telephonic interview weekly and biweekly, reporting several exposure variables (time spent at work on and off water, catch species and gear, geographic area fished, maintenance activities, and glove use) as well as incident injuries requiring first aid, medical care, or time away from work. The objective/rationale for the study was to identify and potentially intervene in risk factors for non-fatal injury. Incidence rates were calculated and Poisson regression models fit to the data to calculate incidence rate ratios, controlling for other variables. The majority of injuries were penetrating wounds to the hand followed by back sprains/strains. Maintenance work was associated with an increased injury rate. Glove use was protective in this study. Limitations included selection (volunteer) bias, incomplete follow-up, and limited power due to sample size (wide confidence intervals as reported by the authors).

Also in 2010, sampling from the same target population, Kucera and Lipscomb used ergonomic methods to assess risk factors for musculoskeletal shoulder symptoms.[22] In this descriptive observational study, posture, activity, tools and handling were used to describe awkward postures in a sample of 11 small scale crab pot fishing crews. Awkward postures varied by a number of factors and increasing crew size did not uniformly affect awkward posture among captain and mates. Limitations included small sample size and potential for misclassification of shoulder postures.

Discussion

Fatality rates in the U.S. commercial fishing work sector remain high, and non-fatal events have been investigated only to a limited degree. The objective of this review has been to examine recent knowledge surrounding the variables that may influence occupational injuries in commercial fishing, both fatal and non-fatal. As previously noted, such variables include machinery and equipment (e.g. winches), the environmental elements at sea, physical and ergonomic components (e.g., lifting, posture, tools, materials handling), fishery type, regional differences, and human factors such as language (as in Vietnamese fishermen of the Gulf Coast), perceptions, attitudes, and beliefs.[6,5] That there might be opportunities for creating effective and innovative solutions combined with approaches to enhancing their implementation hinges upon thorough identification of variables or exposures closely associated with fatal and non-fatal outcomes.

It seems clear that progress has been slow both in terms of identifying causal factors, as well as designing interventions that might ultimately reduce the high rate of both event types. Regarding fatalities, review of available studies suggests two primary contributing factors, namely, vessel disasters and falls overboard. In some instances (Alaska), the former have declined while there has been little change in the latter. With respect to fatal on-board injuries, those involving machinery such as winch entanglement appear to require primary prevention via a barrier or separation, although emergency stops as a form of secondary/tertiary prevention may prove of value. Reported on-board non-fatal events otherwise seem to predominate in the form of acute hand/wrist penetrating injuries or back and shoulder musculoskeletal conditions with wide variability associated with a variety of contributors such as fishery type, gear, tasks, maintenance, and an array of ergonomic factors as previously characterized.

Limitations have included reduced power related to small sample size, selection bias, recall bias, incomplete information or data gaps, and lack of generalizability of findings from one fishery to another. The last point is worth emphasis given the wide variability of vessel, machinery, gear, and task design from one fishery to the next, not even considering the range of environmental parameters (climate, vessel balance/stability, etc.). Of note is the absence of a comparison group for the majority of fatalities, as articulated by Lucas and Lincoln.[13] Given a particular event such as a fall overboard, for any who survive, there is rarely a record, hence no group for comparison. Some would suggest that the absence of such a comparison group might lead to alternative conclusions from these studies and serve as a stronger argument for recording near miss events.

Future work must continue not only to improve study design and minimize sources of bias, but also to trial interventions. Based upon this review, the identification of winch entanglements and falls overboard as two exposures responsible for contributing to the significant burden of fatalities point to these variables as continued opportunities for intervention. However, it is not simply a matter of designing a viable intervention, but also testing approaches to insure its adoption. Hence, an emergency stop as an engineering intervention aboard vessels in certain fisheries as well as use of certain PFD designs (as personal protective equipment) while working on deck require that barriers to adoption be overcome. Such future studies will need to consider barriers such as cost (e.g., engineering intervention such as an emergency stop) as well perceived risks and obstacles (entanglement or interference with work relative to PFDs). In conclusion, the future approach must include experimental studies to test enhanced approaches to adoption of safety measures recognized to reduce the public health burden of fatal and non-fatal events whether they be use of PFDs to circumvent drowning, or glove use as a preventive measure for penetrating hand injuries. Measuring the effectiveness of introducing work practice measures or use of personal protective equipment to reduce workplace injuries and fatalities can help to drive optimal approaches for prevention.

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CHAPTER II

FACTORS INFLUENCING SAFETY AMONG A GROUP OF COMMERCIAL FISHERMEN ALONG THE TEXAS GULF COAST*

Synopsis

Introduction: The commercial fishing trades are among the most dangerous jobs in the world. Little published information exists regarding some populations of commercial fishermen such as along the United States Gulf Coast. Studying these unique and often vulnerable groups is important to characterize potential influences on or barriers to safety in anticipation of designing interventions that can change safety behaviors.

Methods: Working closely with the United States Coast Guard (USCG), a cross-sectional convenience sample of Gulf Coast shrimp fishermen in and near the Port of Galveston, Texas was surveyed. The survey included demographic factors and broadly covered areas such as type of work and fishing activities, general or global perceptions and beliefs related to safety and accidents, self-report of ability to use safety equipment or apply procedures aboard vessel, and training considerations.

Results: Surveys were obtained following informed consent (n=133). Of the participants, 96.7% were male with 60.9% > or = to 40 years old. A majority were of Asian descent (57.1% of all fishermen, 82.1% of shrimp fishermen). Over half claimed to speak little or

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* This is an Accepted Manuscript of an article published in the Journal of Agromedicine online [October 15, 2010], available online: http://www.tandfonline.com/doi/full/10.1080/1059924X.2010.509701 . Reprinted with permission from Factors influencing safety among a group of commercial fishermen along the Texas Gulf Coast by Levin JL, Gilmore K, Shepherd S, Wickman A, Carruth A, Nalbone JT, Gallardo G, Nonnenmann MW. *J Agromedicine*. 2010;15(4):363-374. Copyright 2010 by Taylor & Francis Group, LLC.

no English and nearly 60% considered the job to be very safe to neutral. A third to half of respondents expressed doubt about their knowledge of using essential safety equipment in the event of emergency. A large portion of the participants preferred hands-on safety training (40.6%).

Conclusions: Important findings about this group of commercial fishermen will help with future development of effective prevention practices through the delivery of culturally appropriate safety awareness training. One element which must be addressed in training programs is to increase the awareness among fishermen about the severe occupational risks inherent in this type of work. Community trust and collaborative partnerships are essential to the success of such initiatives.

Introduction

The fishing trades are among the most dangerous jobs in the world. The hazardous nature of fishing has grown more complicated over the past century as fishing decks have evolved into more complex industrial settings.[1] In the United States, the occupational fatality rate for commercial fishers has reached thirty times as high as the overall occupational fatality rate.[2,3] The Census of Fatal Occupational Injuries in 2008 for selected occupations demonstrated a fatal injury rate nearly 35 times as high among fishers and related fishing workers (128.2) as the rate for all workers (3.7).[4] As illustrated in Table 2.1, though the number of total fatalities in fishing varies annually, recent data from 2003 to 2008 show no evidence of a persistent decline in this number.[5]

Table 2.1. Fatal Occupational Injuries for Fishing in the United States, 2003-2008.[5] Reprinted with permission from J Agromedicine.[27]

Year	Total Fatalities
2008	46
2007	36
2006	48
2005	47
2004	39
2003	47

Human factors contributing to high occupational fatality include fatigue, inexperience, and failure to use safety practices and equipment. These factors, combined with hazards from machinery, the work environment (e.g., slippery and unstable work surfaces), and the elements at sea (e.g., extremes of temperature and weather), create significant risks for workers.[6] The National Institute for Occupational Safety and Health (NIOSH) has demonstrated that preparation and use of protective equipment including personal flotation devices and emergency equipment such as life rafts, electronic beacons, and immersion suits will enhance crew survival.[7]

Despite the recognized dangers associated with commercial fishing and the identification of many contributing factors, development of mandatory safety standards and regulations in the United States was slow in coming.[8] In September of 1988, President Ronald Reagan signed into law the Commercial Fishing Industry Vessel Safety Act of 1988 (CFIVSA). A key element resulting from the Act is the Voluntary Dockside Exam of the U.S. Coast Guard (USCG). This program is designed to educate and provide commercial fishermen with an opportunity to bring their vessels into compliance and receive a Commercial Fishing Industry Vessel Dockside Exam Decal.[9] The comprehensive exam can last one hour to one day depending upon the size of the vessel.[10] It includes inspection of safety gear, lifesaving equipment, administrative requirements, navigational publications, pollution compliance, and where applicable, written procedures for emergencies.

Increased training and use of personal protective equipment following the implementation of commercial fishing vessel safety legislation in 1988 has shown a corresponding decline in fatalities among Alaskan fishermen between 1991 and 1997.[11] A similar finding has been noted comparing selective outreach efforts with fishing vessel losses.[12] The USCG Voluntary Dockside Exam (VDE) program includes such an outreach effort to raise awareness. In 1995, and from 1999 to 2000, there was an overall increase in VDEs accompanied by a corresponding decline in fishing vessel loss. In spite of an overall reduction in casualties following the legislation, the occupational fatality rate remains high[13] as confirmed by recent data.[4,5]

A good deal has been written regarding Alaska's commercial fishermen. A significant decline in occupational fatalities in Alaska's commercial fishing industry has been achieved during the 1990s and was a function of many factors.[2,14] Included among these was the establishment of a NIOSH field station in Anchorage in 1991 with the development of comprehensive injury surveillance facilitating strong interagency and industry collaboration. A 67 percent decline in commercial fishing deaths from 1990 to 1999 was largely a result of remarkable progress made in reducing fatalities from drowning and deaths due to hypothermia resulting from vessel-related events. Available data also suggest that this progress is a consequence of post-event factors such as use of personal flotation devices, immersion suits, life rafts, and electronic positioning beacons. Though this progress has partly been a function of regulatory intervention, availability and proper use of these tools has been a result of behavioral decision-making influences. Recent work has demonstrated that many fatal falls overboard might be prevented through a better understanding of the circumstances surrounding these events and design of interventions targeted at related risk factors.[15]

A smaller proportion of fatalities has been due to deck injuries.[2] On-deck dangers have also been recognized as an important cause of fatal and non-fatal workplace injuries among Alaskan commercial fisherman.[16,17] An example of a practical engineering control has been developed to protect workers from a hazardous piece of equipment by preventing injuries due to entanglement.[18] However, unlike fatalities due to loss of a fishing vessel, there has not been a corresponding decline in fatalities due to work-place injury independent of vessel loss. The implication is a corresponding increase in the proportion of all fatalities occurring while working on the vessel.

A review of lost U.S. fishing vessels and crew fatalities from 1994-2004 prepared by the USCG showed that nearly half of the incidents occurred in the 17th (Alaska) and the 8th (Gulf Coast from Texas to the panhandle of Florida) Districts.[12] Data analyzed for the eleven year period indicate there were 1398 lost vessels and 641 fatalities; an average of 127 lost vessels and 58 fatalities per year. Comparable data for Districts 17 and 8 over the same eleven-year period were 338 lost vessels/146 fatalities and 268 lost vessels/125 fatalities respectively. Water exposure was the most significant factor in personnel loss (three quarters of all fatalities), with 24 percent of the total due to falls overboard. Forty percent of the fatalities involving falls overboard occurred in the 8^{th} District (61/154). A decline in annual commercial fishing fatalities nationwide beginning in the year 2000, in spite of a steady number of vessel losses, may suggest the importance of increased emphasis on safety equipment and procedures. The fatality experience in District 8 during this same time frame was, by comparison, virtually flat.

These observations in District 8 suggest an opportunity to affect safety behaviors, perhaps through a better understanding of the target population. Unlike Alaska (USCG District 17), less information is available concerning the commercial fishermen in the Gulf Coast region (USCG District 8), and in particular, regarding shrimp fishermen or "shrimpers". Surveillance information for this region and group is considerably more limited in quantity, scope, specificity, and analysis compared with District 17. There are few studies which characterize potential influences on or barriers to safety among Gulf Coast commercial fishermen. Available information in the southern region has relied upon use of qualitative tools and ethnographic methods to assess seasonal variations in activities as they relate to workplace risk factors.[19]

There is limited published information pertaining to demographic make-up, general work characteristics, global perception of work safety risk, and receptivity to safety training among commercial fishermen along the Gulf Coast (USCG Eighth District). Given the improved fatality experience in District 17 and limited observations made to date in District 8, the present study undertook to characterize the population of commercial fishermen along the Gulf Coast in the region of Galveston, Texas. In particular, the cross-sectional survey conducted attempts to examine global perceptions of work safety risk as well as potential barriers to safety training in this group.

Methods

This project was initiated with a field visit of the NIOSH Southwest Center for Agricultural Health, Injury Prevention, and Education and its External Advisory Board in March of 2003. An introduction to the hazards associated with shrimp fishing, available safety measures and training, and a site visit to the fleet at Galveston, Texas were conducted by a Commercial Fishing Industry Vessel Examiner with the USCG Marine Safety Unit in Galveston (one of the authors). Of note is that this initial visit to the docks was conducted on a day with light rain, affording the group a first hand view of the influences of weather on safety risks in this environment. The late fall, winter, and early spring are periods during which commercial shrimp vessels along the Gulf Coast are frequently in port for maintenance and repairs. A second visit in the fall of 2003 helped the research team to better understand some of the "on-board" and "on-deck" hazards (see Figure 2.1). For instance, observations were made of the some of the potentially slippery or unsteady work conditions which can exist at sea such as vertical descent of a metal rung ladder into the engine room. Additionally, use of equipment which poses an entanglement hazard, particularly if unguarded, was noted.

In an effort to characterize the population of commercial fishermen in and near the Port of Galveston, the research team worked closely with the USCG to host a meeting involving multiple stakeholders including vessel owner operators, suppliers, several representatives from USCG District 8, and other members from the fishing community (primarily Vietnamese) in this area. An external advisory group to the project was identified from among these individuals and key community members. This external advisory group later met with the project investigators in February of 2005 to collaborate on a survey tool to be administered to the fishermen. Their recommendations for location, timing, and recruitment of subjects (e.g., radio public service announcements in Vietnamese), were key to maximizing voluntary participation within this convenience sample. The proposed research received institutional review board approval.

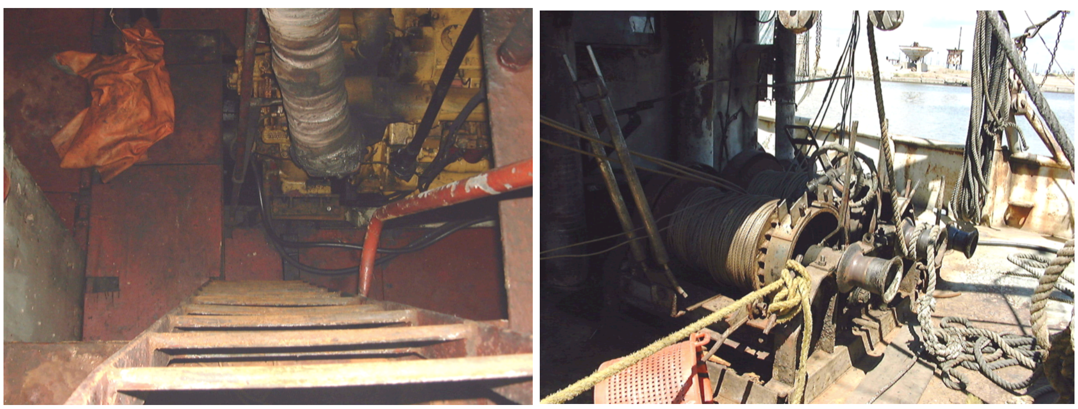

Figure 2.1. On-board hazards associated with commercial shrimp fishing as illustrated by steep and unsteady ladder descent in engine room compartments and on-deck unguarded machinery/winches as well as low height of the deck railing. Reprinted with permission from J Agromedicine.[27]

The survey included demographic factors and broadly covered areas such as type of work and fishing activities, general or global perceptions and beliefs related to safety and accidents, self-report of ability to use safety equipment or apply procedures aboard vessel, and training considerations. It was translated into and back-translated from Vietnamese and Spanish. The survey was administered in person by trained individuals, in the primary language of the participants, after obtaining a signed consent. These individuals were outreach coordinators with the regional Area Health Education Center and were assisted by local community leaders and translators as well as a member of the USCG Marine Safety Unit (co-author). Surveyors used multiple sites - dockside and congregating locations popular with fishermen - throughout the Galveston coastal region in Galveston, Kemah, and Anahuac, Texas (see Figure 2.2). The survey was conducted in the early spring of 2005. As noted in the figure, a logo for the project survey was created to enhance its visibility within the community for recruitment and participation purposes.

The survey consisted of 30 questions with response options. Table 2.2 contains the questions (and sample response options) for which results are reported. The survey was intentionally brief to enhance participation and due to language considerations. There were no “open-ended” questions. At this stage of working with the commercial fishermen, the goal was to obtain some very basic and preliminary information. However, a subsequent series of focus groups were conducted among this group which emphasized in greater detail some of the cultural factors and resulting regional differences related to issues such as risk perception, safety awareness, and receptivity to training. Due to a different questioning methodology (focus group versus survey) and emphasis, the findings of the focus groups with specific quotations and examples of these cultural factors have been included in a separate manuscript by Carruth et al., included in this special issue of the journal.

Figure 2.2. Locations of survey administration in the Galveston coastal region including the Port of Galveston, Kemah, and Anahuac, Texas. A logo was designed to advertise and recruit for the survey. Reprinted with permission from J Agromedicine.[27]

Results

Table 2.3 contains a summary of the 133 completed surveys for this convenience sample. Volunteer fishermen attended and participated in the survey in response to community announcements (public notices and by radio; in English, Vietnamese, and Spanish) and "word-of-mouth" within an approximate two week time frame before the survey was administered at each of the three locations in the Galveston area. Information concerning survey locations and schedule was communicated dockside and at congretating locations popular with fishermen such as marine supply houses. Advisory group members and some commercial fishing employers in the region encouraged participation by word-of-mouth. Recruitment was not by specific invitation. The exact size of the group of commercial fishermen in this region is unknown. Therefore, a response rate to the survey could not be calculated for this convenience sample at any of the three locations.

Table 2.2. Survey questions for which results are reported. Reprinted with permission from J Agromedicine.[27]

Question No.	Question	Sample Responses
1-5	Age, gender, race, ethnicity, immigration status, residence in U.S.	Standard
6	What is your primary language? (Language spoken at home)	English Spanish Vietnamese
7	How well do you speak English?	Not at all – Very Well (5 "point" scale)
8	How long have you been in commercial fishing?	<1 year, 1-3, 3-5, 5-10, 10-15, >15 years
9	Which of the following is your major catch as a commercial fisherman? Select only one.	Shrimp Long line Other
10	Which of the following best describes your job in commercial fishing? Select only one.	Owner/captain Deckhand
13	Where do you fish most of the time? Select only one.	Bay Gulf
16	Average number of hours worked per day in commercial fishing	8, 8-12, 12-16, >16
17	Average number of days worked per year in commercial fishing including maintaining and repairing the boat and equipment	<50, 51-100, 101-200, >200
19	How risky is your work?	Very safe Safe Neutral Risky Very risky
23	Are you covered by Workers' Compensation insurance?	Yes or No
24	Do you believe that drinking beer or alcohol while working at sea causes accidents?	Yes or No
25	Which of the following could you show and tell how to use correctly in case of an emergency? Select all that apply.	Personal flotation device (PFD) Survival craft EPIRBs
26	Which of the following could you show and/or tell how to take care of correctly? Select all that apply.	Machinery hazards Abandoning vessel Fighting fires Man overboard
27	Do you receive safety training every year?	Yes or No
28	What format is the best way for you to learn safety information? Select only one.	Classroom Hands-on Classroom and hands-on
29	In which language would you rather have safety training? Select only one.	English Spanish Vietnamese
30	Would you be in favor of a dockside exam at the time you renew your fishing license?	Yes No Depends, on what?

Almost all participants were male (96.7 percent) with well over half being 40 years of age or older (60.9 percent). A majority of the group were of Asian descent (57.1 percent) and approximately one-quarter Hispanic (26.3 percent). Only 13.5 percent were white, one respondent was black (African American), and three selected “other”. Over half claimed to speak little or no English (52.0 percent). Ninety (90) percent of the group reported they were either vessel owners/captains or deckhands, roughly evenly divided (47.4 percent owner/captain, 42.9 percent deckhand). The survey would only allow for one selection of job or role in commercial fishing. The remainder (ten percent) who responded to the question indicated their role in “processing” or “other” category. Similarly, bay and Gulf fisherman were roughly evenly divided based upon self-report of predominant fishing location (42.9 percent and 54.9 percent respectively). Gulf fishing is typically characterized by greater distances from shore and longer periods at sea, often with greater inherent risks. Nearly half had been engaged in commercial fishing for longer than 15 years (45.1 percent) with the predominant catch being shrimp (58.6 percent).

Regarding a global perception of work safety risk, nearly 60 percent of the respondents indicated that the job was very safe to neutral (59.4 percent). As the survey questions in Table 2.2 indicate, the fishermen were not asked to qualitatively rate the perceived magnitude of specific or component risk factors. Instead, in this initial survey, they were asked to indicate if they felt they could correctly perform certain work tasks or use emergency equipment recognized as being associated with selective occupational risks in commercial fishing. In excess of 80 percent believed that alcohol use or consumption

Table 2.3. Summary Findings of Commercial Fishermen Survey, U.S. Coast Guard Eighth District, Port of Galveston Area (n=133). Reprinted with permission from J Agromedicine.[27]

Demographics of Commercial Fishermen (CF) in Port of Galveston Area	**Type of Work, Perceptions/Beliefs**	**Can Use Safety Equipment or Apply Procedures**	**Training Participation/ Preferences**
60.9% > or = to 40 years old 96.7% male 3.3% female 57.1% Asian (n=76) 26.3% Hispanic (n=35) 13.5% Caucasian (n=18) 3.0% Other (n=4) 52.0% speak little or no English	45.1% in commercial fishing > 15 years 47.4% owner/captain 42.9% deckhand 58.6% primary catch is shrimp 42.9% bay, 54.9% Gulf 59.4% consider job very safe to neutral 81.2% believe alcohol causes accidents	91.0% personal flotation device 49.6% survival craft 62.4% electronic beacon 47.4% machine hazards 18.0% drug/alcohol use policies 44.4% chemicals/ preservatives 77.4% favor a dockside exam at time of boat fishing license renewal	42.1% receive safety training every year 35.3% classroom 40.6% hands-on 24.8% class/hands-on

while working at sea causes accidents (81.2 percent). Over 90 percent expressed confidence with their ability to use a personal flotation device (91.0 percent), yet participants were less familiar with use of survival craft (49.6 percent), use of electronic beacons (62.4 percent), and management of machine hazards (47.4 percent). Less than half (44.4 percent) had awareness of procedures surrounding use of chemicals/preservatives and less than a fifth (18.0 percent) of drug/alcohol use policies while working. Fewer than half of the group (42.1 percent) reported receiving safety training every year, though this was not explored in further detail in the survey as to the extent of such training (e.g., formal training versus safety briefing). However, in excess of three-quarters (77.4 percent) favored a dockside vessel exam at the time of boat fishing license renewal. Hands-on training format was considered to be the most desirable (40.6 percent) compared with classroom only (35.3 percent) or a combination of classroom and hands-on formats (24.8 percent) for learning safety information. The work by Carruth et al. in this special issue of the journal offers greater detail as to the preferred source of the training and its format.

Table 2.4 offers observations comparing those in the group who reported their primary catch as shrimp versus the non-shrimper commercial fishermen. Of note is that a larger portion of the shrimpers were 40 years of age or older (73.1 percent compared with 43.6 percent among non-shrimpers). The vast majority of the shrimp fishermen were Asian (82.1 percent) with a comparable proportion whose primary language was Vietnamese (82.1 percent). Among the shrimpers, nearly three-quarters (74.3 percent) had lived in the United States for longer than 15 years with 59.0 percent naturalized citizens. The table also shows that the shrimp fishermen reported nealy twice as much activity in the Gulf compared with their non-shrimper counterparts (70.5 percent versus 32.7 percent) as well as a higher proportion reporting longer work days (87.2 percent versus 54.5 percent working 12+ hours/day). Nearly three-quarters of the shrimpers considered that their work was “very safe”, “safe”, or were “neutral” on this issue (70.5 percent) compared with less than half (43.6 percent) of the non-shrimper fishermen. Interestingly, nearly half (47.4 percent) of the shrimp fishermen reported workers’ compensation insurance coverage with a scarce proportion of non-shrimpers reporting such coverage (2.0 percent). Surprisingly, 59.0 percent of shrimp fishermen reported receipt of safety training every year while less than a fifth of non-shrimpers (18.2 percent) reported this to be the case. This finding may have resulted from an absence of detail as to the extent or definition of safety training in the survey.

Table 2.4. Observations comparing shrimpers (n=78, 58.6%) and non-shrimper (n=55, 41.4%) commercial fishermen.* Reprinted with permission from J Agromedicine.[27]

	Shrimpers %	**(n=78)**	**Non-Shrimpers %**	**(n=55)**
Age > or = 40 years old	73.1	57	43.6	24
Asian	82.1	64	21.8	12
Naturalized citizens	59.0	46	20.0	11
Lived in US > 15 yrs	74.3	58	29.1	16
Vietnamese is primary language	82.1	64	20.0	11
Fish primarily in Gulf	70.5	55	32.7	18
Fish 12+ hours/day	87.2	68	54.5	30
Fish > 200 days/year	62.8	49	85.5	47
Consider job very safe, safe, neutral	70.5	55	43.6	24
Covered by Workers' Compensation	47.4	37	2.0	1
Receive safety training every year	59.0	46	18.2	10

*Self-report of primary catch

Discussion

Cultural factors, work practices, risk perception, and receptivity to safety training may influence occupational morbidity and mortality among commercial fishermen, particularly shrimp fishermen. A better understanding of these factors and potential barriers in the USCG Eighth District may explain the apparent lack of a decline in fatalities associated with training and interventions which have been implemented elsewhere. Reducing this knowledge gap to influence proactive safety behaviors is likely to have an impact on work injuries and fatalities. The development of suitable and effective interventions toward this end requires consideration of factors which may influence engagement in safety activities such as training and adoption of safety behaviors. The "process of change" in behavior often begins with awareness about the causes, consequences, and remedies of a particular behavior.[20] This may include a health behavior which can impact work or an unsafe work practice. Interventions that increase awareness such as education can, therefore, be applied. In commercial fishing, this education has actually become a requirement in the form of instruction, drills, and safety orientation for vessel personnel that operate beyond the boundary line (as in the Gulf).[21]

Though there is considerable knowledge regarding measures that can be taken to improve safety on commercial fishing vessels,[13] little basic information is available about this particular commercial fishing population, including the subset of shrimp fishermen, concerning the adoption of these measures. The application of these measures is largely a function of risk perception among fishermen and the education they receive to ready them for sea. Despite high injury and fatality rates among commercial fishermen, safe work is often not given a high priority by these workers.[22] The traditional concern by small fishing vessel enterprises concerning the added cost of safety is one explanation which has been offered. However, behavioral and psychological factors are also at play. Attitudes of fatalism and risk acceptance, along with risk perception, social norms, and cultural patterns have negatively influenced the adoption of safe work practices.

The effectiveness of prevention depends on the successful communication/dissemination/transfer of knowledge to a participatory audience in the face of the behavioral balance between concern for safety and resignation to accept hazards and risks as inherent to the work.[23] Thus, prevention effectiveness requires, at minimum, characterization within the at-risk population of potential influences on or barriers to a "process of change" activity such as increased awareness of safety. The purpose of this cross-sectional survey was to identify some of these factors among Gulf Coast commercial fishermen, such as type of work and fishing activities, general or global perceptions and beliefs related to safety and accidents, self-report of ability to use safety equipment or apply procedures aboard vessel, and training preferences.

Given the large proportion of Vietnamese fishermen, it is important to recognize that cultural factors, including language barriers, may influence perceived behavioral control, as well as receptivity to safety instruction and preferences for delivery format of the information. Large numbers of Cambodian and Vietnamese refugees began arriving in the United States in the mid-1970s, facing socioeconomic challenges and language barriers different from other Asian subpopulations established in this country for many generations.[24] Older Vietnamese refugees have more problems with language acculturation than their younger counterparts.[25]

The survey results describe a group of commercial fishermen who are primarily male and largely of Asian racial make-up, with a significant self-reported language barrier that may be related to training intervention efforts. This is of particular importance among shrimp fishermen who make up nearly 60 percent of the group and who are predominantly older immigrant Asian males whose primary language is Vietnamese. Nearly three-quarters of them operate in the "riskier" waters of the Gulf and most fish more than 12 hours per day subjecting them to fatigue. Alcohol consumption may be a contributer to accidents. Though there is considerable fishing experience among the group and a general perception that the work is safe, a third to half of respondents expressed doubt about their knowledge of using essential safety equipment in the event of emergency, of safety policies/procedures, and of managing selective hazards. Overall, fewer than half of the commercial fishermen receive safety training every year. Anecdotally, past participation in drills training by this group has been limited.

These two observations, in particular, are of paramount importance. Well over half of the fishermen surveyed perceived their jobs overall as being safe or neutral, with 70 percent of shrimp fishermen expressing this sentiment. At the same time, these fishermen operate in riskier waters, work longer hours, and express doubt about their abilities surrounding safety measures. These observations imply an opportunity for intervention through increased training and awareness of risk factors and safety measures, if receptivity to such interventions can be enhanced. Though respondents were not asked to grade specific risk factors, it is clear from their expressed doubt about the ability to correctly use survival craft, lack of knowledge surrounding machine hazards, and their belief that alcohol contributes to accidents (Table 2.3), that these areas should be emphasized through training and related measures.

Despite low risk perception and knowledge gaps, there is an apparent willingness and readiness among the group to undergo hands-on training and in support of examinations of their vessels to insure safe operation (VDE at the time of fishing vessel license renewal). The VDE serves as mechanism to improve “readiness for sea” and its performance at the time of vessel license renewal would insure periodic assessment of this state of readiness perhaps combined with training. In fact, between December of 2006 and

September of 2007, three separate training sessions were held along the coast of Texas and Louisiana, with 80 captains trained. The training, well received, was largely conducted in Vietnamese, and the support materials were developed as bilingual documents.

Regarding generalizabiilty of the findings of the present study, undertaken in a convenience sample of commercial fishermen, "widespread experience indicates the impossibility of a true random sample for interviewing shrimpers."[26] This poses inherent limitations for obtaining representative responses in such a population as a result of selection bias. Furthermore, the exact number of fishermen in this region (even prior to several subsequent hurricane events) is unknown, leading to the absence of a survey response rate. There is a state registry of annually licensed commercial fishing vessels. However, there is no such registry, to our knowledge, of actual fishermen. Though it would seem straight forward to make estimates of the number of fishermen, there are several limitations in doing so. The population of deckhands, in particular, fluctuates and is transient. There is no specific record of the number of fishermen aboard a given vessel. Vessels "migrate" and make their landings at several ports along the coast, not just those in and near Galveston. All of these factors make it difficult to know with any precision the size of the population from which the convenience sample was drawn. However, significant efforts were made to recruit a random selection of participants through community announcements and word-of-mouth, who would be representative of commercial fishing groups in nearby ports along the Gulf.

Conclusions

Commercial fishermen represent a unique population with a high occupational fatality rate. The intent of studying this convenience sample was to characterize this group in order to enhance the effectiveness of future potential interventions, particularly in the context of training and awareness. In order to design an effective intervention of this nature, it was necessary to characterize potential influences on or barriers to safety among Gulf Coast commercial fishermen. The demographic make-up of the group (particularly among shrimp fishermen) consisting largely of older Vietnamese males was an important observation. Perception of safe work in the face of significant gaps in safety knowledge, preference for a hands-on training format, and cultural barriers such as language, were additional important findings in anticipation of developing safety training which could be more broadly applied and received in this region among this vulnerable population.

Cultural factors readily influence perception of occupational risk among commercial fishermen as further outlined in the manuscript by Carruth et al. in this special issue of the journal. These cultural influences lend to regional differences in perception of risk and receptivity to training among the fishermen. The perception of the work as "very safe to neutral" by a majority of the fishermen overall and by 70 percent of the shrimp fishermen leads to an inference that they assume what is recognized as significant occupational risk in the face of limited awareness of or appreciation for the magnitude of these risk factors. The disproportionately high make-up of the group of shrimp fishermen by Vietnamese, further emphasizes the relative importance of these cultural factors and regional differences. The companion article (Carruth et al.) outlines factors that influence receptivity to training/education on issues which reduce risk, thereby potentially improving the circumstances for these workers. There are few other studies or reports among commercial fishermen nationally or internationally which explore the cultural influences described in these two manuscripts (except as cited in the paper by Töner and Eklöf, 2002).[22]

Since the performance of this survey, the role of several other external factors relative to occupational risk, such as economic determinants (e.g., the price of diesel fuel), weather disasters (e.g., hurricanes Katrina, Rita, and Ike), and most recently, the Deep Water Horizon Well explosion and spill has yet to be determined. Due to the impact of the oil spill on regional fisheries, some commercial fishermen are diverting use of their vessels for remediation and clean-up operations while others are traveling greater distances to fish, both of which may increase potential for and introduce new risk. The resulting economic pressures from these tragedies may also influence diverted attention from safety considerations due to their cost in time and resources. Some of these concerns are explored in a key informant interview also included in this special issue of the journal.

The initiative described in this manuscript requires an approach that relies heavily on community trust and input, while considering the cultural factors which may significantly impact success. Such an approach is formative, often slow, and incremental, but more likely to yield desired outcomes. Collaborating with key partners such as the U.S. Coast Guard has been essential to accomplishing these preliminary steps to developing or adapting available educational materials in a culturally appropriate and desirable way. One element which must be addressed in training programs is to increase the awareness among fishermen about the severe occupational risks inherent in this type of work.

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CHAPTER III

HEARING LOSS AND NOISE EXPOSURE AMONG COMMERCIAL FISHERMEN IN THE GULF COAST[*]

Synopsis

Introduction: Noise is a hazard in commercial fishing. This cross-sectional study associates occupational noise exposure with hearing loss in commercial fishermen.

Methods: A comprehensive survey and audiometric testing were administered to 227 participants in the Gulf Coast. Sound level measurements were obtained aboard a sample of fishing vessels. Criteria specific for hearing impairment (HI) and noise-induced hearing loss (NIHL) were applied to each audiogram.

Results: The majority of these fishermen work shifts more than 16 hours for an extended duration. Hazardous noise levels were measured in the engine rooms ranging from 94.8 to 105.0 dBA. NIHL was significantly associated with years spent fishing, but not with age. HI was significantly associated with age, but not with years fishing.

Conclusions: Commercial fishermen in the Gulf may be at considerable risk of occupational NIHL and would benefit from hearing conservation programs.

[*] This is a non-final version of an article published in final form in Hearing loss and noise exposure among commercial fishermen in the Gulf Coast by Levin JL, Curry WF, 3rd, Shepherd S, Nalbone JT, Nonnenmann MW. *J Occup Environ Med*. 2016;58(3):306-313. Available online: https://journals.lww.com/joem/Abstract/2016/03000/Hearing_Loss_and_Noise_Exposure_Among_Commercial.14.aspx .

Introduction

Commercial fishermen are a largely underserved occupational population even though commercial fishing is one of the most dangerous occupations in the United States.[1] Of the four major United States fishing regions, the Gulf Coast accounted for 23% of the U.S. commercial fishing fatalities from 2000 to 2009.[1] The highest overall number of fatalities occurred within the shrimp fishery along the Gulf Coast (55 deaths), making it one of the most hazardous fisheries in the United States.[1] Almost half of the total commercial fishing deaths in the Gulf of Mexico (46% of 116 deaths) during that time frame were caused by falls overboard, with the Gulf of Mexico also having the highest percentage of fatalities due to on-board injuries.[2] Similarly, among shrimp fishermen of the Gulf of Mexico, falls overboard accounted for the majority of fatalities (29, 53%), with the largest proportion of the remaining deaths due to on-board injuries (12, 22%), followed by vessel disasters (10, 18%). This is in contrast to U.S. commercial fishing fatalities as a whole, in which over half of the fatalities occurred from vessel disasters (flooding, vessel instability, being struck by a large wave).[1] Clearly, the Gulf of Mexico stands out in terms of the frequency of fatalities from falls overboard as well as on-board injuries. Yet, potential contributing risk factors are not well understood.

Among the many workplace hazards present in the commercial fishing industry, occupational noise exposure is largely under-recognized. However, it may substantially contribute to noise-induced hearing loss (NIHL), a potential safety issue aboard these fishing vessels. High noise levels[3] and hearing loss[4] are associated with increased risk of occupational injury, and hearing loss could be a risk factor impacting the injury and fatality rate among these fishermen. Since NIHL is irreversible but completely preventable,[5] it may be necessary to incorporate hearing conservation into the safety training of commercial fishermen.

Occupational hearing loss is one of the most common work-related illnesses in the United States.[6] The prevalence of hearing loss among workers on fishing boats is largely unknown, but it has been reported as high as 50.5%.[7] Workers are exposed to excessive noise predominantly in the engine rooms aboard fishing vessels.[8] Short-term exposure to high noise levels can cause a temporary threshold shift (TTS), a transient decrease in hearing sensitivity.[9] With repeated or chronic exposure to TTS-inducing noise, a permanent threshold shift, or irreversible hearing loss, can result.[9] Exposure to high noise levels and extended work shifts predispose commercial fishermen to a significant risk of occupational NIHL.

Statutory authority over commercial fishing vessels is shared by both the Occupational Safety and Health Administration (OSHA) and the United States Coast Guard (USCG). OSHA jurisdiction of commercial fishermen extends to three nautical miles from the coastline, except off the Gulf Coast of Texas, Florida, and Puerto Rico where it increases to nine nautical miles, at which point the USCG claims jurisdiction.[10] When it comes to working conditions aboard commercial uninspected fishing vessels, the USCG is the lead agency and has authority to set and enforce regulations with regard to safety and health.[10] Under Section 4(b)(1) of the Occupational Safety and Health Act (OSH Act), when another federal agency has statutory authority over working conditions affecting occupational safety or health, the OSH Act does not apply.[11] While the USCG recommends noise limits aboard ships,[12] it has not promulgated an occupational noise regulation. Therefore, with regard to noise exposure in commercial fishing, OSHA is the primary regulatory agency,[10] and the occupational hearing conservation standard for general industry, 29 CFR 1910.95, applies. However, OSHA has previously been precluded from conducting safety inspections at worksites with ≤ 10 employees within the shellfish fishing industry via directives created through Appropriations legislation.[13] Moreover, inspections by the USCG focus primarily on lifesaving equipment, fire protection equipment, and vessel stability. Ultimately, hearing conservation in the commercial fishing industry is not enforced.

The primary objective of this cross-sectional study was to correlate hearing loss among commercial fishermen with their level of noise exposure aboard fishing vessels. To do this, we examined the prevalence of hearing loss in three regional samples of Gulf Coast commercial fishermen, the duration and characteristics of their involvement in the fishing industry, and noise levels in the engine rooms and crew compartments aboard a sample of commercial fishing vessels.

Methods

Study Design and Participants

A reliable enumeration of the commercial fishermen operating on vessels along the Gulf Coast is not available. Most vessels are privately owned with crews of three or fewer including the owner/captain. In this observational, cross-sectional study, participants were recruited from three areas along the Gulf Coast in Louisiana and Texas as part of a National Institute for Occupational Safety and Health (NIOSH)-supported Southwest

Center for Agricultural Health, Injury Prevention, and Education project. This project was designed to characterize workplace factors and lifestyle behaviors that may contribute to commercial fishing morbidity and mortality. These three locations were identified with input from the USCG as ports with large commercial fishing operations and landings, including two port locations for Louisiana (Abbeville west of New Orleans and Belle Chasse near New Orleans) and one for Texas (Houston). Shrimp is the major fishery at these locations.

Public service announcements and multimodal recruitment efforts were developed for each area with the assistance of local representatives, the Area Health Education Center (AHEC), agricultural extension, and USCG representatives inviting commercial fishermen over the age of 21 to voluntarily complete a survey accompanied by audiometric testing. Other multimodal recruitment efforts included announcement of the survey/testing along with placement of postings (in multiple languages) both dockside and in other venues frequently attended by the fishermen (church, marine supply, community center, etc.), beginning at least two weeks in advance of data collection events. Other forms of health screening, safety/drills training, and nominal incentives were offered to enhance participation. The inclusion criteria consisted of all adults engaged in commercial fishing along the Gulf Coast with a primary spoken language of English, Vietnamese, or Spanish. The participants were enrolled at random on a "first-come" basis on the day of survey administration and testing. Survey/testing was administered on April 7, 2008 in the Houston, TX area; December 15, 2008 in the Belle Chasse, LA area; and December 18, 2008 in the Abbeville, LA area. No specialized classes of subjects or those considered as vulnerable populations were recruited for the study outside of the requirement that participants have an active work role in fishing operations. Ethics approval was obtained from the University of Texas Health Science Center at Tyler Institutional Review Board, and all participants signed an informed consent form.

Survey

The survey was administered to 227 participants among the three regional samples using skilled surveyors from the AHEC, agricultural extension service, and other collaborating groups. Individuals trained in the primary language of the participants and with knowledge and experience in maritime operations were used to translate the survey to Vietnamese and Spanish. Questions focused on demographic factors, hearing and prior noise exposure, fishing activities, perceptions of safety risk, and training considerations. The survey tool was developed building upon a prior questionnaire administered to Vietnamese fishermen at the Port of Galveston, Texas[14] and was a component of a larger study designed to examine multiple occupational safety and health risk factors, attitudes, and behaviors to be reported elsewhere.

Sound Level Measurements

Sampling for noise was performed in the engine compartments and crew compartments of four commercial shrimping vessels. Area sampling was conducted with a Type 2 Quest 2900 Datalogging Sound Level Meter equipped with an OB-100 Octave Band Filter conforming to ANSI S1.4-1983 R1997. The frequency components of the noise were analyzed and weighted for human hearing using the typical A-weighted scale (dBA) developed from the 40 phon curve of the Fletcher-Munson equal-loudness contours

(ISO 226:1987). These data were used to create a noise-frequency spectrum. Personal sampling was conducted with two Quest Q-300 Type 2 dosimeters (meeting the requirements of ANSI S1.25 – 1991 and ANSI S1.4 – 1983) for a duration of 30 minutes aboard each vessel. Dosimetry measurements were recorded as L_{AVG}, an A-weighted sound level average over the duration of the sampling as fast time weighted using a threshold of 70 dB and an exchange rate of 5dB, and reported in dBA. All instrumentation was calibrated before and after field use with a QC-10 pure tone calibrator.

Hearing Ability

For each participant surveyed, hearing ability was measured in both ears using pure-tone audiometry at the following frequencies: 0.5, 1, 2, 3, 4, 6, and 8 kHz. Hearing threshold levels (HTL), or the intensity of sound below which no sound is detected, were measured in decibels (dB) at each frequency and recorded in 5-dB increments. Prior to audiometric threshold testing, participants were encouraged to avoid exposure to noise for at least 14 hours. A third-party mobile testing service conducting audiometry conforming to current OSHA standards was used to perform the hearing tests. Testing equipment was previously calibrated according to Appendix E of OSHA's hearing conservation standard. Audiometric tests were administered by trained audio technicians certified by the Council for Accreditation in Occupational Hearing Conservation. All participants were tested in a soundproof booth meeting ambient noise level standards at multiple frequencies as prescribed by the OSHA standard. Translators were available to ensure that participants were able to comply with performance instructions.

Hearing Loss Determination and Classification

Hearing impairment (HI) was defined as an average HTL among frequencies 1, 2, 3, and 4 kHz > 25 dB in either ear. This definition was proposed by the American Speech-Language-Hearing Association (ASHA) Task Force in 1981[15] and is an accurate predictor of hearing disability[16] since it is important to human speech[17] and is aimed at evaluating a material impairment rather than a compensable illness.[9,18] For the purpose of this study, since asymmetrical, or unilateral, hearing loss can affect the ability to localize sounds,[19,20] the worse ear was used in the classification and data analyses in order to categorize participants and quantify HTLs. The worse ear was defined as the ear with the greater average HTL among 1, 2, 3, and 4 kHz. In the case of equal averages, secondary (0.5, 1, 2, and 4 kHz) and tertiary (3, 4, and 6 kHz) averages were used. The degree of hearing loss was classified according to ASHA as normal (≤ 25 dB), mild (26 – 40 dB), moderate (41 – 55 dB), moderately severe (56 – 70 dB), severe (71 – 90 dB), and profound (> 90 dB).[21]

Audiometric NIHL Criteria

NIHL was defined for each participant by a set of criteria applied to audiometric analyses of the National Health and Nutrition Examination Surveys (NHANES) participants from 1999 to 2004[22] based on an audiometric notch at 4 kHz. An audiometric notch maximal at 3, 4, or 6 kHz with improvement at 8 kHz is typical of NIHL but can be obscured by age-related hearing loss, or presbycusis, which causes an effacement of the notch.[23] It is also important to note that spurious notches are known to occur in non-noise exposed populations.[22,24] Thus, NIHL cannot be diagnosed simply on the presence of a notch, but rather, in combination with a positive history of noise exposure.[25] To define the notch suggestive of NIHL, each of the following criteria was used: (1) HTL at 4 kHz ≥ 25 dB, (2) HTL at 4 kHz ≥ 10 dB worse than the HTL at 2 kHz, and (3) HTL at 4 kHz ≥ 10 dB worse than the HTL at 8 kHz.[22]

It is recognized that, among older individuals, it may prove difficult to distinguish age-related hearing loss from the effects of noise without the availability of prior audiograms. While notches may occur in the non-noise exposed, guidance from the American College of Occupational and Environmental Medicine (ACOEM) identifies notching of the audiogram as the first sign of NIHL.[5] The prominence of the notch may be blunted by the effects of noise on adjacent frequencies or of presbycusis. The latter results in a down-sloping pattern of the audiogram in the high frequencies. The National Hearing Conservation Association reiterates that the presence of a noise notch is usually indicative of hearing loss due to noise exposure.[26] Furthermore, the latter guidelines emphasize that such hearing loss should be construed as work-related (more likely than not), "unless there are clear and cogent reasons why the loss is entirely unrelated to the work environment."[26,27]

Data Analyses

Descriptive statistics were calculated from the survey results and presented as counts and percentages. A total of 227 audiometric tests were performed. After excluding 30 due to incomplete or missing survey or audiogram data, 197 audiometric tests were included in the data analyses. For each audiometric frequency tested, mean HTLs were presented by ear, by years of experience in commercial fishing, and by age group. Years of experience in commercial fishing as an independent risk factor for NIHL and HI was examined, and these results were adjusted for age to control for its confounding effect. Since age is an established cause of hearing loss, we assessed it independently as a risk factor as well, and these results were adjusted for years of experience. Measures of association were computed from 2x2 contingency tables and reported as odds ratio (OR) with a 95% confidence interval (CI). Adjusted OR and 95% CI were calculated according to the Cochran-Mantel-Haenszel method. A p-value < 0.05 was considered statistically significant. Data analyses were conducted using Microsoft Excel 2010 (Microsoft Corporation, Redmond, WA, USA).

Results

Characteristics of Participants

Our survey sample included 227 participants with their demographics and hearing-related history obtained from the survey summarized in Table 3.1. Of note, not all participants answered every question. These participants ranged in age from 21 to 74 years (median = 49 years). They were predominantly male (86.3%) and of Asian origin (94.7%) with a primary spoken language of Vietnamese (96.9%). The majority of them denied having hearing problems due to exposure to loud noise and/or chemicals in prior occupations or military service (86.5%). Most of them also denied having noisy hobbies (78.3%) as well as any history of hearing problems (89.3%).

Occupational Noise Exposure Assessment

Participant fishing-related activities are summarized in Table 3.2. Almost all of the participants were involved in commercial shrimp fishing (99.1%). Crew sizes were relatively small as 62.7% of participants reported working with crews of three or four

Table 3.1. Demographic Characteristics of Participants (n = 227).* Reprinted with permission from J Occup Environ Med.[31]

Variable	n	(%)
Age, years (median = 49)		
< 40	24	(11.4%)
40 - 44	29	(13.8%)
45 - 49	52	(24.8%)
50 - 54	54	(25.7%)
55 - 59	30	(14.3%)
60+	21	(10.0%)
Gender		
Male	196	(86.3%)
Female	31	(13.7%)
Race		
Asian	215	(94.7%)
White	7	(3.1%)
Black	2	(0.9%)
American Indian/Alaska Native	2	(0.9%)
Native Hawaiian/Pacific Islander	1	(0.4%)
Primary language		
Vietnamese	220	(96.9%)
English	6	(2.6%)
French	1	(0.4%)
Noisy hobbies		
No	177	(78.3%)
Yes	49	(21.7%)
Prior occupational exposure to loud noise/chemicals		
No	192	(86.5%)
Yes	30	(13.5%)
History of hearing problems		
No	201	(89.3%)
Yes	24	(10.7%)

*not all participants answered every question

Table 3.2. Commercial Fishing Characteristics (n = 227).*
Reprinted with permission from J Occup Environ Med.[31]

Variable	**n**	**(%)**
Major catch		
Shrimp	224	(99.1%)
Other	2	(0.9%)
Crew size		
1	18	(8.0%)
2	34	(15.1%)
3	91	(40.4%)
4	50	(22.2%)
5+	32	(14.2%)
Duration in commercial fishing		
> 15 years	138	(61.1%)
10 - 15 years	39	(17.3%)
5 - 10 years	24	(10.6%)
< 5 years	25	(11.1%)
Hours / day during active fishing season		
> 16	92	(40.9%)
12 - 16	53	(23.6%)
8 - 12	75	(33.3%)
< 8	5	(2.2%)
Days / month during active fishing season		
22+	139	(62.1%)
< 22	85	(37.9%)
Consecutive days / month during active fishing season		
> 14	155	(68.6%)
10 - 14	36	(15.9%)
7 - 10	24	(10.6%)
< 7	11	(4.9%)
Days / year during active fishing season		
> 200	143	(63.8%)
101 - 200	62	(27.7%)
51 - 100	12	(5.4%)
≤ 50	7	(3.1%)

*not all participants answered every question fishermen. The majority have been involved with commercial fishing for more than 15 years (61.1%). During the active fishing season, most worked more than 16 hours/day aboard the vessel (40.9%) with the majority having reported working more than 12 hours/day (64.5%). Most worked more than 22 days out of the month (62.1%), and 68.6% reported that those days are worked consecutively for at least 14 days in a row. On a yearly basis, the majority reported working more than 200 days (63.8%). Regardless of the proportion of work time actually spent sleeping in the crew compartment, these fishermen spend a great deal of time aboard their fishing vessels.

Sound Level Measurements

Sound levels were obtained in the engine rooms and crew compartments aboard four representative commercial fishing vessels, and the findings are shown in Table 3.3. The number of operating engines and generators varied among each vessel at the time of measurement. Using the dosimeter, the noise levels in the engine rooms ranged from 94.8 dBA to 105.0 dBA. As expected, the highest sound level was recorded in the engine room on the vessel with two operating engines and generators, and the lowest sound level was recorded on the vessel which had only one operating engine. Using the sound level meter, the resultant sound levels in the engine rooms ranged from 95.1 dBA to 102.5 dBA. Interestingly, the highest noise level was obtained from the vessel with two operating engines but only one operating generator. Additionally, the lowest noise level was observed from the vessel with one operating engine and two operating generators, as opposed to the vessel with only one operating engine. The sound levels in the crew compartments were quieter, ranging from 62 dBA to 70 dBA.

Audiometry

Mean HTLs at each frequency for the left and right ears as well as the worse ear are shown in Figure 3.1. Overall, the left ear was slightly more hearing-impaired than the right ear. In the worse ear, the threshold for normal hearing (25 dB) was exceeded at each frequency with the exception at 1 kHz. Hearing loss was more pronounced at the higher frequencies (3 kHz to 8 kHz) and most prominent at 4 kHz.

The mean HTLs at each frequency for the worse ear by years spent in the commercial fishing industry are shown in Figure 3.2. As the duration in commercial fishing increased, the degree of hearing loss worsened, especially at higher frequencies. Also, the notch at 4 kHz, which is characteristic of NIHL, became more distinct.

Table 3.3. Sound Level Measurements (in dBA) from Commercial Fishing Vessels. Reprinted with permission from J Occup Environ Med.[31]

	Vessel 1	**Vessel 2**	**Vessel 3**	**Vessel 4**
# Engines in operation	1	2	2	1
# Generators in operation	2	2	1	0
Location				
Engine room				
Dosimeter (L_{AVG})*	95.8	105.0	100.0	94.8
Sound Level Meter†	95.1	100.7	102.5	96.5
Crew compartment				
Sound Level Meter	64	70	68	62

*sampling duration = 30 minutes
†calculated from A-weighted sound levels from a spectrum of frequencies, 32 Hz to 16,000 Hz

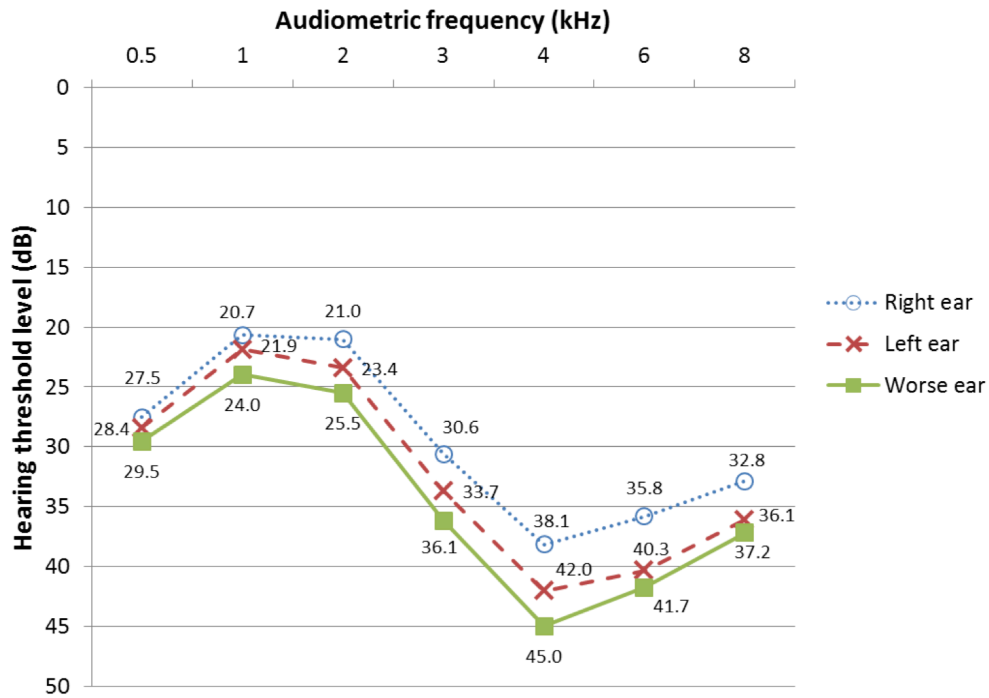

Figure 3.1. Mean hearing threshold levels in the sample of commercial fishermen for both ears and the worse ear at all frequencies tested. Reprinted with permission from J Occup Environ Med.[31]

A similar trend in hearing loss was seen in Figure 3.3, which shows the mean HTLs at each frequency for the worse ear by age group. As age increased, hearing became more impaired. For all but the oldest age group, HTLs were worst at 4 kHz, and there was relative sparing of HTLs at 8 kHz. In those age 60 years and above, however, there was no notch at 4 kHz, and the worst HTLs were seen at 8 kHz. Effacement of the notch seems to have occurred in th is age group, and this is consistent with presbycusis.

The prevalence of hearing loss for each set of criteria (as previously defined) is shown in Table 3.4. Using the HI criteria, the prevalence of hearing loss was considerably higher at 59.4%. Almost half (49.3%) of the participants tested were mildly- to moderately-impaired. The prevalence of an audiometric notch suggestive of NIHL by this set of criteria was similarly high at 53.8%.

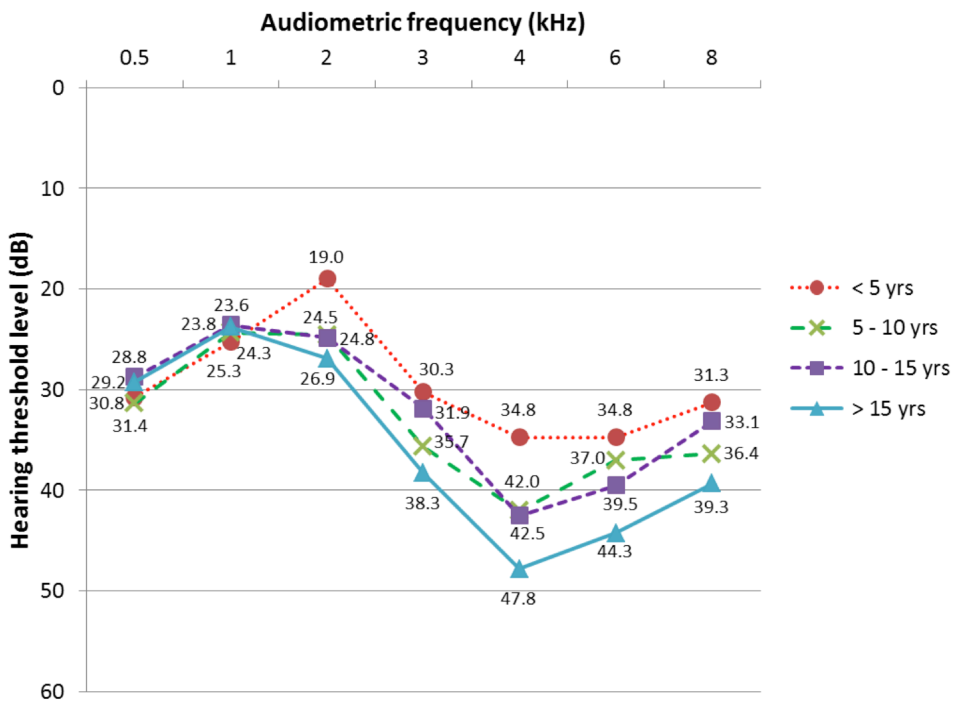

Figure 3.2. Mean hearing threshold levels in the worse ear at all frequencies tested categorized by years of experience in the commercial fishing industry. Reprinted with permission from J Occup Environ Med.[31]

Correlation Among Experience, Age, and Hearing Loss

In order to perform measures of association between study groups and a reference group, the groups were defined as illustrated in Figure 3.4. Of the 197 audiometric tests included in the analyses, 117 met criteria for HI, and 106 met criteria for NIHL. Of those

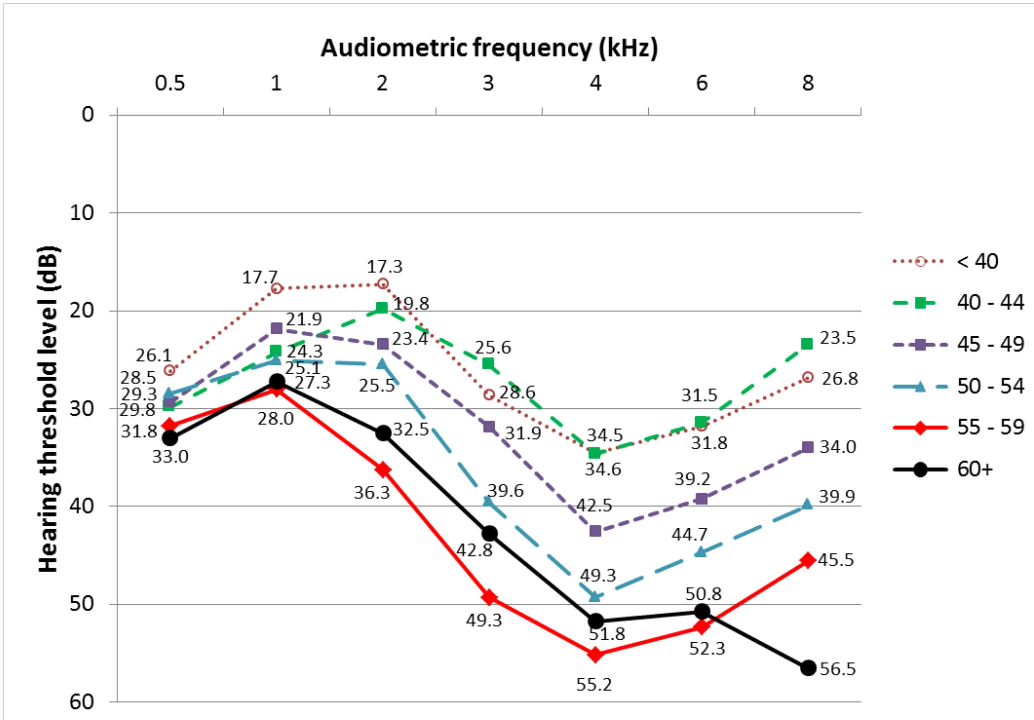

Figure 3.3. Mean hearing threshold levels in the worse ear at all frequencies tested categorized by age group. Reprinted with permission from J Occup Environ Med.[31]

Table 3.4. Prevalence of Hearing Loss by Criteria. Reprinted with permission from J Occup Environ Med.[31]

	n	(%)
Hearing Impairment (HI) criteria		
Normal (≤ 25 dB)	80	(40.6%)
Hearing Impaired	117	(59.4%)
mild (26 – 40 dB)	60	(30.5%)
moderate (41 – 55 dB)	37	(18.8%)
moderate-severe (56 – 70 dB)	16	(8.1%)
severe (71 – 90 dB)	3	(1.5%)
profound (> 90 dB)	1	(0.5%)
Noise-Induced Hearing Loss (NIHL) criteria		
Normal	91	(46.2%)
NIHL	106	(53.8%)

who met criteria for NIHL, 73 also met HI criteria and were labeled as “more impaired.” Only 33 met criteria for NIHL only and were labeled as “less impaired.” The 44 who only met HI criteria were labeled as “non-NIHL.” Lastly, there were 47 who had normal audiograms that met neither criteria and were used as the reference group.

Associations between the study groups and the following independent risk factors are summarized in Table 3.5: (a) greater than 15 years of experience in commercial fishing and (b) age greater than 50 years.

a. A significant association ($p < 0.05$) was revealed between experience greater than 15 years and NIHL (OR 2.51) even after adjusting for age (OR 2.23). This association was highly significant ($p < 0.01$) among those with NIHL who were more impaired (OR 2.81, age-adjusted OR 2.34). There was also a significant association between years of experience and those who had HI (OR 2.46); however, this was not maintained after adjusting for age (OR 2.04).

b. No association was observed between age over 50 and NIHL (OR 1.70, adjusted OR 1.37, $p > 0.05$). Even though there was an association in the more impaired NIHL subgroup (OR 2.39), it was not upheld after adjusting for experience. There were highly significant associations ($p < 0.01$) between age over 50 and HI (OR 2.63) as well as the non-NIHL subgroup (OR 3.09) even after adjusting for years of experience.

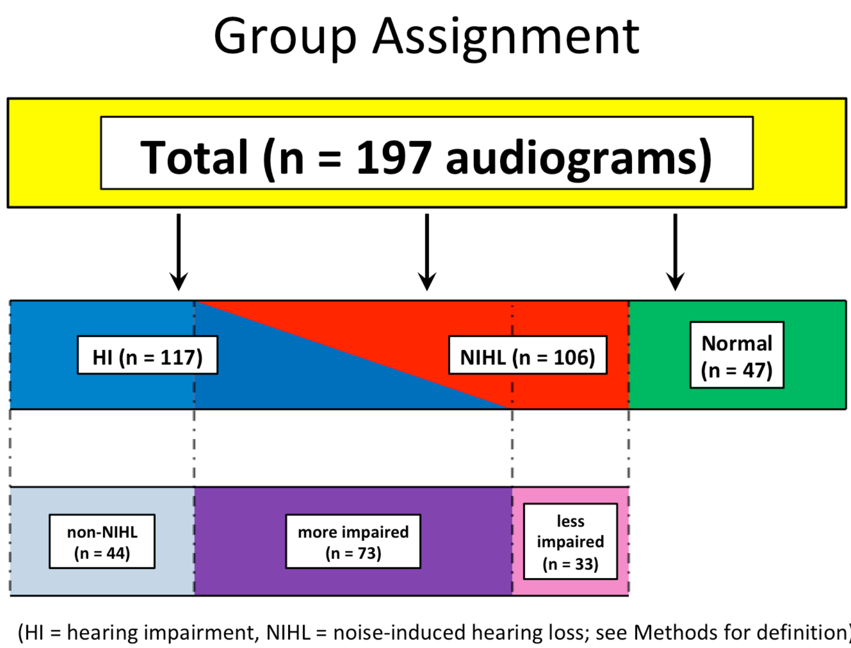

Figure 3.4. Assignment of study groups after application of HI and NIHL criteria to each included audiogram. Overlapping of HI and NIHL groups leads to formation of the illustrated subgroups. Reprinted with permission from J Occup Environ Med.[31]

Discussion

This study revealed that more than half of the Gulf Coast commercial fishermen tested with pure tone audiometry had evidence of impaired hearing (HI 59.4% and NIHL 53.8%). The high prevalence of an audiometric notch (53.8%) combined with a mostly negative history of non-occupational sources of noise suggests that hearing loss may be due, at least in part, to occupational noise exposure. Most of the fishermen spend a great

Table 3.5. Hearing Loss Associations with Experience and Age.
Reprinted with permission from J Occup Environ Med.[31]

RF	Group	OR	(95% CI)	*p*		Adj OR	(95% CI)	*p*	
Experience > 15 years						†			
	Normal	1.00	Ref	---		1.00	Ref	---	
	NIHL	2.51	(1.24 - 5.09)	0.0104	*	2.23	(1.08 - 4.63)	0.0304	*
	more impaired	2.81	(1.31 - 6.05)	0.0080	**	2.34	(1.04 - 5.23)	0.0386	*
	less impaired	1.99	(0.80 - 4.95)	0.1397		2.17	(0.85 - 5.52)	0.1036	
	HI	2.46	(1.23 - 4.91)	0.0110	*	2.04	(0.98 - 4.21)	0.0547	
	non-NIHL	1.99	(0.80 - 4.95)	0.1086		1.54	(0.64 - 3.72)	0.3463	
Age ≥ 50 years						‡			
	Normal	1.00	Ref	---		1.00	Ref	---	
	NIHL	1.70	(0.84 - 3.44)	0.1415		1.37	(0.65 - 2.87)	0.4198	
	more impaired	2.39	(1.12 - 5.08)	0.0234	*	1.86	(0.84 - 4.15)	0.1274	
	less impaired	0.77	(0.30 - 1.99)	0.5974		0.63	(0.24 - 1.69)	0.3678	
	HI	2.63	(1.30 - 5.30)	0.0069	**	2.23	(1.07 - 4.63)	0.0310	*
	non-NIHL	3.09	(1.31 - 7.26)	0.0097	**	2.72	(1.13 - 6.52)	0.0249	*

RF = risk factor; OR = odds ratio; CI = confidence interval; Adj OR = adjusted odds ratio
Ref = reference group
*$p < 0.05$
**$p < 0.01$
†adjusted for age
‡adjusted for experience

deal of time aboard their fishing vessels especially during the active fishing season. Most work more than 16 hours daily with the majority working more than 12 hours daily for more than 14 consecutive days out of the month. These work shifts extend for more than half of the year. Additionally, it is apparent from the sound level measurements from this study that the fishermen are exposed to hazardous noise levels in the engine rooms aboard their vessels (at times as high as 105 dBA, an intensity level which would not be permissible under current OSHA regulation for greater than one hour). These noise levels, accompanied by an extended duration of exposure given the nature of the work, place the fishermen at significant risk for occupational NIHL. Guidance from ACOEM suggest that the risk of NIHL increases significantly for exposures above 85 dBA.[5] Although the use of hearing protection devices was not specifically addressed on the survey, it was noted during recruitment and noise sampling that these commercial fishermen did not have access to any hearing protection devices while aboard their vessels. While those with NIHL could have had the condition prior to entering into the commercial fishing industry, the vast majority of them denied loud noise exposure with previous occupations, and this was also true with non-occupational noise.

A recent systematic review of NIHL in working life confirms that its incidence is declining in industrialized countries.[28] At the same time, selective occupational groups remain at high risk as in the military, construction workers, the maritime trades, and agriculture workers. Little is known about hearing loss in commercial fishermen where work-related noise exposures may be high, poorly controlled, and/or unmonitored, with limited use of personal protection. Based upon ISO 1999 and recent revisions, median age-related thresholds for US adults and noise-induced permanent threshold shifts at 2, 3, and 4 kHz are consistent with widespread agreement that NIHL is dose-related and increases dramatically for every 5 dB increase in exposure.[27] Moreover, age-related loss progresses with an accelerating trajectory while NIHL progresses with a decelerating trajectory.[27]

After inspecting the mean HTLs for both ears from audiometry, a pattern of NIHL was apparent in this sample (Figure 3.1). The left ear was slightly worse than the right at each frequency tested, and this is consistent with previous audiometric studies.[29] The degree of hearing loss worsened as the duration in commercial fishing increased (Figure 3.2). This observation could be due to the effect of age on hearing as was seen in Figure 3.3. However, the pattern of hearing loss remained consistent with NIHL as age increased until after the age of 60 years, at which point a pattern consistent with presbycusis was observed. Since increasing age causes hearing loss independent of noise exposure, this was considered to be a potential substantial source of confounding. Thus, numeric audiometric criteria specific for NIHL were used in order to circumvent the effect of age. Furthermore, efforts were made to control for this confounder by adjusting for age when testing measures of association.

As can be seen from Table 3.5, NIHL was significantly associated with more years spent in commercial fishing even after adjusting for age, and it was not associated with increasing age when analyzed independently of duration of experience. Based upon this sample, the odds of having NIHL with more than 15 years of work experience in commercial fishing (while adjusting for age) were 2.23 times more likely relative to those with lesser years of exposure (95% CI 1.08 – 4.63, $p < 0.05$). The odds were slightly greater among fishermen with more impairment as determined by HTLs (OR = 2.34, 95% CI 1.04 – 5.23, $p < 0.05$). For those fishermen with NIHL with lesser impairment, there was no statistically significant association with duration of work experience in commercial fishing, irrespective of age adjustment. Overall, age was not considered a source of confounding in those who met criteria for NIHL, with statistically significant associations suggesting an occupational-related cause of NIHL in these commercial fishermen.

Age was a confounder in commercial fishermen who met criteria for HI. A significant association was seen between HI and years spent in commercial fishing, but this association dissipated after adjustment for age (Table 3.5). The odds of having HI with more than 15 years of work experience in commercial fishing were 2.46 times more likely relative to those with lesser years of exposure (95% CI 1.23 – 4.91, $p < 0.05$). However, when adjusted for age, these odds were no longer statistically significant. Also, when testing the association between HI and age (greater than or equal to 50 years versus less than 50 years), independent of years of experience in commercial fishing, the odds of having HI with or without meeting the criteria for NIHL were notable (OR = 2.63 and 3.09 respectively) and highly significant ($p < 0.01$). These associations persisted despite adjustment for duration of experience (> 15 years versus lesser experience), albeit at a lower significance level ($p < 0.05$). These odds ratios suggest that the criteria for HI are more reflective of hearing loss due to aging rather than noise.

When evaluating the association of NIHL with age, independent of duration of work experience in commercial fishing, those fishermen who were more impaired did have a statistically significant odds ratio (OR = 2.39, $p < 0.05$) which faded after adjusting for years of experience. Those fishermen who were less impaired had no statistically significant association with age at all. One explanation is that fishermen with NIHL who were less impaired were younger than fishermen who were more impaired and would not yet have had the chance to accrue experience and thus, excessive noise exposure in commercial fishing. In fact, in this sample, the mean age for fishermen less impaired was 47.2 years compared with an older mean age of 50.7 years for fishermen who were more impaired (data not shown).

Data from ISO 1999 is based upon representative samples of the US population, and while there are racial considerations, there is no specific comparison for Vietnamese. However, at every age, at least for 2, 3, and 4 kHz, men hear worse than women.[27] In the current study, the prevalence of NIHL remained high despite the inclusion of women. Nonetheless, the proportion of women was small (13.7%).

There are a number of study limitations of note. The prevalence of HI (59.4%) and NIHL (53.8%) may represent overestimates due to the criteria used to define hearing impairment or loss in this study. Impaired hearing resulting from noise exposure is, most commonly, bilateral and symmetrical in frequency pattern. However, the degree of impairment at one or more frequencies may not be identical between the ears. Identifying an individual or test subject as having impaired hearing by using the presence of HI in either ear is more inclusive since one ear may be normal or unimpaired. The hearing loss may be due, at least in part, to occupational noise exposure. Nonetheless, in this sample, identifying individuals or test subjects as having impaired hearing only when present in both ears yielded an HI prevalence of 43.7% (not depicted).

Other limitations surround the absence of detail regarding actual circumstances and duration of noise exposure during work activities aboard vessel. While the survey collected information surrounding the work shift and the time spent in the commercial fishing industry, the proportion of time spent at an important source of hazardous noise, the engine room, was not recorded. Those work practices and duration of potential exposure in years of work experience as outlined by the survey are limited by self-report and recall bias of the participants. Anecdotal information suggests one or more hours are spent daily performing activities in the engine room. Also, the amount of time the engines and/or generators were typically operating during a work shift was not determined. It is noteworthy that the occupancy of the engine compartment of the vessel occurs primarily during repair or maintenance activities and that when out of this area, the worker may continue other activities resulting in noise exposures that were not evaluated or measured during the sampling. Thus, an accurate exposure assessment could not be performed.

Ideally, when evaluating for HI and NIHL using audiometry, a baseline audiogram and/or prior audiograms are useful for comparison. Since this study employed a cross-sectional design and these fishermen did not have previous audiograms, there was no baseline to compare against, and no trends in hearing ability could be assessed.

Regarding confounding, age was primarily addressed. Controlling for confounding related to prior noise exposure or non-occupational noise exposure could not be performed due to gaps in survey data. Due to challenges associated with enumerating this work group, it was felt that recruitment strategies resulted in a sample of participants representative of the population of commercial fishermen in this region. However, regarding potential sources of bias, recruitment may have selected for commercial fishermen with hearing loss. Although hearing ability was not the primary focus during recruitment, those with HI may have been more apt to participate once they learned that a hearing test was included. However, self-selection would not have been exclusively on the basis of perceived hearing loss. Rather, fishermen were aware that there would be other health screening tests available such that self-selection could have occurred on this basis (free general health screenings). Also, the use of surveys lends itself to recall bias when participants do not accurately answer historical questions pertaining to exposure risks. Generalizability is a matter of some concern as well. The commercial fishermen in this study were predominantly shrimp fishermen. Commercial fishing in different fisheries such as Bering Sea crab or Atlantic grouper involves different processes and techniques, and this may involve different exposures to noise. However, if noise exposures among different commercial fishing vessels are similar to those in this study, and adequate controls are not in place to reduce these exposures, the same conclusions may apply.

Methods to reduce exposure to noise in the engine rooms of commercial fishing vessels include a hierarchy of controls: engineering, administrative, and personal protective equipment (PPE). These can also be thought of as interventions at the level of the noise source, path, and receiver. Some engineering controls that could be implemented include: sound-dampening engine mounts, engine/generator enclosures, sound curtains, and maintenance/lubrication of engine/generator moving parts. Administrative controls involve limiting the amount of time spent in the engine room and increasing the distance from the engine/generator. Lastly, if engineering or administrative controls are not feasible, ear plugs and/or ear muffs should, at a minimum, be available and worn when inside the engine room. Given economic considerations involved in implementing engineering as well as administrative control measures in a setting of this nature, use of PPE may prove to be the most pragmatic approach in this population.

Conclusions

Commercial fishermen are at considerable risk of occupational NIHL. NIHL can negatively impact physical and emotional function as well as quality of life and employment.[30] This study has helped to elucidate possible associations between occupational noise exposure and NIHL among commercial fishermen in the Gulf, supporting this association independent of age. Nonetheless, additional study is needed to further elucidate the nature of this relationship. Workers on fishing vessels would benefit from a hearing conservation program that includes noise monitoring, annual audiometric testing and evaluation, hearing protection, and education/training on the use of hearing protection. Ultimately, prevention of NIHL may play a role in decreasing the high injury and fatality rate among these fishermen.

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CHAPTER IV

WORKPLACE SAFETY INTERVENTIONS FOR COMMERCIAL FISHERMEN OF THE GULF[*]

Synopsis

Introduction: Commercial fishing continues to have one of the highest rates of occupational fatalities compared with other work sectors in the United States. Attitudes/beliefs among Vietnamese shrimp fishermen of the Gulf of Mexico may influence behaviors that are risk factors for fatal and non-fatal injuries.

Methods: The study employs a community trial with quasi-experimental pretest/posttest intervention design. An advisory group made up of key stakeholders including representatives from the U.S. Coast Guard was assembled. A survey was designed using the Theory of Planned Behavior as the theoretical framework. Three community groups at port sites along the Texas/Louisiana Gulf Coasts were identified. Focus groups were convened at each site to select priority areas for risk intervention using training and awareness measures. Initial and follow-up surveys were administered pre-/post-interventions for each of the three community groups (2008, n=217 completed surveys; 2012, n=206 completed surveys). The follow-up survey was condensed and 'intent to act'

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questions were added for the priority concerns identified (noise-induced hearing loss, machinery/winches, and fatigue).

Results: Statistically significant changes (p ranging from 0.000 to 0.042) were observed in selective attitude/belief responses for hearing/noise and fatigue. Intent to action or to adopt the intervention was high among all three groups of shrimp fishermen (hearing conservation, 82.4%; machinery/winch safety, 94.6%; fatigue awareness, 95.3%).

Conclusions: Simple, yet culturally appropriate training and awareness measures in the form of visual and written safety messages, favorably influence attitudes, beliefs, and behavioral intent related to priority risk factors identified by Vietnamese commercial shrimp fishermen along the Texas and Louisiana Gulf Coasts.

Introduction and Background

Commercial fishing continues to be one of the most dangerous occupations in the United States.[1] Casualties that occur in these jobs are often the result of a combination of human factors, machinery and equipment, and the environmental elements at sea.[2] There has been a gradual decline in the annual number of commercial fishing deaths over the last two decades, but much of this progress has been regionally focused, such as in Alaska.[1,3] Though the historically high rates of work-related fatalities in Alaska might be related, in part, to extreme northern environmental conditions, the fact that, some Nordic countries with similar industrial make-up and extreme environmental conditions had notably lower occupational fatality rates, suggested the existence of other contributing factors.[3,4]

The progress that has occurred in Alaska has been attributed to a comprehensive and concerted effort in establishing surveillance systems to assess occupational hazards and collaboration with partners to develop and evaluate interventions.[3,5] Despite progress, the U.S. occupational fatality rate in the commercial fishing industry remains among the highest in the nation, 23 times higher in 2013 than the rate for all U.S. workers.[6] During the period 2000 - 2009, vessel disasters and falls overboard continued to be the main incidents contributing to this mortality.[1] In this same time period, of total deaths with known fishery type, the largest percentage (47%) occurred while fishing for shellfish, and, among these, the highest number of deaths from falls overboard occurred in the Gulf of Mexico shrimp fishery.

Understandably and reasonably, given that vessel disasters and falls overboard account for the majority of deaths across the U.S., much attention has been given to event/post-event factors such as personal flotation devices, immersion suits, life rafts, and electronic positioning beacons to reduce fatalities.[1,4,5,7,8] Further, regulatory efforts beginning with the Commercial Fishing Vessel Safety Act of 1988 and more recently, the Coast Guard Authorization Act of 2010 have provided for a variety of preparedness requirements in the event of an incident, including vessel dockside examinations and training for workers.[9] However, the availability and proper use of these event/post-event tools is still influenced by behavioral decision-making factors.

Less is actually known of the variables related to occupational morbidity and non-fatal injuries in commercial fishing both in quantity and severity.[10] On-deck dangers have been recognized as an important cause of fatal and non-fatal workplace injuries among Alaskan commercial fisherman, concluding the need for additional attention to worker safety on deck, particularly around deck machinery.[11,12] In the absence of a more complete understanding of the severity of these on-deck incidents, it can be difficult to separate factors that may contribute to both non-fatal and fatal events.

Considering a traditional tiered approach to occupational health and safety intervention design, engineering measures, administrative and work practice controls, and personal protective equipment (PPE) are typically employed. The emergency-stop or E-stop system, used to stop a winch in the event of entanglement or other emergency, serves as an example of an engineering measure installed on commercial fishing vessels.[13] The E-stop, when engaged, locks the winch in place, thereby limiting the extent of an entanglement. Retrofit kits have become commercially available.[14] However, engineering measures may be expensive and impractical in some settings, particularly if hydraulic systems are dated and require more extensive replacement of a winch system in order to retrofit an E-stop. (*Personal Communication to author A.C. from C. Woodward)* Administrative and work practice controls as well as use of PPE may also be hampered by behavioral obstacles and cost.

Risk factors for occupational morbidity and mortality vary by fishery. During 2000 – 2009, falls overboard caused 53% of the fatalities among shrimp fishermen in the Gulf of Mexico, with 22% caused by on-board injuries.[15] During 2000 – 2011, ten percent of the commercial fishing fatalities across the U.S. were due to on-board injuries such as machinery entanglements, occurring most often in the Gulf of Mexico.[16] Of the 35 work-related injuries (eight of which were fatal) occurring in this time frame among the Southern shrimp fleet and involving winches, 74% were in the Gulf of Mexico and nearly 50% off the coasts of Texas and Louisiana.

In this setting, the high cost of some engineering solutions might prevent their adoption. Crew members are to be discouraged from working alone on deck (a significant risk factor) combined with training to include procedures for stopping the winch in the event of an emergency and administering first aid for severe injuries.

There is considerable knowledge regarding measures that can be taken to improve safety on commercial fishing vessels.[17] Yet, the application of these measures are largely a function of risk perception among fishermen and the education they receive to ready them for sea. In spite of high injury and fatality rates among commercial fishermen, safe work is often not given a high priority by these workers.[18] The traditional concern by small fishing vessel enterprises over the added cost of safety is one explanation which has been offered. However, behavioral and psychological factors are also at play. Studies of commercial fishing have revealed that attitudes of fatalism and risk acceptance, along with risk perception, social norms, and cultural patterns have negatively influenced the adoption of safe work practices. Additionally, adopting safety practices as well as altering behaviors may be a function of cultural factors unique to fishermen in select geographic areas such as the Vietnamese shrimpers of the Gulf Coast.[19-21]

The current study focuses on the predominantly Vietnamese shrimp fishery of the Texas and Louisiana Gulf Coasts with the following objectives: 1) to characterize selective workplace factors and behaviors which may contribute to morbidity and mortality among Gulf Coast shrimp fishermen (shrimpers) and 2) to utilize a community-based approach to planning, implementing, and evaluating prevention and education/awareness measures directed at priority workplace factors and behaviors as identified by stakeholders.

The study employs a community trial with quasi-experimental pretest/posttest intervention design to address the question of whether simple, yet culturally appropriate training and awareness measures in the form of visual and written safety messages, favorably influence attitudes, beliefs, and behavioral intent related to priority risk factors identified by Vietnamese commercial shrimp fishermen along the Texas and Louisiana Gulf Coasts.

Methods

The project team worked collaboratively with the United States Coast Guard (USCG) Marine Safety Unit in the Eighth District along with other partners such as Louisiana Agricultural Extension and the Area Health Education Center program. A project advisory group was established comprised of representation from these groups as well as from the Vietnamese communities in target locations including volunteers with marine industry and/or commercial fishing experience, otherwise recognized as opinion leaders. Support and participation from trusted members of the Vietnamese communities, USCG, and commercial fishing industry were essential to recruitment and participation in project activities.

Survey Development and Focus Groups

A survey tool was developed building upon a prior questionnaire administered to Vietnamese fishermen at the Port of Galveston.[20] Questions related to age, race/ethnicity, gender, language, school completion (demographic factors), role and duration in commercial fishing, usual crew size, physical demand and riskiness of job, ability to perform emergency procedures and familiarity with vessel policies, safety training, and average work days/work hours (work-specific factors) were retained. Similarly styled questions were added concerning sleep/fatigue, hearing problems, work-related respiratory risks, and smoking.

Additional questions for the survey tool were designed to emphasize a number of potential outcomes associated with recognized risk factors in commercial fishing. These included traumatic injuries associated with machinery and equipment, falls overboard, back injuries, falls aboard vessel, traumatic eye injuries and ocular exposure to ultraviolet radiation, hearing loss, breathing hazards, skin cancer, and injuries related to fatigue. The Theory of Planned Behavior (TPB) was used as a framework.[22] Therefore, groups of questions assessed behavioral, normative, and control beliefs as well as intention for each of these priority injury/illness risk areas associated with the commercial fishing trades, using a 6-point scale. For each outcome category, one to two questions to assess each of the belief types were developed based upon potentially contributing factors. For example, questions to assess normative beliefs were designed for the potential influence of the opinions of family members versus vessel captains. For each category of risk, as, for example, machinery, there were approximately six questions formulated. There were slightly more than 100 total questions in the survey including demographic questions.

The questions were assessed for face and content validity and adjusted for a ninth grade (or less) reading level. The questions were subsequently translated into Vietnamese by individuals with Vietnamese as their primary language that also had experience and/or a working knowledge of marine safety in the United States. The tool was reviewed on multiple occasions by this group of translators until consensus was reached in areas of discrepancy. Informed consents along with the surveys and testing (blood pressure by automated cuff, spirometry, and pure-tone audiometry, the latter to be reported elsewhere) were administered by trained personnel with the translation assistance of these same individuals in the latter half of 2008. Survey administration for the individual participant took approximately 45 minutes to one hour. The study protocol, survey tools, and informed consent were approved by the Institutional Review Board at The University of Texas Health Science Center at Tyler.

Following administration and analysis of the initial surveys and testing (n=217 completed surveys), a focus group, participatory approach was utilized to identify a single, but distinct focus strategy for implementation at each of three geographically separate sites along the Texas/Louisiana Gulf Coast. Focus groups of Vietnamese commercial fishermen were convened during the summer months of 2009 at each of three port locations (Houston/Kemah, TX, n=19; Belle Chasse, LA, n=16; and Abbeville, LA, n=9). With the assistance of a moderator using a structured approach to facilitate the process, each focus group independently selected an area for developing/disseminating an intervention targeted at a priority occupational safety and health concern as outlined above. Houston/Kemah chose hearing/noise conservation, Belle Chasse chose machinery safety (with special attention to winches), and Abbeville selected fatigue awareness as their intervention topics. Distinct and non-overlapping intervention strategies were used for each of the three geographic groups.

Follow-up surveys were completed in each of the intervention groups in 2012 (n=206). For these data collection events, the original survey was shortened to include only those groups of questions related to the three priority injury/illness risk areas selected by the focus groups. Further, a single ‘intent to act’ question was added for each of the priority safety and health concerns identified (hearing/noise, machinery/winches, and fatigue), for a total of approximately 40 questions.

Sample Selection, Recruitment, Data Collection, and Statistical Analysis

A reliable enumeration of the commercial fishermen operating on vessels along the Gulf Coast is not available. Most vessels are privately owned with crews of three or fewer including the owner/captain. Deckhands may move from vessel to vessel in a given port location, move between port locations, or work other jobs outside of the shrimp harvesting season. There is also some variability between states as to when the coastal waters are open for fishing off their shoreline. Vessels are licensed by each state for operation, but not individual fishermen. Therefore, the community trial design was best suited to study of this workforce.

With input from the USCG, three geographically separate locations along the Texas and Louisiana Coasts were identified for purposes of this study: two port locations for Louisiana (Abbeville west of New Orleans and Belle Chasse near New Orleans) and one for Texas (Houston and nearby Kemah). The three locations were selected given their recognized concentration of Vietnamese shrimp fishermen. Previous study at the port of Galveston revealed a high concentration of Asian shrimp fishermen (>80%), mostly Vietnamese.[20] These fishermen were considered highly likely to participate as part of the Houston/Kemah group. The three survey locations were, therefore, in Abbeville, Belle Chasse, and Houston/Kemah. Figure 4.1 is a map of the United States Gulf Coast indicating the distinct and separate locations of the commercial fishermen sampled in Texas (Houston/Kemah) and Louisiana (Abbeville and Belle Chasse).

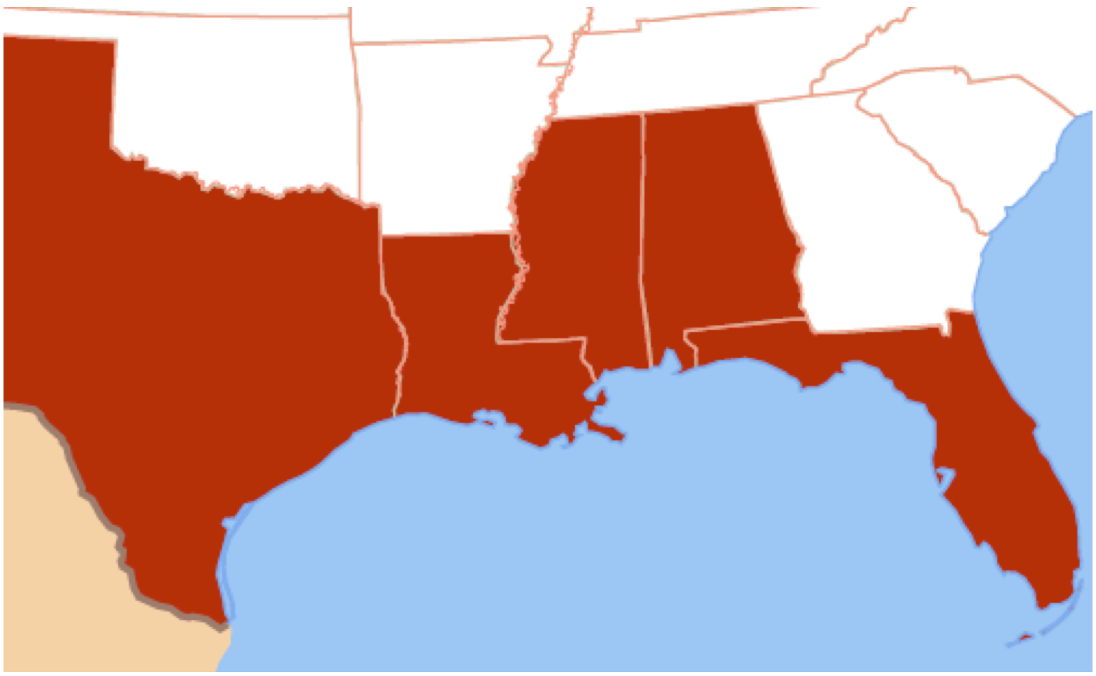

Figure 4.1. A map of the United States Gulf Coast (adapted from https://commons.wikimedia.org/wiki/File:US_map-Gulf_Coast.svg on 11/29/2015) indicating the distinct and separate locations of the commercial fishermen sampled in Texas (Houston/Kemah) and Louisiana (Abbeville and Belle Chasse). Reprinted with permission from J Agromedicine.[26]

Multimodal efforts were made at each of the three geographic sites to recruit eligible study participants currently working in shrimp fishing operations. These multimodal methods included engagement of key local partners to publicly announce the survey activities and place postings (in English and Vietnamese) both dockside and in other venues frequently attended by the fishermen (church, marine supply, community center, etc.), beginning at least two weeks in advance of a study data collection event. Additionally, health and safety screening and training not directly related to the survey behavioral questions or interventions (e.g., blood pressure, navigation signaling and Mayday simulation), were offered to encourage participation along with nominal incentives. All commercial fishermen (shrimp is the major fishery at these locations) over the age of 21, who identified themselves as actively engaged in fishing operations and who volunteered participation, were included in the surveys/testing even if they were not Vietnamese. Women were included if they played an active work role in fishing operations. There were rare exclusions of women volunteers who said they were attending the surveys on their fisherman husband's behalf.

Surveys and testing were administered following informed consent and using an assigned subject number for each participant in order to maintain confidentiality of responses and data. Paper surveys were administered predominantly in Vietnamese (participants could select Vietnamese or English). This was accomplished using trained personnel, with assistance from trusted translators as previously noted. Surveys were reviewed for complete responses as they were submitted. Data cleaning involved review of any unclearly marked responses and multiple marked responses where not appropriate. Final complete surveys were entered into a Microsoft Access database constructed for this purpose. Statistical analysis was completed using IBM SPSS Statistics Version 19.

Initially, survey data were analyzed to estimate the prevalence of demographic factors and work-specific factors (previously identified) in order to: 1) examine the distribution of potential confounding variables across the three survey locations and 2) complete the descriptive and formative assessment of risk factors and development of possible strategies for prevention and education among the focus groups. Next, for each of the three priority intervention areas (hearing/noise, machinery/winch safety, and fatigue), comparison of pre-/post-intervention group question response means was conducted using a two-tailed t-test with an alpha = 0.05 and several assumptions: the three geographically separate groups were independently sampled, scaled question responses were treated as continuous variables, and sampling distributions of differences in means for each group question were normally distributed based upon sample size (>30) and the central limit theorem, with sample variances also approaching population variances in the source populations and assumed to be equal.

Statistically significant results were then interpreted relative to intermediate impact, that is, the degree to which changes in attitudes/beliefs might influence outcomes such as noise-induced hearing loss, machinery/winch injuries, and fatigue related on-board incidents.

Distinct and non-overlapping intervention strategies were used for each of the three geographic groups. Selection of different priority injury/illness categories for each group reduced the risk of introducing information bias which could alter the results.

Finally, the single 'intent to act' question was added only to the follow-up survey for each of the priority safety and health concerns identified during the focus groups. Since responses to these questions could not be evaluated using a pre-/post-intervention approach, the prevalence of 'intent to act' within each of the three intervention groups was estimated and described.

Results

Figure 4.2 demonstrates schematically the organization of this community trial. Group sample size for each port location ranged from n=63 to n=92.

Intervention Development and Deployment for Community Trial

The project advisory group including USCG Marine Safety Unit representatives, along with project investigators and other community stakeholders with expertise in marine safety. This group met to select an intervention approach that could be customized for each of the three prioritized target strategies identified by the focus groups. Selection of interventions considered the traditional hierarchy of workplace safety approaches such as engineering controls, administrative and work practice controls, and use of PPE. Practicality of the intervention in terms of cost and ease of dissemination/application was also considered. It was determined that safety messaging using easily and often universally recognized images/colors, along with written messages that were cautionary in nature, and culturally, linguistically (translated into Vietnamese), and literacy appropriate, would be adopted. The images and written messages were placed on durable and reflective signage for use in the marine environment. Images were also placed on bright t-shirts that are sought after by the Vietnamese fishermen. Figure 4.3.a includes sign images adopted for each of the three interventions accompanied by written safety messages (in English). Figure 4.3.b provides an actual example of the signage (in Vietnamese) for hearing protection while working in the high noise area of the engine room.

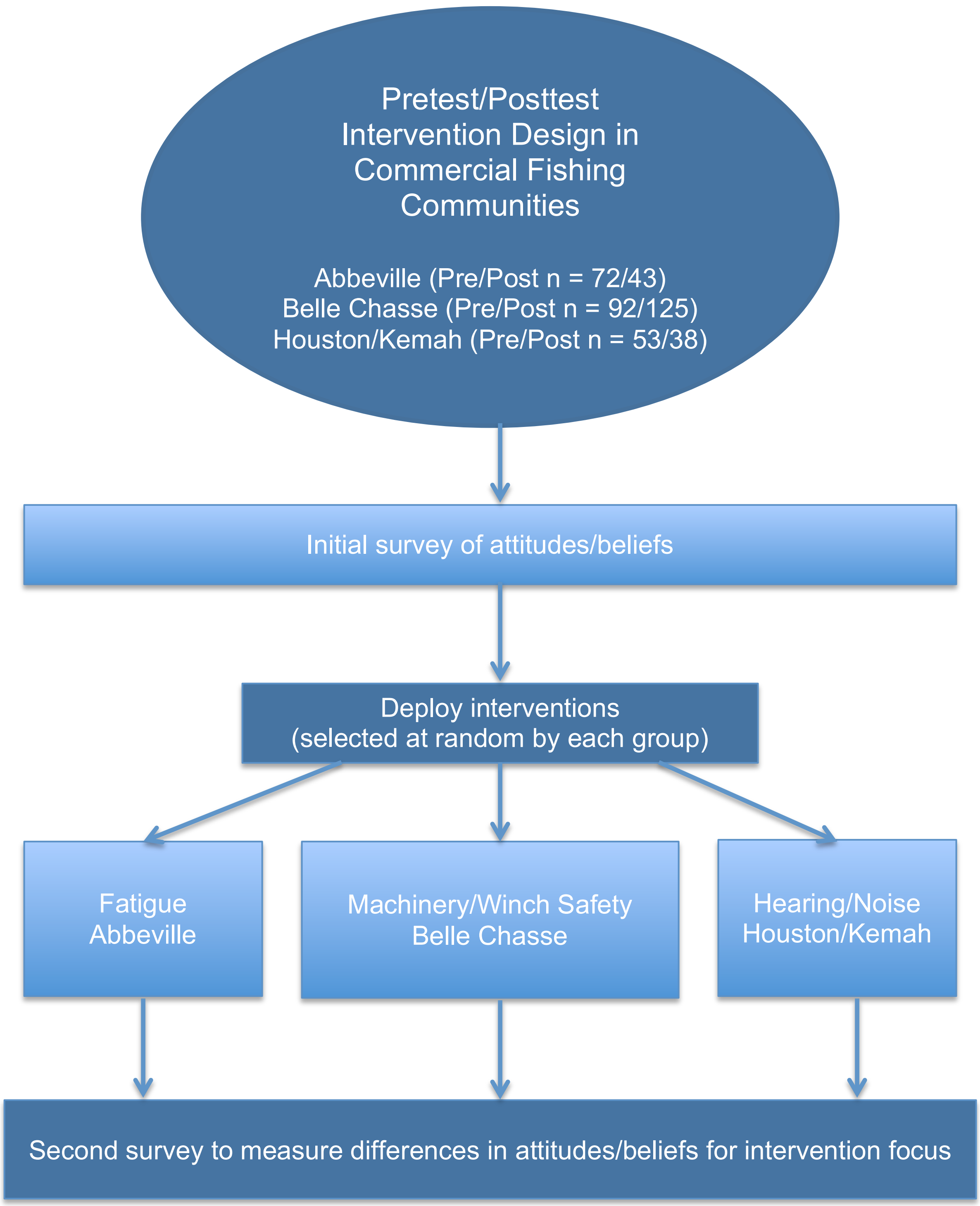

Figure 4.2. Schematic for quasi-experimental community trial with focus group selected areas for intervention development and deployment. Group sample size for each port location ranged from n=63 to n=92. Reprinted with permission from J Agromedicine.[26]

Each port site received signage and t-shirts with their respective priority message. These were delivered as part of a community training session emphasizing more usual safety measures for commercial fishing (similar to survey administration) along with the specific target priority message. The latter priority message was uniquely disseminated to its targeted site so as not to “contaminate” the remaining two community groups. Additional dissemination of materials was conducted dockside and in other venues frequented by commercial fishermen at their respective port locations over the ensuing months. These repeated efforts took place between the spring of 2010 and the spring of 2011, engaging Vietnamese opinion leaders in intervention diffusion efforts.[23]

In the case of the Houston/Kemah site, distribution of a pair of earmuffs as PPE was also accomplished. The fishermen in this location received an inexpensive hanger device for engine room door placement so that a single pair of earmuffs could be shared by all crew members who enter the engine room where noise levels are highest aboard vessel. Accompanied by signage, this was a ready reminder to fishermen of the importance of hearing protection. For the remaining two priority areas (machinery/winch safety, fatigue), placement of signage was encouraged in a readily visible location nearby the winch. Figure 4.3.b again illustrates actual hearing signage (in Vietnamese) placed aboard a shrimp vessel (Houston/Kemah) at the entry to the engine room, accompanied by PPE.

Initial and Follow-up Survey Analysis

Comparison of demographic factors and other work-specific factors between the initial and follow-up surveys demonstrated considerable similarity between the participants

Figure 4.3.a. Sign images and written safety messages (in English) adopted for each of the three interventions: hearing/noise, machinery/winch safety, and fatigue. Reprinted with permission from J Agromedicine.[26]

Figure 4.3.b. Actual hearing signage (in Vietnamese) and personal protective equipment (PPE) placed aboard a Houston/Kemah shrimp vessel at the entry to the engine room. Reprinted with permission from J Agromedicine.[26]

at the beginning of the project (2008), and those who completed the survey in 2012 after interventions were diffused[23] in the community (Table 4.1; n=217 completed surveys in 2008 and n=206 completed surveys in 2012). Of particular note is the preponderance of Asian fishermen, approximately 95% or greater, during both surveys. Most were over the age of 40 (>90%) and most were owners/captains (>80%). Also of interest is a self-reported history of limited hearing difficulties in both groups at approximately 10% or less.

Table 4.1. Demographic and work-practice findings from the initial and follow-up surveys conducted in 2008 and 2012 respectively. Reprinted with permission from J Agromedicine.[26]

Demographic Findings and Work Practices	Abbeville		Belle Chasse		Houston/Kemah		All Locations Combined	
Worker Health Protection Survey	Initial Survey	Follow up Survey	Initial Survey	Follow up Survey	Initial Survey	Follow up Survey	Initial Survey	Follow up Survey
Date Administered	Spring/ Winter 2008	Spring 2012	Spring/ Winter 2008	Spring 2012	Spring/ Winter 2008	Spring 2012	Spring/ Winter 2008	Spring 2012
Number of surveys completed	72	43	92	125	53	38	217	206
> or = 40 years old	87.5%	97.7%	85.9%	86.1%	100.0%	97.4%	89.9%	90.7%
Male	90.3%	93.0%	77.2%	84.8%	94.3%	97.4%	85.7%	88.8%
Asian	97.2%	97.7%	91.3%	97.6%	96.2%	97.4%	94.5%	97.6%
Caucasian	0%	2.3%	7.6%	4.0%	0%	0%	3.2%	2.9%
Hispanic	1.4%	7.0%	17.4%	16.8%	7.5%	5.3%	9.7%	12.6%
Speak little or no English	55.5%	46.5%	54.3%	54.0%	65.4%	55.3%	57.4%	52.7%
< 12 years school	72.2%	62.8%	77.2%	74.4%	91.5%	84.2%	79.2%	73.8%
> 15 years in commercial fishing	59.7%	69.8%	58.2%	55.3%	64.2%	86.5%	60.2%	64.0%
Owner/captain	80.2%	90.5%	73.7%	92.0%	96.2%	92.1%	81.4%	91.7%
Deckhand	15.5%	7.1%	24.2%	8.1%	3.8%	7.9%	16.3%	7.8%
Work > 16 hours per day	65.3%	58.1%	26.4%	15.2%	28.8%	44.7%	40.0%	29.6%
< 6 hours sleep per day	71.9%	41.8%	68.5%	63.4%	69.8%	52.8%	69.9%	56.9%
Work > 22 days per season	74.6%	73.8%	54.9%	67.2%	53.8%	65.8%	61.2%	68.3%
History of hearing problems	8.3%	11.6%	15.2%	8.0%	7.5%	5.3%	11.1%	8.3%

In addition, there is comparability between voluntary participants in the three community groups (Table 4.1). Overall, the same demographic factors are individually comparable to all three groups combined as well as to each other. There appeared to be a modestly smaller proportion of men during the initial survey at Belle Chasse, as well as a somewhat higher proportion of deckhands (in 2008) and Hispanics (in both 2008 and 2012). Of particular interest is the strikingly greater number of self-reported days worked per season and hours worked per day at Abbeville. This may well explain the selection of fatigue as a risk factor for intervention by this group.

All belief/attitude questions common to both the initial and follow-up surveys are reported (Table 4.2). The relevant questions that demonstrate statistically significant improvement ($p \leq 0.05$) at the intervention location are indicated with a (+) in the Intervention Location column. Improvement is defined as a strengthened level of agreement with the statement (post-intervention mean greater than pre-intervention mean). The questions are grouped by both intervention and corresponding location of deployment. A significant increase ($p \leq 0.05$) in Pre I vs Post I survey question means (I = Intervention) at a location **other than** that of the intervention dissemination is signified by the symbol (§). There is concordance for pre-/post- improvement in question responses relevant to the location of the corresponding intervention, specifically for fatigue (Abbeville) and hearing/noise (Houston/Kemah). This is less notable at Belle Chasse where the machinery/winch safety intervention was deployed.

Post- only 'intent to action' questions on the follow-up survey also suggested the intermediate impact of the interventions selected by and disseminated to each group of fishermen as illustrated in Table 4.3. The fatigue intervention at Abbeville and the hearing/noise intervention at Houston/Kemah appeared to have the greatest impact on intent as would be expected. However, strong intent in response to machinery/winch safety questions was unexpectedly greater at Abbeville than at Belle Chasse, the latter being the location of dissemination.

Discussion

This study employs a community trial with quasi-experimental pretest/posttest intervention design to address the question of whether simple, yet culturally appropriate training and awareness measures in the form of visual and written safety messages, favorably influence attitudes, beliefs, and behavioral intent related to priority risk factors

Table 4.2. Comparison of attitudes/beliefs pre- and post- intervention at three geographic port locations of commercial fishermen. Reprinted with permission from J Agromedicine.[26]

	Inter-vention	**Location**	**Pre-Intervention (Pre I) vs Post-Intervention (Post I) Survey**								
Location			**Abbeville**			**Belle Chasse**			**Houston/Kemah**		
Question			Pre I	Post I	T Test	Pre I	Post I	T Test	Pre I	Post I	T Test
17 - I plan to be more careful to avoid injury	Winch safety	Belle Chasse	n = 72 m = 5.85 sd = .548	n = 43 m = 5.93 sd = .338	t = -.896 df = 113 p = .372	n = 92 m = 5.52 sd = 1.181	n = 125 m = 5.62 sd = 1.169	t = -.634 df = 215 p = .527	n = 53 m = 5.64 sd = 1.178	n = 38 m = 5.95 sd = .226	t = -1.577 df = 89 p = .118
18 - Being careful is useful in preventing injury	Winch safety	Belle Chasse	n = 72 m = 5.92 sd = .366	n = 42 m = 5.95 sd = .216	t = -.576 df = 112 p = .565	n = 92 m = 5.80 sd = .715	n = 121 m = 5.88 sd = .503	t = -.958 df = 211 p = .339	n = 53 m = 5.62 sd = 1.197	n = 38 m = 5.92 sd = .359	t = -1.488 df = 89 p = .140
19 - Being careful prevents injury	Winch safety	Belle Chasse	n = 71 m = 5.89 sd = .216	n = 43 m = 5.98 sd = .152	t = -1.221 df = 112 p = .224	n = 92 m = 5.49 sd =1.236	n = 123 m = 5.64 sd = .916	t = -1.044 df = 213 p = .298	n = 53 m = 5.40 sd = 1.432	n = 38 m = 5.89 sd = .453	t = -2.070 df = 89 p = .041*§
20 - My family thinks I should be more careful	Winch safety	Belle Chasse	n = 69 m = 5.70 sd = 1.089	n = 43 m = 5.86 sd = .774	t = -.865 df = 110 p = .389	n = 87 m = 5.57 sd = 1.300	n = 124 m = 5.72 sd = .851	t = -.966 df =209 p = .335	n = 49 m = 5.43 sd = 1.443	n = 38 m = 5.63 sd = 1.195	t = -.700 df = 85 p = .486
21 - Vessel captains are likely to be more careful	Winch safety	Belle Chasse+	n = 72 m = 5.75 sd = .975	n = 43 m = 5.88 sd = .762	t = -.769 df = 113 p = .443	n = 92 m = 5.48 sd = 1.209	n = 124 m = 5.83 sd = .537	t = -2.887 df = 214 p = .004**	n = 53 m = 5.42 sd = 1.262	n = 38 m = 5.74 sd = .921	t = -1.336 df = 89 p = .185
22 - Injuries from becoming caught in machinery are often possible to prevent.	Winch safety	Belle Chasse	n = 69 m = 5.36 sd = 1.403	n = 42 m = 5.81 sd = .634	t = -1.945 df = 109 p = .054	n = 88 m = 5.45 sd = 1.144	n = 116 m = 5.43 sd = 1.253	t = .138 df = 202 p = .891	n = 52 m = 5.38 sd = 1.286	n = 38 m = 5.68 sd = .809	t = -1.264 df = 88 p = .210

Table 4.2. Continued

	Inter-vention	Location	Pre-Intervention (Pre I) vs Post-Intervention (Post I) Survey								
Location			**Abbeville**			**Belle Chasse**			**Houston/Kemah**		
Question			Pre I	Post I	T Test	Pre I	Post I	T Test	Pre I	Post I	T Test
23 - I can prevent injuries by being aware	Winch safety	Belle Chasse	n = 71 m = 5.54 sd = 1.169	n = 43 m = 5.86 sd = .774	t = -1.621 df = 112 p = .108	n = 92 m = 5.60 sd = 1.059	n = 125 m = 5.70 sd = .925	t = -.786 df = 215 p = .433	n = 53 m = 5.58 sd = 1.036	n = 38 m = 5.95 sd = .226	t = -2.165 df = 88 p = .033*§
24 - I can prevent injuries by what I wear	Winch safety	Belle Chasse	n = 71 m = 5.56 sd = 1.118	n = 43 m = 5.98 sd = 2.057	t = -2.407 df = 112 p = .018*§	n = 91 m = 5.43 sd = 1.318	n = 124 m = 5.60 sd = 1.139	t = -1.049 df = 213 p = .296	n = 53 m = 5.45 sd = 1.202	n = 38 m = 5.84 sd = .679	t = -1.799 df = 89 p = .075
26 - I plan to wear ear plugs while working in noisy areas aboard vessel to protect my hearing.	Hearing	Houston/ Kemah +	n = 72 m = 5.01 sd = 1.657	n = 43 m = 4.91 sd = 2.057	t = .018 df = 113 p = .761	n = 92 m = 5.03 sd =1.693	n = 125 m = 4.68 sd = 1.873	t = 1.427 df = 215 p = .155	n = 53 m = 4.09 sd = 1.983	n = 38 m = 5.79 sd = .664	t = -5.063 df = 89 p = .000**
27 - Wearing ear plugs while working in noisy areas aboard vessel is useful in protecting my hearing.	Hearing	Houston/ Kemah +	n = 72 m = 4.97 sd = 1.752	n = 43 m = 5.05 sd = 1.963	t = -.210 df = 113 p = .834	n = 92 m = 4.91 sd = 1.758	n = 125 m = 4.73 sd = 1.851	t = .743 df = 215 p = .458	n = 52 m = 4.46 sd = 1.873	n = 38 m = 5.58 sd = .948	t = -3.372 df = 88 p = .001**
28 - Wearing ear plugs while working aboard vessel will protect my hearing.	Hearing	Houston/ Kemah +	n = 71 m = 4.90 sd = 1.830	n = 43 m = 5.05 sd = 1.963	t = -.399 df = 112 p =.690	n = 92 m = 4.95 sd = 1.673	n = 125 m = 4.84 sd = 1.820	t = .437 df = 215 p =.658	n = 53 m = 4.66 sd = 1.839	n = 38 m = 5.58 sd = 1.130	t = -2.729 df = 89 p = .008**
29-My family thinks I should wear ear plugs to protect my hearing while working in noisy areas aboard vessel.	Hearing	Houston/ Kemah +	n = 72 m = 4.92 sd = 1.750	n = 42 m = 5.60 sd = 1.191	t = -2.228 df = 112 p =.028*§	n = 92 m = 5.03 sd = 1.544	n = 123 m = 4.85 sd = 1.751	t = .830 df = 213 p =.408	n = 53 m = 4.21 sd = 1.945	n = 38 m = 5.03 sd = 1.732	t = -2.072 df = 89 p = .041*
30 - Vessel captains are likely to wear ear plugs to protect their hearing while working aboard vessel.	Hearing	Houston/ Kemah +	n = 72 m = 4.69 sd = 1.962	n = 43 m = 4.74 sd = 2.139	t = -.127 df = 113 p = .899	n = 92 m = 4.97 sd = 1.674	n = 124 m = 4.63 sd = 1.854	t = 1.382 df = 214 p = .169	n = 53 m = 4.08 sd = 2.093	n = 38 m = 5.29 sd = 1.541	t = -3.033 df = 89 p = .003**

Table 4.2. Continued

	Inter-vention	**Location**	**Pre-Intervention (Pre I) vs Post-Intervention (Post I) Survey**								
Location			**Abbeville**			**Belle Chasse**			**Houston/Kemah**		
Question			Pre I	Post I	T Test	Pre I	Post I	T Test	Pre I	Post I	T Test
31 - Hearing loss from noise exposure while working aboard vessel is often possible to prevent.	Hearing	Houston/ Kemah +	n = 71 m = 5.08 sd = 1.547	n = 40 m = 5.73 sd = 1.109	t = -2.304 df = 109 p = .023*§	n = 91 m = 5.35 sd = 1.311	n = 122 m = 5.12 sd = 1.480	t = 1.170 df = 211 p = .243	n = 53 m = 4.83 sd = 1.411	n = 38 m = 5.45 sd = 1.267	t = -2.146 df = 89 p = .035*
32 - I can prevent hearing loss from noise exposure while working aboard vessel by wearing ear plugs.	Hearing	Houston/ Kemah +	n = 72 m = 4.86 sd = 1.833	n = 43 m = 5.28 sd = 1.750	t = -1.203 df = 113 p = .232	n = 88 m = 5.53 sd = 1.114	n = 125 m = 4.86 sd = 1.752	t = 3.165 df = 211 p = .002**§	n = 52 m = 4.75 sd = 1.691	n = 38 m = 5.79 sd = .664	t = -3.589 df = 88 p = .001**
34 - I plan to work fewer than 12 hours each day and to get enough sleep in order to avoid injuries while working aboard vessel.	Fatigue	Abbeville +	n = 71 m = 4.46 sd = 2.144	n = 43 m = 5.60 sd = 1.294	t = -3.153 df = 112 p = .002**	n = 92 m = 4.91 sd = 1.832	n = 125 m = 4.83 sd = 1.826	t = .323 df = 215 p = .747	n = 52 m = 4.54 sd = 1.627	n = 38 m = 4.68 sd = 1.890	t = -.392 df = 88 p = .696
35 - Enough rest is useful in preventing injuries	Fatigue	Abbeville +	n = 72 m = 4.74 sd = 1.80	n = 43 m = 5.70 sd = 1.013	t = -3.210 df = 113 p = .002**	n = 92 m = 4.57 sd = 1.974	n = 123 m = 5.19 sd = 1.538	t = -2.596 df = 213 p = .010**§	n = 52 m = 4.90 sd = 1.550	n = 38 m = 4.82 sd = 1.943	t = .239 df = 88 p = .812
36 - Enough rest prevents injuries	Fatigue	Abbeville +	n =71 m = 5.27 sd = 1.341	n = 42 m = 5.79 sd = .842	t = -2.252 df = 111 p = .026*	n = 92 m = 4.75 sd = 1.885	n = 125 m = 5.16 sd = 1.593	t = -1.733 df = 215 p = .085	n = 52 m = 4.96 sd = 1.414	n = 37 m = 4.84 sd = 1.908	t = .351 df = 87 p = .726
37 - My family thinks I should work fewer than 12 hours each day and get enough sleep in order to avoid injuries while working aboard vessel.	Fatigue	Abbeville +	n = 71 m = 4.76 sd = 1.793	n = 43 m = 5.81 sd = .546	t = -3.744 df = 112 p = .000**	n = 89 m = 4.73 sd = 1.863	n = 123 m = 5.04 sd = 1.586	t = -1.306 df = 210 p = .193	n = 51 m = 5.02 sd = 1.435	n = 37 m = 4.92 sd = 1.831	t = .289 df = 86 p = .773
38 - Vessel captains get enough rest	Fatigue	Abbeville +	n = 72 m = 5.18 sd = 1.407	n = 43 m = 5.81 sd = .546	t = -2.823 df = 113 p = .006**	n = 92 m = 4.74 sd = 1.833	n = 125 m = 5.08 sd = 1.522	t = -1.494 df = 215 p = .137	n = 53 m = 4.96 sd = 1.427	n = 38 m = 4.92 sd = 1.715	t = .125 df = 89 p = .901

Table 4.2. Continued

	Inter-vention	Location	Pre-Intervention (Pre I) vs Post-Intervention (Post I) Survey								
Location			**Abbeville**			**Belle Chasse**			**Houston/Kemah**		
Question			Pre I	Post I	T Test	Pre I	Post I	T Test	Pre I	Post I	T Test
39 - Injuries related to fatigue are possible to prevent	Fatigue	Abbeville +	n = 71 m = 5.15 sd = 1.509	n = 43 m = 5.88 sd = .324	t = -3.119 df = 112 p = .002**	n = 92 m = 4.88 sd = 1.851	n = 123 m = 5.55 sd = 1.073	t = -3.348 df = 213 p = .002**§	n = 53 m = 4.96 sd = 1.556	n = 38 m = 5.53 sd = 1.390	t = -1.782 df = 89 p = .078
40 - I can prevent injuries while working aboard vessel by working fewer than 12 hours and getting enough sleep.	Fatigue	Abbeville +	n = 72 m = 4.60 sd = 1.962	n = 43 m = 5.95 sd = .213	t = -4.509 df = 113 p = .000**	n = 92 m = 4.87 sd = 1.859	n = 125 m = 5.30 sd = 1.420	t = -1.916 df = 215 p = .057	n = 53 m = 4.96 sd = 1.493	n = 38 m = 5.55 sd = 1.224	t = -2.002 df = 89 p = .042*§

* ($p < 0.05$) ** ($p < 0.01$) Equal variances assumed on all T-tests
\+ Significant increase ($p < 0.05$) in Pre I vs Post I survey questions at location of intervention dissemination
§ Significant increase ($p < 0.05$) in Pre I vs Post I survey questions at location **other than** that of intervention dissemination

Table 4.3. Findings from 'intent to action' questions from follow-up survey (post- only evaluation). Reprinted with permission from J Agromedicine.[26]

Intent to Action Questions on Follow-up Survey	**% responses 5 or 6 (strong intent)**			
N=207	Abbeville	Belle Chasse	Houston/ Kemah	Total
This safety information helped me. I will be more careful around winches aboard vessel.	100.0	94.6*	94.7	95.6
This safety information helped me. I will wear ear protection while working aboard vessel.	83.7	73.4	84.2*	77.5
This safety information helped me. I will get enough sleep while working aboard vessel.	95.3*	88.0	94.7	90.8

*Indicates location where intervention occurred identified by Vietnamese commercial shrimp fishermen along the Texas and Louisiana Gulf Coasts.

In the context of a community trial, a community may represent any number of defined units,[24] in this instance, a commercial fishing community with vessel landings predominantly taking place at a geographic port or dock location. Though community trials may suffer, in comparison to clinical trials, with respect to controlling participant entrance to the study, shifts in the composition of the study population, delivering the intervention, and monitoring outcomes, they can be useful in evaluating the impact of behavior change or other modifiable risks.

In the current study, the initial survey of 2008 suggested that Vietnamese commercial shrimp fishermen in this region perceive their work to be somewhat to very risky (>70%). The follow-up survey confirmed that the shrimp fishermen of the Gulf Coast work longer hours and more days with less sleep during the open fishing season.

All three community groups demonstrated favorable benefit from the interventions with strong intent to adopt safety measures. Statistically significant changes were noted in related belief responses following introduction of priority risk factor interventions among commercial shrimp fishermen at two of the three geographically separate locations (Houston/Kemah and Abbeville). These changes over time appear related to and surround the period of disseminating an intervention focused on a unique concern selected by each of these groups. Specifically, using the Theory of Planned Behavior[22] to construct a survey administered before and after the dissemination of interventions for community selected priority concerns, there were detectable favorable changes in two of the groups (hearing/noise and fatigue).

The nature of these changes to include behavioral beliefs, normative beliefs, and control beliefs was more extensive for hearing/noise (Houston/Kemah area) and fatigue (Abbeville), than for machinery/winch safety (Belle Chasse). For hearing/noise, all three belief areas changed significantly as was the case for fatigue. The latter may, in part, have been influenced by the greater number of days and longer work hours undertaken by the Abbeville fishermen during the active fishing season. Improvement of control beliefs in Houston/Kemah may be a function of use of PPE as part of this intervention (accessible earmuffs) as a tangible method for controlling noise exposure and hearing loss while working in the engine room. For both hearing/noise and fatigue, the nature of the cautionary safety images may have successfully conveyed to the fishermen the importance of the opinions of others they respect (normative beliefs). The absence of statistically significant changes in most of the belief categories for machinery/winch safety in Belle Chasse, may reflect the varied nature and scale of dangerous machinery situations aboard vessel. Though the fishermen at Belle Chasse may intend to be more careful, they may construe accidents that occur with machinery as being outside of their immediate control.

The intermediate impact of the interventions and their corresponding influence on intention to action for all three groups was considered to be strong, although this conclusion is largely predicated upon the post- only component (follow-up survey) of this community trial. More than 84% of respondents in Houston/Kemah indicated the safety information helped them and they intended to wear hearing protection. Over 95% of survey respondents in Abbeville said that the project was helpful and they intended to get enough sleep while working aboard vessel. Similarly, nearly 95% of respondents at Belle Chasse indicated that safety information helped them and that they would be more careful around machinery/winches aboard vessel.

An important ***strength*** of this study design is the use of a prospective, quasi-experimental community trial to manipulate a study factor in the form of an intervention that allows evaluation of intermediate impact on attitudes and beliefs. These, in turn, have the potential to culminate in action(s) that can reduce risk. An additional strength is the application of an actual and unique intervention to each of the three community groups. This has the potential to reduce the impact of the Hawthorne effect in which a change is purported due to singling out a group to receive an intervention (similar to a placebo effect).[24]

Several ***challenges*** presented themselves during the course of this study including hurricanes and hurricane recovery and economic factors such as the rising cost of diesel fuel. An additional challenge was identification of optimal times to conduct data collection and community reinforcement of the selected intervention messages through dockside dissemination efforts and a repeat community training initiative at each of the three sites. This was largely due to variability of scheduling around the busy fishing season. This challenge was significantly compounded for a period of several months by the Deepwater Horizon explosion (April 20, 2010) and oil spill in the Gulf of Mexico.

The study also has several ***limitations***. Despite efforts toward a community-based approach to select an intervention and maximize participation of Vietnamese fishermen within each community group, the study still suffers from an inability to randomize community participants to study conditions. Given that different participants are likely to have been involved in the surveys of 2008 and 2012, similarities in age, gender, race/ethnicity, language, school completion, role/duration in commercial fishing, and hours worked help to reduce confounding influences of these factors on responses to attitude/belief and ‘intent to act’ questions.

Although several individuals completing the initial survey participated in the follow-up, it proved difficult to match surveys due to similarities in participant names and inconsistent retention by study subjects of unique identifying cards provided with the first survey. Additionally, there may have been migration among the communities of fishermen and inability to ensure that the same fishermen were participants at both pre- and post-intervention surveys. A paired analysis of surveys could not be performed for these reasons. As a result, the proportion of individuals from a given community who participated in both the pre- and post-intervention surveys could not be ascertained, also limiting the ability to know, with any certainty, the extent to which the intervention was delivered.

Given the four-year period between administration of initial and follow-up surveys, there may also have been loss of effect due to a shift in study population composition surrounding the interventions deployed between 2010 and 2011. This might be construed as strengthening the statistically favorable findings that were, in fact, identified. Although a distinct and non-overlapping focus strategy/intervention was applied to each of the three groups separated by geographic distance, the commercial fishermen of the Gulf Coast are known to conduct their landings at various ports other than their home location. This could have resulted in cross-contamination of the groups with the interventions, i.e., less rigid control of the "exposure". Moreover, an intervention effect might have occurred in any single community group as a result of the overall message of health and safety delivered in the context of training. However, careful efforts were made to ensure that all three groups received comparable awareness training except for the unique intervention received by each.

Additional ***weaknesses*** include reduced external validity and generalizability of the findings due to self-selection of the intervention. However, in this particular study, a number of common potential confounders were shown to be comparably prevalent between the initial and follow-up surveys (see Table 4.1). Differing opinion leaders within the separate communities may have emphasized different interventions to varying degrees (e.g., use of hearing protection for noise exposure may have received greater emphasis in Houston/Kemah than machinery/winch safety received in Belle Chasse). Finally, the matter of sustainability is always a concern, and the present study does not examine the actual or persistent adoption of behaviors over the long-term as with use of hearing protection. Moreover, what measures should or could be taken to ensure widespread dissemination of interventions throughout the regional commercial fishing community? Perhaps the USCG has a valuable role to play in this regard.

Another incidental, yet important finding during this study was that >50% of participants during the initial survey were noted to fall into the category of Stage 1 or greater hypertension (based upon a single sitting automated blood pressure measurement).

In many cases, participants were unaware of elevated blood pressure or poor control of hypertension and received education as to its significance and need for potential lifestyle change and follow-up for appropriate medical intervention.

Considering the findings of the current study and scale of the problem of winch injuries among shrimp fishermen along the Gulf Coast, future efforts would be reasonable to determine if there are work practice behaviors which could significantly influence the frequency and severity of these injuries.

Conclusions

Participatory methods are considered important preventive tools in the public health arena to determine and test effective strategies for reducing risk factors leading to illness, injury, and even death, in a culturally appropriate way, and for translating these research findings into practice (r2p). This study has demonstrated how support and participation from trusted members of the Vietnamese communities, USCG, and commercial fishing industry were essential to recruitment and participation in project activities, development of practical interventions, and their dissemination to the target communities. It addressed the question of whether simple, yet culturally appropriate training and awareness measures in the form of visual and written safety messages, favorably influence attitudes, beliefs, and behavioral intent. It has also confirmed the intermediate impact of community input to carrying out research activities in a vulnerable population such as the Vietnamese commercial shrimp fishermen. Further, this project addressed multiple priority areas as defined by the National Institute for Occupational

Safety and Health (NIOSH) under its National Occupational Research Agenda (NORA), and its associated Agriculture, Forestry, and Fisheries Strategic Plan.[25]

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CHAPTER V

A BRIEF REPORT DESCRIBING THE UNION OF MEDICAL TRAINING AND AGRICULTURAL HEALTH*

Synopsis

This brief report describes a mutually beneficial partnership forged to extend agricultural medicine training to physicians, nurses, veterinarians, public health workers, health care professionals, medical residents, and students. '*Agricultural Medicine: Occupational and Environmental Health for Rural Health Professionals*' originated at the University of Iowa, Iowa's Center for Agricultural Safety and Health, and the Great Plains Center for Agricultural Health. Through a NIOSH-funded Training Project Grant, The University of Texas Health Northeast worked with the University of Iowa and regional experts to adapt the agricultural medicine content for the southwestern United States. Further partnerships were developed with The Southwest Center for Agricultural Health, Injury Prevention and Education, The University of North Texas Health Science Center – College of Osteopathic Medicine, and the Texas Rural Health Association to extend the reach of this training to other important stakeholders. Each of the collaborators offered unique resources to the coordination of the agricultural medicine course. Likewise, each organization benefitted from extending regionally relevant agricultural medicine training to

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current and future healthcare providers. The long term goal for the partnership is to train a broad array of health care providers with the basics of anticipation, recognition, diagnosis, treatment, and the prevention of occupational and environmental illnesses and injuries within rural and agricultural communities, customized to the Southwest Region. This brief descriptive report highlights the process by which strategic partners collaborated to conduct a regional agricultural medicine course, such that other organizations interested in offering a similar training might gain insight to best practices from our experience.

***Key words*:** rural, agricultural, medicine, collaboration, partners, occupational, building capacity

Introduction

Agricultural medicine includes "the anticipation, recognition, diagnosis, treatment, prevention, and community health aspects of health problems peculiar to agricultural populations."[1] This specific field of practice is important because agricultural workers face unique workplace challenges that can lead to unique illnesses and injuries.[1-7] Agricultural producers often work long hours in hazardous environments. They are exposed to extreme temperatures and weather conditions, as well as, dangerous chemicals and heavy machinery. Farms are also frequently located on the same land as the home, posing unique risks for children.[2,5] According to the 2013 Bureau of Labor Statistics, U.S. workers in farming, fishing, and forestry (AFF) occupations had a fatal work injury rate of 23.1; compared to the all-worker fatal injury rate of 3.2.[8] Similarly, workers in AFF experienced a higher incidence rate of nonfatal occupational injuries than the all-industry average.[9] It is widely believed that fatal and nonfatal injuries and illnesses within the agriculture, forestry, and fishing sector are under-reported because the statistics do not capture incidents that occur on operations with fewer than 11 employees.

Professionals who provide healthcare services in rural and agricultural settings need specialized training to effectively respond to the injuries and illnesses that occur to their patients.[10] In the 1970s, faculty at the University of Iowa, including Kelley Donham, DVM, recognized that agricultural medicine training was scarce. Dr. Donham and his colleagues founded a training program that was later transformed into a graduate course and a 40 hour continuing education course. Jeffrey Levin, MD, MSPH, at The University of Texas Health Northeast (UT Health Northeast) also recognized the value in training residents in agricultural medicine. A NIOSH-funded Training Project Grant (TPG) awarded to UT Health Northeast has helped to prepare occupational medicine resident physicians to enter independent practice with an emphasis on the occupational health needs of rural and agricultural workers. As part of the TPG, occupational medicine residents at UT Health Northeast were enrolled in the 40 hour course offered by the University of Iowa. The agricultural medicine course in Iowa included a range of significant instructional topics in agricultural medicine important to a broader range of healthcare professionals in the southwest.

In order to bring this training to the southwest region, UT Health Northeast applied for a grant from The University of Iowa to conduct a regional agricultural medicine course. In order to maximize the success of reaching a sizable and diverse group of health care providers, a set of strategic partners was organized to plan and coordinate a four day course delivered over two years. These partners included the University of Iowa Building

Capacity Project; TPG personnel from UT Health Northeast; The Southwest Center for Agricultural Health, Injury Prevention and Education (SW Ag Center); The University of North Texas Health Science Center-College of Osteopathic Medicine (UNTHSC-TCOM); and the Texas Rural Health Association (TRHA). John Bowling, DO, is the Assistant Dean for Rural Medical Education/Professor and the Director of the Rural Osteopathic Medical Education (ROME) program at UNTHSC-TCOM. Dr. Bowling is also the current President of the TRHA. The agricultural medicine course content and ROME curriculum address many of the same topics; therefore, presenting an opportunity for synergy and efficiency.[11]

The purpose of this brief descriptive report is to highlight the process by which strategic partners collaborated to conduct an agricultural medicine course in the southwest, such that others might gain insight to best practices from this experience, particularly for reaching a diverse group of relevant health care professionals.

Methods

In order to take advantage of the valuable contributions offered by each of the strategic partners, Dr. Bowling hosted an in-person meeting in Fort Worth in January 2014. Dr. Levin described the importance of the agricultural medicine course and how each partner could benefit from a collaborative approach. Each organization then described their respective goals and what resources they could offer to aid in the coordination of a regional course.

TPG staff at UT Health Northeast provided overall course coordination, meeting management, and marketing. Four residents receiving support from the TPG were required to attend the agricultural medicine course as part of their training. Applications were submitted and approved for continuing medical education (CME) for both allopathic and osteopathic physicians, CNE for nurses, and CE for veterinarians.

SW Ag Center staff helped to coordinate the course, identify content experts, and conduct the marketing strategy. Center staff circulated information through online marketing tools, email, and postal mail. Appropriate healthcare associations were contacted directly by phone to extend coverage to their websites and event calendars. The Center also worked with speakers to adapt the course materials to be regionally relevant. Funding for speaker travel was provided by the SW Ag Center.

UNTHSC-TCOM contributed three key elements to the course: participants, funding through registration fees, and the TRHA connection. Students enrolled in the ROME program (about 30) were required to attend the agricultural medicine course. Students' course registration fees were paid for by the ROME program. Dr. Bowling also recognized an opportunity to align the agricultural medicine course with the TRHA annual conference.

The TRHA board members viewed the course and the partnership favorably. They committed to hosting the course within their annual conference over a two-day period for two consecutive years. TRHA provided a dedicated website to collect agricultural medicine course registrations. They also provided course meeting space and set-up, catering coordination, signage, name tags, audio visual equipment, and marketing.

The University of Iowa provided grant support, training materials, and coordination counsel. The University of Iowa, Iowa's Center for Agricultural Safety and Health, and the Great Plains Center for Agricultural Health contributed vetted content materials and extensive professional development for speakers through a formal orientation process. Dr. Donham also traveled to Texas to deliver portions of the course and to serve as a keynote speaker at the TRHA conference. (See Figure 5.1)

Results

More than thirty ROME students and four occupational medicine residents (TPG-funded) gained exposure to health issues peculiar to workers and families from rural and agricultural communities in the southwest. In addition to the residents and students, six individuals from diverse backgrounds attended the course. Those attendees included a pediatric cardiologist, nurse, extension specialist, Farm Bureau representative, professor of nursing, and an assistant professor of occupational health sciences. Three of these individuals were investigating the possibility of organizing similar courses in their home states (NM, AR and LA). TRHA added valuable content to their existing conference program that has the potential to increase and expand the target audience for their annual conference. The SW Ag Center broadened its network of strategic partners, a key tenet of its mission. Finally, the University of Iowa extended the reach of its agricultural medicine course.

Through strategic collaboration, agricultural medicine training was offered to forty participants in 2014. Pre/post-tests revealed a 38% improvement in participant content knowledge scores. Over 70% of participants indicated that they intended to use materials provided by the agricultural medicine conference in their work or practice within the next six months. Planning is underway for the October 2015 agricultural medicine course. The recruitment of physicians, nurses and other practicing health care providers to the course has been challenging. Providers from rural areas are often short

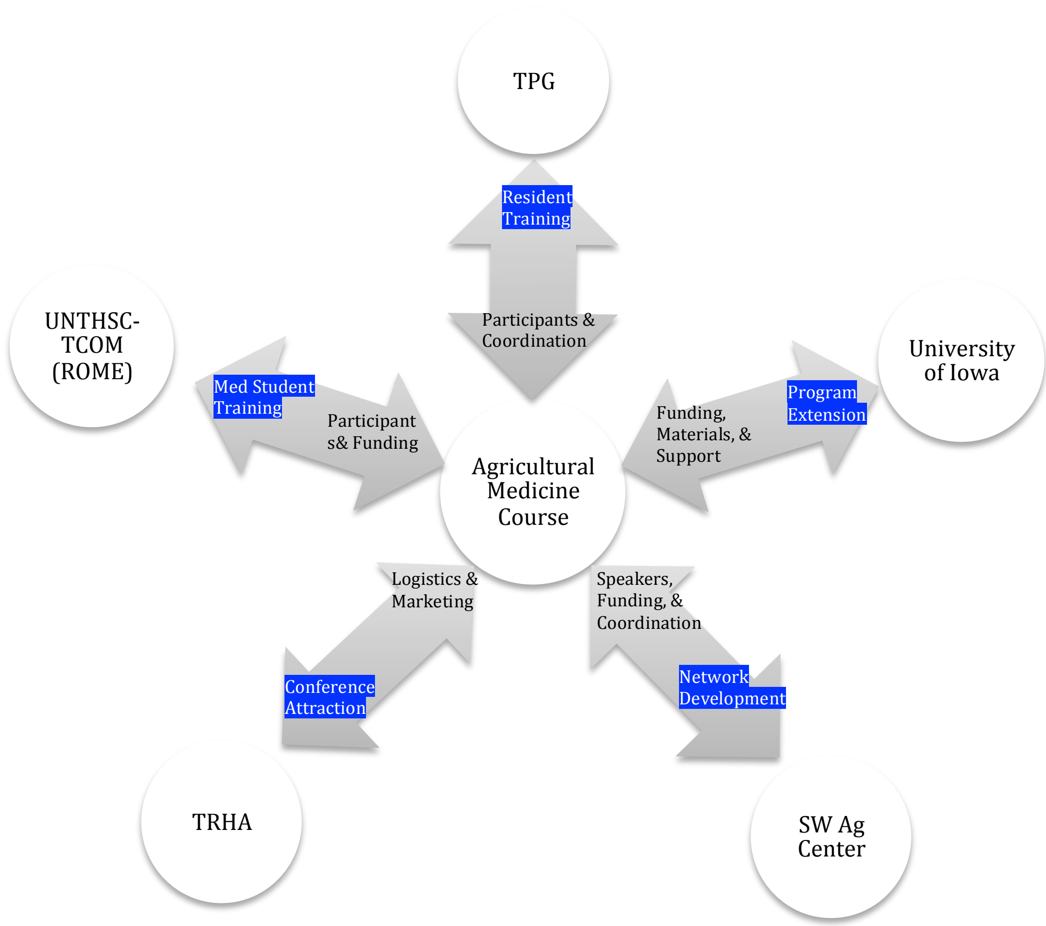

Figure 5.1. Summary of the contributions of each of the agricultural medicine strategic partners. Reprinted with permission from J Agromedicine.[12]

staffed and may be unable to travel for continuing education due to busy practices. Most hospitals offer continuing education opportunities for their faculty and staff either through local presentations or webinars. However, there are other rural health advocates that can benefit from the course content. In 2015, Community Health Workers (CHWs), Area Health Education Center (AHEC) staff and extension specialists will be targeted for course recruitment. CHWs and AHEC personnel have historically attended the TRHA Conference and require continuing education credits. Extension specialists have direct access to agricultural producers and rural communities. The course information could be used in the development of extension outreach programs related to health. Moreover, local Farm Bureau has contemplated sponsorship for a community physician or other provider to attend the conference. Evaluation data collected in 2014 and 2015 will elucidate the impact of the course on health professionals in the southwest region.

Conclusions

Two important outcomes have resulted from this effort. The first outcome has been the extension of agricultural medicine training to the southwest that incorporates fundamental topics to the field, customized to the unique circumstances of agricultural production populations in the region. The second outcome has been the development of a training initiative that is both sustainable and can reach a sizeable target audience, by forming a collaboration of strategic partners with established networks of relevant stakeholders. The ROME program and occupational medicine residency at UT Health Northeast have new students/residents each year providing sustainability for the course, at the very least for these groups which contribute significantly to the rural and occupational healthcare workforce respectively. Marketing to additional audiences has the potential to broaden and diversify the reach of rural and agricultural health-related messages. These are construed as best practices for replicating similar agricultural medicine training initiatives in other regions.

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CHAPTER VI

CONCLUSIONS AND RELEVANCE TO PUBLIC HEALTH

Introduction

The commercial fishing trades are among the most dangerous jobs in the world.[1] In the United States (U.S.), commercial fishing is considered part of the Agriculture, Forestry, and Fishing (AFF) industrial sector. The Gulf Coast accounted for 116 of the U.S. commercial fishing fatalities from 2000 to 2009.[2] The highest number of fatalities occurred within the shrimp fishery along the Gulf Coast (55 deaths), making it among the most hazardous fisheries in the U.S. For shrimp fishermen of the Gulf of Mexico, falls overboard accounted for the majority of fatalities (29, 53%), with the largest proportion of the remaining deaths due to on-board injuries (12, 22%), followed by vessel disasters (10, 18%).

Cultural factors, machinery and equipment, and the environmental elements at sea may give rise to hazards that contribute to the burden of fatal events. Less is known about non-fatal occupational morbidity (such as hearing loss), risk factors, and association with fatal events.

Materials and Methods

Over the last decade, Principal Investigators of the Southwest Center for Agricultural Health, Injury Prevention, and Education have been exploring these factors and developing interventions through engagement of a vulnerable population of commercial fishermen in the Gulf of Mexico and forming strategic partnerships with numerous key stakeholders in the region, perhaps most notably the United States Coast Guard (USCG). This has involved a variety of quantitative and qualitative methods including formulation of workgroups of external advisors, focus groups, surveys, training and outreach initiatives, a community trial, some health screening tools, and development of a social media campaign to enhance adoption of personal flotation device (PFD) use while working on deck.

Research data for this study were collected between 2006 and 2012 with Institutional Review Board (IRB) approval from the University of Texas Health Science Center at Tyler (UTHSCT). This was a community trial with quasi-experimental pretest/posttest intervention design. An advisory group made up of key stakeholders including representatives from the USCG was assembled. A survey was designed using the Theory of Planned Behavior as the theoretical framework. Three community groups at port sites along the Texas/Louisiana Gulf Coasts were identified. Focus groups were convened at each site to select priority areas for risk intervention using training and awareness measures. Initial and follow-up surveys were administered pre-/post-interventions for each of the three community groups (2008, n = 217 completed surveys; 2012, n = 206 completed surveys). The follow-up survey was condensed and "intent to act" questions were added for the priority concerns identified (noise-induced hearing loss, machinery/winches, and fatigue). Worksite noise level monitoring and audiometry were also conducted in the pre-intervention phase. The survey tools and informed consent documents were among those approved by the UTHSCT IRB.

This doctoral dissertation represents subsequent analysis and interpretation of pre-existing, de-identified data available from the aforementioned protocol, beginning in the spring of 2013. De-identified data were examined to compare demographic and work-specific factors between survey administrations, as well as to analyze worksite noise level monitoring and audiometry results. For each of the three priority intervention areas (hearing/noise, machinery/winch safety, and fatigue), comparison of pre-/post-intervention group question response means was conducted using a two-tailed t-test with an alpha = .05. The prevalence of "intent to act" within each of the three intervention groups was determined.

Results

Shrimp is a major fishery in the Gulf of Mexico and earlier studies showed that more than 80 percent of these fishermen are Asian, mostly Vietnamese.[3] Over the last decade, safety tip cards, interactive CD instructional tools for vessel sound signaling and Mayday calls, and signage for a variety of safety concerns have been developed and disseminated, with intent to adopt measured. (Figures 6.1 to 6.4)

The impact of some of these products has been demonstrated through unsolicited feedback from various stakeholders.

> *"I was pleased to see the HSC Fishing Vessel Safety Project… materials relate to the people who own and operate commercial fishing vessels in the Gulf of Mexico. The project produced some great tools. I know if they are widely used by the commercial fishing vessel operators they will certainly reduce the number of*

serious collisions." Quote by Tony Rentz, USCG 13th District, Fishing Vessel Safety Coordinator

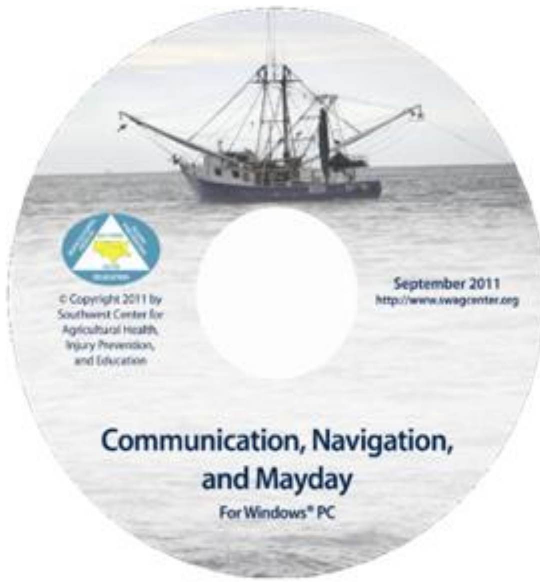

Figure 6.1. Interactive navigation and Mayday CD.

Figure 6.2. Noise warning sign in Vietnamese, at engine room. Note ear muffs.

Figure 6.3. Opinion leader demonstrating fatigue message in Vietnamese.

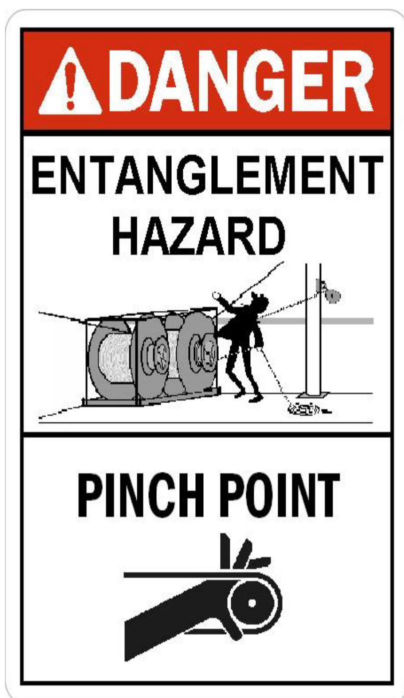

Figure 6.4. Hazard signage for machine/ winch injury.

Statistically significant changes in attitudes/beliefs have also been noted.[4] Although community trials such as this may have several shortcomings in comparison with clinical trials, they do have value in assessing the impact of behavior on risk factors. In this case, culturally appropriate training and awareness approaches using visual and written safety messages focused on a single prioritized risk factor selected by a community, demonstrated enhanced belief responses on pretest/posttest surveys for two of the three communities. Specifically, this was the case for the hearing/noise and fatigue interventions. This outcome may have been influenced by unique variables such as the inclusion of hearing personal protective equipment (PPE) and the greater number of days/work hours in these two communities respectively. Moreover, the absence of a statistically significant favorable response in any of the three belief/attitude constructs assessed (behavioral, normative, and control) in the machinery hazards trial, may have been the result of the range of machinery hazards aboard vessel accompanied by a sense of inability to control these risks. Finally, the influence of all three of these interventions on intention to action was considered to be strong, albeit measured only in the follow-up survey. These interventions were felt to be simple in nature, and, though not focused on ergonomic considerations, similar in approach as other workplace solutions.[5]

Another finding was that occupational hearing loss may be associated with noise-exposure in vessel engine rooms.[6] (Figure 6.5) Hazardous noise levels were measured in commercial fishing vessel engine rooms ranging from 94.8 to 105.0 dBA, and noise-induced hearing loss (NIHL) was associated with years spent fishing. Given that high noise levels and hearing loss have been associated with an increased level of occupational injury, their prevalence in commercial fishing may also contribute to the risk of injuries and fatalities in this work sector.

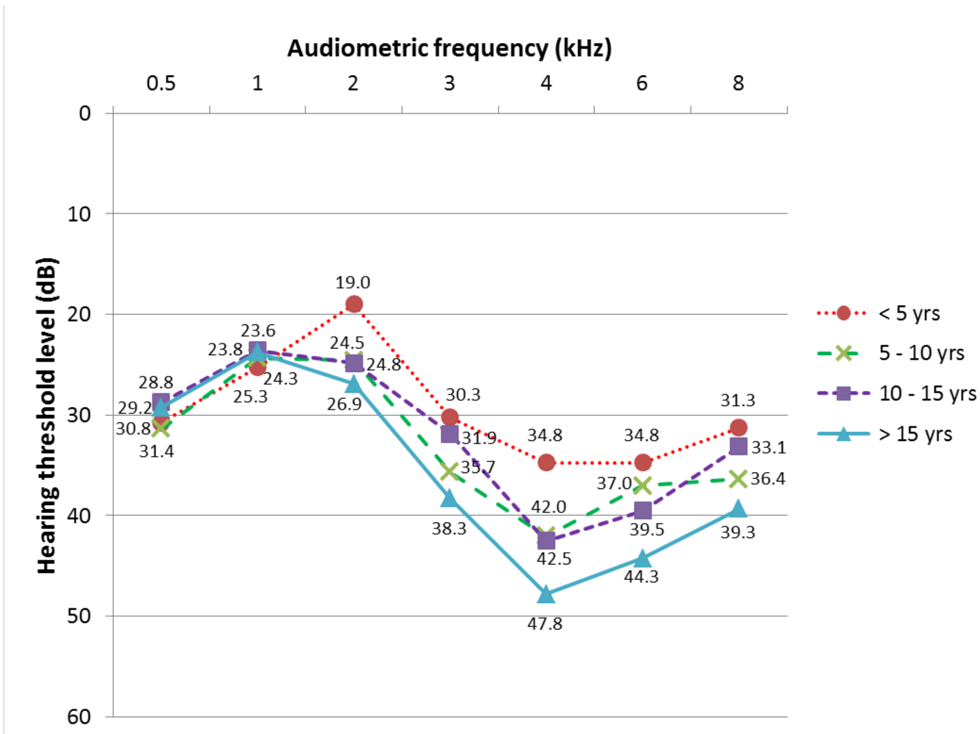

Figure 6.5. Average hearing threshold in the worse ear by years of experience in the commercial fishing trades. Reprinted with permission from J Occup Environ Med.[6]

Presently, identifying barriers to use of lifesaving PFDs, preferences of commercial fishermen for various PFD designs, and development of a social media campaign to promote use on deck are underway with the following observations to date:

- Vietnamese commercial fishermen prefer inflatable suspender type PFDs over ski belt or inflatable belt PFDs when evaluating satisfaction among workers. Suspender type PFDs were found to be cooler, less bulky, and overall preferable.

- Social marketing messages have been developed targeting captains and deckhands. Messages focus on the Vietnamese allegiance to family as a strong motivator to avoid risk of drowning.
- Prototype social marketing messages were tested during summer 2016 and disseminated in the spring of 2017.
- Examining heat stress as a barrier to PFD use is now underway.

Limitations of these studies are succinctly summarized as follows:

- Inability to randomize community participants to study conditions
- Different participants between first and follow-up surveys
- Cross-contamination of groups due to migration between landing sites
- Impact of increased general safety awareness across groups
- Self-selection of participants and recall bias
- Generalizability of results
- Sustainability of intervention effect
- Absence of detail regarding circumstances and duration of noise exposure while working aboard vessel
- Cross-sectional nature of some study results such as audiometry

Conclusions

Culture plays a significant role in attitudes/beliefs among Vietnamese shrimp fishermen of the Gulf, and may influence behaviors that are risk factors for fatal and non-fatal injuries. In particular, commercial fishing industry leaders are able to influence behaviors and practices among fishermen.

Culturally appropriate training and awareness measures combined with recognizing normative influences can favorably alter attitudes, beliefs, and behavioral intent related to workplace safety in this population of Vietnamese shrimp fishermen along the Gulf Coast. This includes not only opinion leaders among commercial fishermen, but also authority figures such as the USCG.

Finally, community participatory methods such as selection of priorities for workplace intervention can be an effective strategy for translating research findings into practice. Occupational noise-induced hearing loss serves as a good example. Implementation of hearing conservation measures including use of PPE may lead not only to sensory preservation, but may also reduce risk for associated injuries and fatalities.

Relevance to Public Health

Texas is among the most populous and fastest growing states in the United States. It is also a state where agriculture, forestry, and fishing contribute considerably to its economy. A substantial portion of its southern border is shared with the Gulf of Mexico where most of its commercial fishing activities take place. The commercial fishing work sector continues to experience one of the highest occupational fatality rates in the U.S. In the Gulf of Mexico, the shrimp fleet had the highest number of fatalities, with half of all deaths in the region during 2010–2014.[7] Among shrimp fishermen, the leading causes of death were vessel disasters, onboard injuries, and falls overboard.

Since the mid-1990s, the number of accredited occupational medicine residency programs across the nation has declined steadily, in spite of a recognized shortfall of physicians with formalized training in this area. In many specialty areas of medical practice, there is also little attention given to the special needs of non-urban populations. Moreover, rural communities often lack the infrastructure for developing and sustaining a preventive approach to occupational disease and injury, particularly for work sectors such as agriculture where a hired and/or migrant workforce and other vulnerable groups may constitute the majority of employees. One can reasonably conclude that there is a need for training occupational medicine physicians who have competencies, skills, and knowledge related to rural worker populations with special cultural considerations. As well, "Northeast Texas is home to just over 1.5 million people, over half of whom live in a rural area,"[8] representing one of the largest rural populations in the state.

These distinct factors, taken together, have helped to set the stage for three things which have happened in Northeast Texas and which are of particular relevance to public health regionally and in a larger context: 1) the creation of the NIOSH-supported Southwest Center for Agricultural Health, Injury Prevention, and Education (SW Ag Center) in 1995 serving Arkansas, Louisiana, New Mexico, Oklahoma, and Texas; 2) the initial (1994) and ongoing accreditation of an occupational medicine residency, the second civilian occupational medicine residency in Texas; and 3) the addition of a training component for residents which focuses on agricultural and rural occupational safety and health, inclusive of an Agromedicine module shared with rural medical students as described in this dissertation.[9] It was an occupational medicine resident graduate in 2004 that initiated project work related to the Gulf of Mexico fishermen on behalf of the SW Ag Center and occupational medicine residency.

Using essential public health services as a framework for describing the relevance of this work with the commercial fishermen to public health, these efforts span all three core functions, namely, assessment, policy development, and assurance.[10] The monitoring of disproportionate fatality rates in an industry sub-sector along with exploration of non-fatal events and risk factors that are not well understood constitute elements of assessment in this model as are so aptly portrayed by the work of occupational photojournalist, Earl Dotter. (Figure 6.6) That is to say, this work has involved monitoring, diagnosing, and investigating health problems.

Similarly, there has been work with community and multiple stakeholders to prioritize risks, and develop and disseminate interventions that coincide with policy development. More specifically, this involves mobilizing community partnerships while informing, educating, and empowering stakeholders.

Conducting a community trial involves a research initiative to advance "new insights and innovative solutions to health problems",[10] while evaluating the outcome of interventions through measuring changes in attitudes and beliefs as well as likelihood of adoption. This assurance function is essential to demonstrating the role of public health.

Finally, and importantly, the efforts put forth in this dissertation have served as a platform for training occupational medicine physicians, medical students, and other related public health professionals, providing opportunities for competency and skills development in the arena of environmental and occupational health as a public health

Figure 6.6. First mate of a ground fishing trawler untangles cables on a stabilizing outrigger spar, as the boat enters the open ocean, Cape Elizabeth, Maine. Reprinted with permission from Earl Dotter.[11]

discipline, particularly in rural populations. In so doing, it has helped to assure preservation of a competent workforce, a matter of considerable relevance to the public health community.

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