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Cardiovascular Disease Among Loggers and Commercial Fishermen: A Preliminary Risk Assessment

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ABSTRACT

Objectives: Cardiovascular disease (CVD) is the leading cause of death globally, and suitable interventions are needed for prevention. Certain occupations can create barriers to accessing healthcare while also being a driving force behind lifestyle behaviors that increase risk of CVD. This study analyzed the Framingham 10-year risk for developing coronary heart disease (CHD), among Maine loggers and commercial fishermen residing in Maine, Massachusetts, Oregon, and Alaska compared to the general population of working adults.

Methods: Between 2019 and 2024, loggers and commercial fishermen engaged in health screenings via three studies. Self-reported data regarding health behaviors, as well as anthropometric and biomarker measures, were collected at each screening and were obtained from National Health and Nutrition Examination Survey (NHANES) for a sample of working adults. Women were excluded due to their limited representation in the logging and commercial fishing populations. Framingham Risk Scores (FRS) for Hard CHD were established for each population, and comparisons were made based on both overall risk and component risk factors.

Results: This study included 44 loggers, 164 commercial fishermen, and 1073 working adults from the NHANES cohort. Commercial fishermen had the highest estimated 10-year FRS with an average of 6.95%, followed by the NHANES sample at 6.39% and loggers with 5.70%.

Conclusion: Though this study demonstrates loggers and commercial fishermen have a similar CVD risk profile to other working aged men, this risk for all three groups is higher than ideal. This study indicates a need to better understand risk among these populations, as well as how the occupational setting can be used for future intervention.

KEYWORDS

Chronic disease; framingham risk score; occupational health

Introduction

Internationally and in the United States, cardiovascular disease (CVD), an encompassing term that includes myocardial infarction (MI) and other coronary heart diseases (CHD), is the leading cause of death and is cause for major concern.[1,2] Traditionally, CVD risk has been targeted by prevention efforts in both clinical practice and via community-wide public health programs. However, given the significant time Americans spend at work, workplaces and workplace communities can also provide important intervention points. Further, certain workplace exposures or contexts may contribute to poor CVD outcomes, increasing the motivation for targeted workplace CVD interventions.[3,4] A first step in targeting individual workplaces is understanding the burden of CVD within particular industries as well as influential factors unique to their contexts. This study provides a preliminary assessment of CVD burden among two rural, blue-collar workforces: Maine loggers and commercial fishermen in Maine, Massachusetts, Oregon, and Alaska.

While both workforces are important to the economy and culture of their local communities, myriad adverse health outcomes have been reported among both.[5–11] Fishing and logging are among the most dangerous occupations, each with high rates of traumatic injuries and fatalities.[12,13] As such, much work has been done to mitigate these risks in culturally responsive ways.[14] Both occupations are carried out in isolated conditions, often miles into the forest or offshore, with minimal access to emergency medical services or other resources to support healthy behaviors.[15] Unfortunately, though there has been much

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progress regarding traumatic injuries within these populations, chronic diseases have often taken a backseat, justified by the ample research and programming available for the wider population, combined with the physical (and thus "healthy") nature of the work. Creating further burden, prior studies have demonstrated it can be both culturally and logistically challenging for workers in these industries to seek medical treatment, particularly preventative care.[4,11,16]

Prior studies have further demonstrated loggers and commercial fishermen have relatively poor health indicators. For example, a 2016 Morbidity and Mortality Weekly Report focused on CVD status indicated these two populations (along with farmers) frequently had poor diets (84.3%), body mass index (BMI) ≥25 kg/m^2 (68.7%) and did not meet recommendations for physical activity (≥150 minutes of moderate activity or ≥75 minutes of vigorous activity per week) (47.1%).[17] Additionally, both loggers and commercial fishermen face high stress and, at times, social isolation,[18,19] both of which are important predictors of CVD risk.[20] Further, a 2013 literature review of this topic within commercial fishing highlighted the importance of delving further into these issues.[21] Despite this past work, assessment of overall CVD risk among commercial fishermen and loggers is lacking in current literature.

The current study aimed to contribute to the relatively sparse literature pertaining to CVD risk among commercial fishermen and loggers using the Framingham Risk Score (FRS)[22] as a primary outcome measure. The long-term goal of this pilot study is to understand these workers' needs related to CVD prevention and treatment.

Materials and methods

This is a comparative study assessing the estimated 10-year risk for MI or coronary death among working male populations in the United States via the FRS. The risk prediction algorithm was developed from the original Framingham Heart Study Cohort[23] and was selected as data pertaining to diabetes (necessary for other FRS algorithms) was not consistently collected among our study populations. The algorithm was modified by the third Adult Treatment Panel (ATP III) in 2002, resulting in the widely accepted risk estimation for hard coronary heart disease (HCHD), used in this study.[24]

Study population

Two blue-collar, geographically isolated occupations were highlighted in this study: commercial fishing and logging. Data were obtained from three studies as described below. Though these data were collected separately, the data collection instruments and protocols used the same basic structure and questions, with minimal modifications to tailor the instruments to the specific settings. Thus, the measures described below and relevant to this study are comparable.

Occupational cohorts

The logger cohort was established via in-person health assessments conducted at five different locations within Maine as part of the 2019 Maine Logger Health and Safety Study.[11] The purpose of the Maine Logger Health and Safety Study was to capture comprehensive data on the overall well-being of logging workers in the region. Subjects who enrolled in the longitudinal survey portion of the study were contacted by way of postal mail, email, or telephone to schedule a health assessment coinciding with logger safety trainings or at the annual loggers' expo. Additionally, walk-in appointments were offered to loggers interested in participating at any location, effectively enrolling in the full study from that point forward.

Data for the fishermen were collected at health assessments offered via two separate studies. First, via a study assessing the cognitive impacts of sleep deprivation among commercial fishermen in Alaska, Oregon, and Massachusetts in the spring of 2022. Second, in the winter 2024 via an ongoing pilot study taking place in a rural community in Downeast, Maine, to evaluate the effectiveness of applying the community health worker (CHW) model[25] to improve the wellbeing of commercial fishermen. Fishermen were initially identified via settlement houses, which are management institutions for scallop fishermen[26] (sleep deprivation project) or permit lists (CHW project & sleep deprivation project), randomized, and contacted via telephone, text, or email. Because these

methods resulted in lower than anticipated enrollment, both studies subsequently used dockside recruiting and snowball sampling to engage additional fishermen.

In all three studies, participants completed health questionnaires prior to or at the time of their screenings. Health screenings were free for all participants, and they were compensated for their time with gift cards. All screening services were administered by trained technicians and a medical provider. More detailed information regarding the health screenings can be found in other publications.[8,11,11]

General population

Between August 2021 and August 2023, the National Health and Nutrition Examination Survey (NHANES) utilized a 2-year sample design that "drew a multi-year, stratified, clustered four-stage sample of the U.S. civilian noninstitutionalized population.[27]" A subset of these data were taken to best represent a national sample of working and able-bodied men in the United States. The sample of subjects drawn from NHANES 2021–2023 included those who reported one of the following: they are 1) currently working, 2) looking for work, or 3) did not work in the last week because they were taking care of the house or family, attending school, can't find work/on layoff, or engaged in seasonal or contract employment, as stated on the occupation questionnaire (OCQ_L).[28] NHANES questionnaire methods can be found in detail elsewhere.[29]

Inclusion criteria

To be eligible for this comparative analysis, participants were required to be men between the ages of 30 and 79 (as required by the FRS guidance).[30] As men predominately comprise the commercial fishing and logging industries (95.7% and 93.2% in the logging and fishing cohorts of this study, respectively), women and those of other reported genders were excluded. FRS calculations further limited eligibility to those who were free of CHD, intermittent claudication, diabetes and had not had a prior MI or stroke as per self-report or by documentation by occupational health technicians during screenings.[22,30]

All participating individuals in the fishing and logging studies were required to sign an informed consent prior to data collection, and procedures were approved by the Mary Imogene Bassett Healthcare Network's Institutional Review Board (IRB). NHANES data are publicly available and collected under protocols approved by the National Center for Health Statistics Ethics Review Board. Informed consent was obtained from all participants.

Measurement of physiological variables

The Framingham risk model for 10-year HCHD was used. Predictors used in this calculation include age, total cholesterol (mg/dL), high density lipoprotein (HDL) (mg/dL), systolic blood pressure (BP) (mm/hg), treatment for hypertension, and smoking status.

Occupational cohort

Collection of these variables was similar across the logging and two commercial fishing studies. Age and smoking status were obtained via self-report on the questionnaires. The hypertension medication factor was determined by the technicians at the time of the screening via subjects' oral report of current medications. Resting systolic blood pressure readings were taken either manually with a sphygmomanometer and stethoscope or by using an automated oscillometric blood pressure device (Welch Allyn Spot Vital Signs, Model 0297), depending on availability.[31] Random glucose and cholesterol readings were measured by the CardioChek Plus analyzer from capillary blood samples.[32] All readings were performed by the occupational health technician.

Systolic BP (mmHg), heart rate (bpm), height (inches), weight (lbs), age (years), BMI (lbs/in^2), and waist and hip circumference (inches) measurements were collected following protocols developed by the research team and consistent with best practices.[33] Detailed protocols may be obtained from the authors.

General population

Physiological data for NHANES participants were collected at the time of their examination following standardized protocols for examination and

laboratory data collection. Age, blood pressure medication status, and smoking status were determined through demographic data and questionnaire responses.[29] Detailed methods are available through the Centers for Disease Control and Prevention (CDC).[34–36]

Statistical analyses

All statistical analyses were performed using SAS 9.4 (Cary, NC).[37] The FRS was calculated for each individual in this study. Continuous variables were reported as mean and standard deviation values. A one by three analysis of variance (ANOVA) model was used to compare the mean estimated risk scores for fishermen, loggers and the general population. This method was also used to compare the individual Framingham risk component variables as well as BMI, waist-hip ratio, and heart rate. A binary generalized linear mixed (GLIMMIX) model with logit link function was used to evaluate the differences in prevalence of smoking across the three groups. The threshold for statistically significant differences was set at $p < .05$.

Results

The study sample included a total of 1281 participants. There were 164 fishermen (mean age = 51.94 ± 12.54), 44 loggers (mean age = 47.86 ± 12.71), and 1073 working males from the NHANES 2021–2023 study (mean age = 49.05 ± 12.48). There were no significant differences in 10-year mean estimated risk between fishermen, loggers, and the general working male population, although estimated risk was highest in the fishing population (6.95% vs. 5.70% vs 6.39%, respectively ($p = .3589$)). Median values were also highest for fishing (6.50, IQR 1.79 – 10.50), followed by NHANES (5.29, IQR 1.23 – 10.08), and logging (3.90, IQR 0.60 – 8.69). Each industry's distribution of risk scores showed some degree of right skew which was most pronounced in the NHANES group.

All continuous risk predictor variables showed some form of significant variation between groups, which are detailed in Table 1. Fishermen were the oldest population in this study, significantly older than the NHANES cohort who were second oldest ($p = .0161$). The NHANES sample had the highest average total cholesterol, whereas loggers showed the lowest, with fishermen showing higher HDL levels than the other two groups ($p < .0001$). Post hoc comparisons show that systolic BP was significantly different between all three groups, with loggers having the highest levels ($p < .0001$). Further, both the logging and commercial fishing populations had mean systolic BP readings considered to be in the hypertension I range. Table 2 shows the prevalence of smoking, high BP diagnoses, and medication treatment for high BP. The NHANES group had the lowest systolic BP readings as well as the largest proportion of any sample taking medication for hypertension (18.27%). The prevalence of smoking in fishermen (30.49%) was significantly higher than for loggers (9.09%) and for NHANES (18.36%) ($p = .0004$). High BP diagnoses were reported as $n = 149$ for fishermen due to missing questionnaire responses for that item.

Table 3 shows average physiological measures and heart rate across groups. Loggers had significantly higher BMI than the commercial fishing and NHANES cohorts ($p = .0164$). Waist-hip ratios were similar between loggers and the NHANES group but significantly lower among fishermen ($p = <0.0001$). Resting heart rate was lowest in the NHANES sample and highest in the loggers

Table 1. Mean age, cholesterol, and blood pressure across study populations.

Variable	Fishing ($N = 164$)	Logging ($N = 44$) Mean (SD)	NHANES ($N = 1073$)	p-value
Age (years)	51.94 (12.54)[a]	47.86 (12.71)[ab]	49.05 (12.48)[b]	0.0161
Total Cholesterol (mg/dL)	179.81 (35.87)[a]	164.34 (35.54)[a]	195.29 (39.88)[b]	<0.0001
HDL (mg/dL)	55.10 (14.87)[a]	41.73 (8.73)[b]	50.02 (12.86)[c]	<0.0001
Systolic Blood Pressure (mm/hg)	132.18 (14.39)[a]	139.52 (13.95)[b]	124.48 (14.69)[c]	<0.0001

HDL, high density lipoprotein.
[a,b,c]Denote significant differences amongst groups determined by post hoc comparison using Scheffe's adjustment. Groups that do not share a superscripted letter are significantly different from each other.

Table 2. Prevalence of smoking and prior diagnosis and treatment of hypertension across study populations.

Variable	Fishing ($N = 164$)	Logging ($N = 44$) Prevalence (%)	NHANES ($N = 1073$)	p-value
Smoking	30.49[a]	9.09[b]	18.36[b]	0.0004
Diagnosed with high BP	26.17[*,a]	36.36[a]	26.65[a]	0.3605
Treated for high BP	12.80[a]	15.91[a]	18.27[a]	0.2252

BP, blood pressure.
*$n = 149$; missing responses for fishermen.
[a,b]Denote significant differences amongst groups determined by post hoc comparison using Scheffe's adjustment. Groups that do not share a superscripted letter are significantly different from each other.

Table 3. Mean BMI, waist-hip ratio, and heart rate across study populations.

Variable	Fishing ($N = 164$)	Logging ($N = 44$) Mean (SD)	NHANES ($N = 1073$)	p-value
BMI (lbs./in^2)	28.54 (5.15)[a]	31.32 (4.28)[b]	28.90 (5.94)[†,a]	0.0164
Waist-Hip Ratio	0.92 (0.09)[a]	0.96 (0.06)[b]	0.97 (0.07)[‡,b]	<0.0001
Heart Rate (bpm)	70.94 (12.34)[*,ab]	73.64 (13.02)[a]	68.86 (11.23)[b]	0.0039

BMI, Body Mass Index.
n = 157; missing heart rate measurements.
[†]$n = 1070$; missing body measurements.
[‡]$n = 1052$; missing body measurements.
[a,b]Denote significant differences amongst groups determined by post hoc comparison using Scheffe's adjustment. Groups that do not share a superscripted letter are significantly different from each other.

($p = .0039$). Mean heart rate was reported as $n = 157$ due to missing measurements from commercial fishermen.

Discussion

The overall 10-year CHD risk among loggers, commercial fishermen, and the general population was not significantly different. Despite the similarities in overall 10-year risk, the analyses did show some form of significant variation in a majority of specific risk factors used to evaluate the FRS between groups (Tables 1–3).

Though working age adults were used as a comparison in this study, the primary purpose of this study was to gain a preliminary understanding of the burden of CVD on loggers and commercial fishermen, as well as to identify areas of potential intervention. As shown, burden has been assessed using FRS components; however, limited data on lifestyle factors influencing these biomarkers was collected through these studies. Despite this, we know from other research that occupations such as logging and commercial fishing can heavily influence ones' health behaviors either directly or indirectly.[3,38]

For instance, commercial fishermen are tasked with vigorous occupational physical activity almost daily. Meanwhile, some loggers, especially those who rely increasingly on mechanization, perform less physical activity throughout the work day. Vigorous activity is known to increase HDL levels in the bloodstream and may be why fishermen had the highest levels in this study, while loggers had the lowest.[39] Further, though increased physical activity is generally shown to be protective in regard to CVD, studies have shown that when not balanced with appropriate rest and leisure time physical activity, increased occupational physical activity is associated with a higher risk of cardiovascular events.[40] This raises concerns in industries like fishing and logging and warrants further investigation.

In addition to physical activity, diet and nutrition likely play a role in risk among these groups. Past literature has explored diet in loggers, with the "traditional loggers" breakfast displayed in photovoice, which depicts a breakfast high in cholesterol, saturated fats, and trans fats.[41] This, in

combination with a workday spent sitting inside a machine would ultimately increase LDL, or "bad" cholesterol levels in an individual. Further, both logging and commercial fishing worksites tend to be located in remote locations – often hours by car or boat from nearby towns. Among commercial fishermen in particular, workdays are often extended to multi-day or weeks long excursions due to the time it takes to travel to worksites as well as regulations pertaining to when fisheries are legally "open." These factors often mean loggers and commercial fishermen are eating meals that can be cooked or purchased quickly, stay fresh for an appropriate amount of time, and satiate workers. Similarly, as a result of this well-known problem, work is being done to better educate commercial fishermen and loggers about how to appropriately meet their nutritional needs while working.[42,43]

Long work hours can also contribute to other behavioral risk factors. In particular, studies have found that extended working hours may promote smoking.[4] Further, such work schedules can reduce the amount of quality sleep workers get, further impacting their cardiovascular wellbeing and the risk factors described here.[44]

In addition to the influence of occupation on lifestyle factors, one study also found various work-related factors increase cardiovascular stress in field machine operators in the logging industry. In this particular study, elevated heart rate while working inside the machine was taken as a sign of strain on the cardiovascular system, citing machine type, noise exposure, whole-body vibration exposure, part of the shift, and cabin lighting as work-related factors that affect this strain.[45] Such factors may have influenced the cardiovascular issues among loggers, who had the highest systolic BP and resting heart rate readings in this study.

Finally, among both loggers and commercial fishermen, stress and other mental health challenges can be particularly problematic. Past studies have determined that fishermen suffer from probable post-traumatic stress disorder (PTSD) at rates three times higher than the national average for men, via the Primary Care Screen for DSM-5.[19] These findings can be exacerbated by increasing regulatory stress and other daily stressors such as the financial burden of commercial fishing. Loggers are faced with similar challenges like increasing costs due to mechanization and lack of health insurance, which only adds to the stress of working in a highly dangerous industry (Zenir et al, manuscript under review). Chronic stress has been linked to the onset of psychiatric conditions such as major depressive disorder, bipolar disorder, and PTSD.[46] Further, mental conditions have been found to increase cardiac morbidity and mortality, thus mental health challenges are risk factors that must be considered in future studies.[47]

Although similar in terms of overall risk, the true CVD burden among loggers and commercial fishermen stems from the cultural differences these groups have from the general working population. In high risk, high reward industries like logging and fishing, workers are more likely to forego doctors' appointments and address chronic illness due to challenges they face when it comes to healthcare.[38] In addition to the challenges that come with rural residency, these workers face additional challenges. Namely, in occupations that are weather-dependent and seasonal, making and keeping appointments can be difficult.[16] This is especially true for commercial fishermen who often are engaged in multi-day trips. In these instances, a single appointment could cost them a week or more in wages if kept.[48]

Because of these challenges, it can be difficult for loggers and commercial fishermen to seek out preventative care. This may help explain why (though not statistically significant) fewer of these individuals were being treated for high blood pressure than the NHANES sample, despite more having reported prior high blood pressure diagnoses – an association that should be considered in future work.

As prevention can be challenging, it is not uncommon amongst fishermen and loggers to treat serious medical problems only as they arise, which can create larger issues not only for the individual but for the industries where oftentimes a rescue team is too far away to step in during emergencies.[16] In particular, it can be difficult to manage a cardiac arrest at one of these workplaces, particularly given few vessels and wood lots have an automated external defibrillator (AED) present. Based on these results, roughly 1 in 14 fishermen

and 1 in 16 loggers are predicted to suffer from MI or coronary death in the next 10 years (compared to 1 in 18 men within the all-worker population). These numbers highlight the risk of potential lives lost due to CVD. While not certain these events will take place at work, those who spend more time at their job and are far from feasible rescues, such as the loggers and commercial fishermen discussed here, are likely to have a greater chance of tragedy striking while on the job. This research encourages raising more awareness surrounding CVD and increasing intervention efforts to prevent such issues in vulnerable populations.

Limitations

Sample size had limiting effects on this study. Small sample sizes for loggers and commercial fishermen may generally influence the results. Specifically, such vast differences in sample sizes between groups weaken the ANOVA and post hoc analyses. Given recruitment methods, it is possible that those loggers and commercial fishermen who participated may have been motivated by an interest in health and, thus, may be different from the overall worker population of their industry. Hence, it is known that significant differences should be interpreted wisely as these findings are preliminary and may not be widely applicable. Related to sample size, it is important that women were excluded from this study due to small numbers in the logging and commercial fishing industries and, therefore, from the cohorts included in this study. Furthermore, race and ethnicity data were not collected, making comparisons between groups impossible in this pilot study. As both demographic classifications are important to CVD risk and presentation,[49,50] they will be important to consider in future studies.

Another notable limitation of this study is the type of data that were accessible through NHANES. Although this study utilized record-level data from NHANES 2021–2023, there was no indication of participants' occupational field, which would have allowed for a more specific comparison across specific types of workers. Lastly, data from NHANES 2019–2020 were not included, as the survey was not completed for that cycle due to the COVID-19 pandemic. One of the studies completed by the research team was done in 2019, thus lacking the most comparable data from NHANES. Despite these limitations, this preliminary study provides a crucial look at CVD risk among loggers and commercial fishermen and provides direction for further research and intervention.

Conclusions

Though in comparison to other working adults, loggers and commercial fishermen face a similar risk of CVD events, this study demonstrates their risk is still higher than ideal. While these findings are preliminary, they point to a need to better understand the specific risk factors each of these industries face in relation to CVD risk, as well as risk of other chronic diseases. Further, as both industries are unique in that employment in them influences culture, lifestyle, and access to care, and health behaviors, it is imperative that further work be done to explore culturally appropriate and accessible CVD prevention and treatment strategies for these groups.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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