Journal of Integrated Community Health
Volume 9, Issue 1 - 2020, Pg. No. 3-16
Peer Reviewed & Open Access Journal

Research Article

Noise Exposure and its Relationship with Hypertension among Fishermen in Thua Thien Hue Province, Vietnam

Nhan Phuc Thanh Nguyen[1,2], Duong Dinh Le[3,6], Man Dinh Minh Nguyen[3], Ai Ha Phan Nguyen[4], Bao Van Anh Ha[5], Huan Minh Tran[1,5], Nam Tran Ton Nu[3], Nontiya Homkham[1], Twisuk Punpeng[1]

[1]Faculty of Public Health, Thammasat University (Rangsit Center), Khlong Luang, Pathum Thani, 12121, Thailand.
[2]Institute for Community Health Research, Hue University of Medicine and Pharmacy, Hue University, Vietnam.
[3]Hue University of Medicine and Pharmacy, Hue University, Vietnam.
[4]Institute of Public Health, Ministry of Health, Vietnam.
[5]Da Nang University of Medical Technology and Pharmacy, Vietnam.
[6]Faculty of Public Health, Khon Kaen University, Thailand.
DOI: https://doi.org/10.24321/2319.9113.202001

I N F O

Corresponding Author:
Nhan Phuc Thanh Nguyen, Faculty of Public Health, Thammasat University (Rangsit Center), Khlong Luang, Pathum Thani, 12121, Thailand & Institute for Community Health Research, Hue University of Medicine and Pharmacy, Hue University, Vietnam.
E-mail Id:
nptnhan@huemed-univ.edu.vn
Orcid Id:
https://orcid.org/0000-0001-8826-9757
How to cite this article:
Nhan Nguyen, Duong D Le, Man DM Nguyen, Ha PA Nguyen, Bao VA Ha, Huan M Tran et al. Noise Exposure and its Relationship with Hypertension among Fishermen in Thua Thien Hue Province, Vietnam. *J Integ Comm Health* 2020; 9(1): 3-16.

Date of Submission: 2020-03-05
Date of Acceptance: 2020-06-11

A B S T R A C T

Introduction: Fishermen work in an unfavorable working environment, which faces many disadvantages such as inclement weather conditions, prolonged working time with hard labor and are effected by adverse environmental factors, in which noise is the most common agent but there are very few studies on the effects of noise to fishermen's health especially on blood pressure.

Methodology: A cross-sectional study was conducted on 159 fishermen who were working in 14 offshore ships, a sound level meter was used for noise measurement and the noise exposures were calculated based on the average working time in 8 hours. Questionnaires were used for interviewing, blood pressure was measured by trained local doctors.

Result: It was found that 71.1% fishermen were expose to the working noise which is over 85 dBA for 8 working hours a day. The highest average sound level was recorded in the engine room (min-max: 91.8-96.2), follow by driving cabin (min-max: 83.1-92.2). Blood pressure measurements showed a result of 28.9% hypertensive fishermen. There was not statistically significant between hypertension and exposure to noise.

Conclusions: It can be concluded that almost three quarters of the fishermen exposed to noise in the working environment exceeds 85 dBA for 8 hours. Futher studies are required to provide comprehensive approach between noise and hypertension.

Keywords: Fishermen, Noise Exposure, TWA8, Hypertension

Introduction

The working environment on the ship contains many hidden risks to workers's health. Working in inclement weather conditions such as the severe climate on the sea, the sun, the sea breeze, the waves affect workers' health.[1] Furthermore, noise, vibration, cramped workspace, unsanitary conditions, lack of nutrition and limited healthcare are creation of working environment taking into specific characteristics of the marine exploitation.[2] Some studies also have shown unreasonable diet, lack of physical activity as well as the issues related to ergonomics lead to accidents, the problems of muscle-skeleton, stress, cardiovascular disease that fishermen often encounter.[1,3] Among above factors, noise is one of the most influential factors on the health of fishermen.

Exposure to noise for a long time leads to disadvantageous effects on workers's health. Exposure to excessive noise in the labor process is a common problem in the industry, including the aquatic fisheries industry.[4] The noise appears regularly and continuously throughout the sea voyage and even when parking at the pier with many different levels. Some positions on fish vessels such as machine chambers, control rooms have higher noise intensity than usual, mainly in high frequency range. Exposure for a long time will have not only hearing effects such as hearing loss, deafness, tinnitus, but also cardiovascular pathologies, stress, sleep disorders.[5-7] These affect the fishermen's health and are associated with a reduction in the overall quality of life.[8] Under of noise influence, endocrine glands have some impact on blood pressure, the increase of heart rate and as well as other hormones such as cortisol, norepinephrine, adrenaline (epinephrine).[9,10]

In Vietnam, some researches on noise pollution have been published in recent years but focus has been mainly on noise intensity or loss of hearing. Only in recent years, the research on the health impacts due to the new industrial noise is focused but it is still very few and on small scale. In addition, the implementation of research such as sampling at long-shore fishing vessels is a hindback to researchers due to the source of information, limited data as well as protection measures, healthcare policies while this is an extremely important group of people for social-economic development, the protection of the sea and sovereignty of the national island. That sets out the needs of studying the impacts of the labor environment on the health of fishermen to provide the evidence for policy-making and to make more effective measures in protecting fishermen's health care. In terms of noise and its influence, determining the proportion of the fishermen who are working under high noise environment (> 85 dBA) and the effects on the health would provide useful information for subsequent intervention programs.

Methodology

Study Design and Participants

A cross-sectional study was carried out from August 2018 to May 2019 in Thua Thien Hue province, a Vietnam-coastal province with 120 km of coastline.

Participants were selected based on a list of fishermen who were working in offshore fishing ship (engine power ≥ 400 HP) provided by local government. A total 159 fishermen were estimated to participate in the research. The criteria for selectionwas over 18 years old age, at least 12 months of work experience, absence of acute health problems and voluntary participant. Exclusion criteria were workers whose ages are lower than eighteen[18] years and work experience less than twelve (12) months and those who did not agree to participate.

Data Collection

Data Collection Process

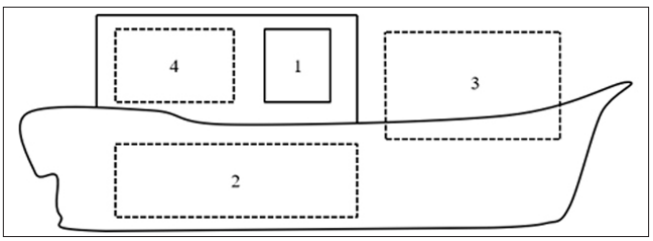
Based on management data of local government, there were 1314 offshore fishing ship (engine power > 400 HP) and 121 fishing ships in research area. The number of employees in a ship normally range from 10 to 12. Then, 11 to 15 fishing ships was chosen until there were at least 151 fishermen. Sound Pressure Level (SPL) in the chosen ships was measured. Finally, fishermen were interviewed with structured questionnaire and blood pressure index was measured.

Data collection Technique

Noise Measument

Sound Pressure Level (SPL) was measured continuously for about 5-minute periods at each location and L_{eq} (dBA) was recorded. This duration was decided according to ISO 9612 standard method, although a minimum of 10-s period was recommended by IMO (1982) and other shorter measurement periods were used in previous studies.[11]

Sound Level Meter Class 1 Rion NL-52 were used for noise measurement in this research. Device was set up with Scale A or A-weighting, Slow response, Exchange rate 3 dB. Rain protection windscreen WS-16 (attach with Rion NL-52) were used to reduce effect of sea wind during data collection. SPL was calibrated every 2 years by Center for Quality Measurement Standards Technology; SLP was tested with sound calibrator before using in fishing ship.



ISSN: 2319-9113
DOI: https://doi.org/10.24321/2319.9113.202001

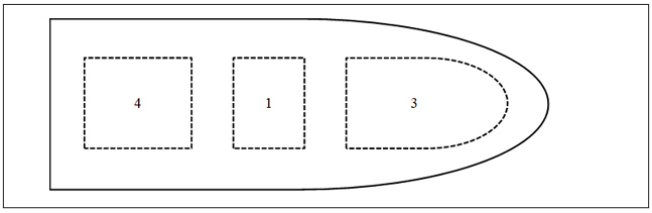


Figure 1.Common structure of offshore fishing ship in research area. (1) Driving cabin, (2) Engine room, (3) Deck, (4) Resting area

Table 1.Description of sound pressure measurement locations

S. No.	Location	Types of work
1.	Driving cabin	Surveillance and driving, only captain take responsibility.
2.	Engine room	Involves activities such as turning the engine on and off, checking and lubricating the engine … There is no worker for most of time, workers come to work for a short time and leave the room.
3.	Deck	Net repairing, collecting fish and place for sitting during resting or waiting time.
4.	Resting area	Sleeping, eating and resting while they have no work.

Hypertension Measurement

According the criteria of World Health Organization, hypertension was defined based on the average Systolic Blood Pressure (SBP) ≥140 mmHg and/ or average Diastolic Blood Pressure (DBP) ≥90 mmHg and/ or self-reported previous diagnosis of hypertension by a health professional.[12] In this research, blood pressure was measured by physician with standard evaluation in sitting position after five minutes resting. The measurement was conducted before the offshore trip to avoid temporary hypertension or some changing in blood pressure during or after offshore trip. Blood pressure was measured twice and if the BP recorded were different by 5 points or more, a third time would be done.

Noise Calculation

Noise exposure calculation was conducted according to the recommended NIOSH standard for occupational noise exposure with time weighted average 85 dBA for 8 hours work shift using 3 dB exchange rate for longer exposure period.[13] With exposure level L_{eq} of each position, the permissible duration in this position was calculated by this formula:

$$T_P = \frac{8}{2^{(Leq-85)/3}} \quad \text{hour} \qquad (1)$$

T_p: permissible exposure duration (hour).
L_{eq}: measured sound level (dBA).

Each fishermen's exposure with different noise level in different position during their work shift and longer than 8 hours in NIOSH standard, the noise level (L_{eq}) was calculated by this formula:

$$L_{eq,T} = 10 * \log\left(\frac{1}{T} * (t_1 \times 10^{0.1*Leq1} + \ldots. + t_n \times 10^{0.1*Leqn})\right) \quad \text{dBA} \qquad (2)$$

T: total time of exposure in hour.
Leq: measured sound level (dBA).
n: number of discrete job.

After obtaining sound pressure data during shift in T (hour), the data were transferred to daily personal noise exposure based on 8-hours ($L_{ex,8}$) with this following formula:

$$L_{ex,8} = L_{eq,T} + 10 \log \frac{T}{8} \qquad \text{dBA} \qquad (3)$$

T: total time of exposure in hour [from formula (2)].

When the daily noise exposure consisted of periods of different noise levels, the daily dose (D) were not equal or exceeded 100, as calculated according to the following formula:

$$D = \frac{C_1}{T_1} + \frac{C_2}{T_2} + \cdots + \frac{C_n}{T_n} \quad *100\% \qquad (4)$$

where

C_n = total time of exposure at a specified noise level,

T_n = exposure duration for which noise at this level becomes hazardous. (using formula (1)).

The daily dose was converted into an 8 hour Time Weighted Average noise levels (TWA8) according to the following formula:

$$TWA = 10 \times \log \frac{Dose}{100} + 85 \quad \text{dBA} \qquad (5)$$

Statistical Analysis

In univariate analysis, baseline characteristics were compared with hypertension of fishermen by appropriate testing. Occupational noise dose was presented followed by the standardized formula in 8 hours TWA. Multiple logistic regression model with Generalize Estimating Equation (GEE) was applied to adjustment the association between exposed noise level and hypertension. In the fitting model, we conducted the GEE for adjustment in the ships, the associated noise volume and hypertension was modified with working time, body mass index, salty diets, alcohol abuse and family history with HP.

Result

Characteristics of Participants and Hypertension Prevalence

Data from 159 fishermen in 14 fishing ship were included in

ISSN: 2319-9113
DOI: https://doi.org/10.24321/2319.9113.202001

our analysis. Prevalence of hypertension was approximately 28.9% (46/159) (Table 2). All fishermen were over 30 years olds and had at least 10 years working in current fishing ship. Most of their age was in 40-49 (97/159) with 10 to 20 experience years (85/159). 45.2% (72/159) participants attained primary level and below, and only 18.9% (30/159) had high school and higher education level.

45.2% were overweight based on BMI criteria for Asian (≥ 23 kg/m^2) but there were no statistical significance between hypertension and BMI index.

On lifestyle behaviors, prevalence of hypertension was higher among participants who was currently smoking, using alcohol at harmful level and having salty diet compared with normal group (p<0.001)

Sound Pressure at Measument Locations

The highest sound level was recorded in Engine room area, where the lowest was 91.8 dBA, and the highest was 96.2 dBA (Figure 2). The second area with a high sound level was the Driving cabin where the lowest level was 83.1 dBA and the highest level was 92.2 dBA. The highest sound level in Deck area was 86.1 dBA and the lowest was 80.9 dbA. In resting area, the highest sound level was 87.7 dBA and 81.3 dBA was the lowest sound level.

Noise Exposure Level

Table 3 shows that there were 113 fishermen, making up 71.1%, bearing the working noise which was over 85 dBA for eight working hours a day (TWA8 > 85 dBA), according to the recommendations of NIOSH.

Table 2.Baseline characteristics of fishermen by level hypertension

Variable	Hypertension n (%)	Normotensive n (%)	p-value*
Age (years)			
30-39	7 (14.3)	42 (85.7)	0.024
40-49	34 (35.1)	63 (64.9)	
≥50	5 (38.5)	8 (61.5)	
Mean±SD			
Currently experience year			
<10 years	3 (6.7)	42 (93.3)	<0.001
10-20 years	27 (31.8)	58 (68.2)	
>20 years	16 (55.2)	13 (44.8)	
Highest level of education attained			
Iliteracy and Primary school	27 (37.5)	45 (62.5)	0.041
Junior high school	17 (29.8)	40 (70.2)	
High school and higher	2 (6.7)	28 (93.3)	
Body Mass Index (kg/m^2)			
Normal (<23)	22 (25.3)	65 (74.7)	0.295
Overweight ((≥23.0)	24 (33.3)	48 (66.7)	
Current Smoking			
Yes	37 (41.1)	53 (58.9)	<0.001
No	9 (13.0)	60 (87.0)	
Alcohol Abuse (>2 units/day)			
Abuse	19 (65.5)	10 (34.5)	<0.001
Normal	27 (20.8)	103 (79.2)	
Salty diet (>5g salt~1 teaspoon/day)			
Salty diet	32 (50.8)	31 (49.2)	<0.001
Normal	14 (14.6)	82 (85.4)	
Total	46 (28.9)	113 (71.1)	

** p-value from Chi-square test*

ISSN: 2319-9113
DOI: https://doi.org/10.24321/2319.9113.202001

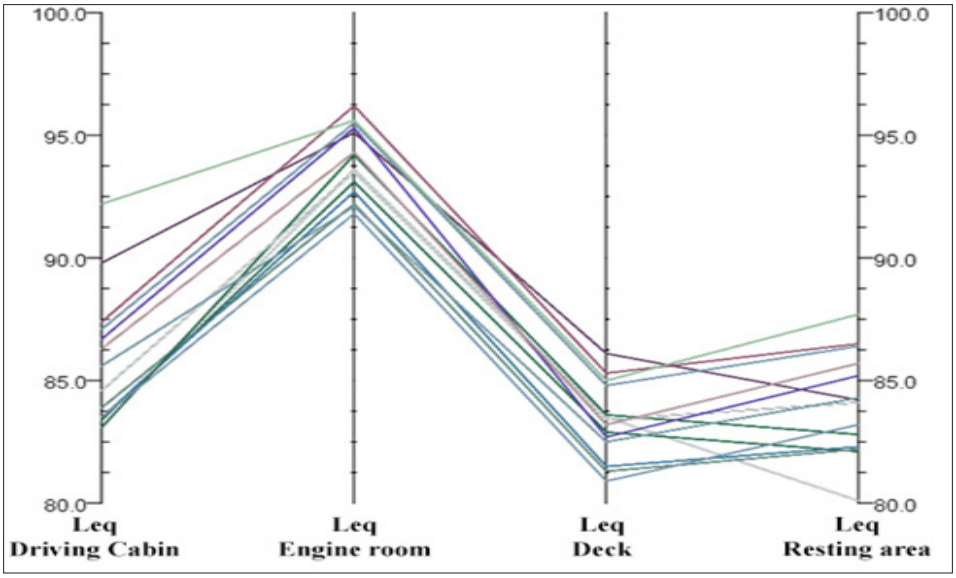


Figure 2.Noise level in measurement locations

Table 3.Time weighted average 8 hours of fishermen

Characteristic		n	Prevalance %
Exposure level	TWA 8 > 85 dBA	113	71.1
	TWA_8 ≤ 85 dBA	46	28.9
Average exposure time daily	Mean ± SD (hour)	12.3 ± 0.61	
	Range: min - max (hour)	11 - 14	

Table 4.Logistic regession model with generalized equation estimating to explain the hypertension on fishermen

Factor	Crude OR (95% CI)	Adj. OR (95% CI)	p
TWA-8hours	1.403 (1.163-1.693)	1.212 (0.981-1.497)	0.075
Experience (years)	1.129 (1.072-1.189)	1.069 (1.007-1.136)	0.028
Body mass index (kg/m²)	1.190 (0.992-1.426)	1.279 (1.026-1.595)	0.029
Salty diets			
No	Ref.	Ref.	
Yes	6.046 (2.851-12.823)	2.482 (0.996-6.187)	0.051
Alcohol abuse			
Not abuse	Ref.	Ref.	
Abuse	7.248 (3.021-17.390)	2.827 (0.979-8.163)	0.055
Family history with hypertension			
No	Ref.	Ref.	
Yes	7.071 (3.163-15.809)	2.768 (1.054-7.268)	0.039

Relationship between Noise Exposure and Hypertension

In the fitting logistic regression model, experience years in current fishing ship, body mass index and family history with hypertension were contributed to explain the relationship with hypertension. The result showed that there was insignificant difference between TWA-8 hours, salty diets, alcohol abuse and outcomes (Table 4).

Discussion

Noise Exposure Level

In this research, working time of fishermen on the ship was

ISSN: 2319-9113
DOI: https://doi.org/10.24321/2319.9113.202001

not fixed, lasted more than 8 hours a day and inconsistently on 14 ships. Therefore, formulas in "Noise Calculation" section given earlier were used to determine the TWA-8 hours of fishermen in this research and results showed that approximately 3 of 4 employees (71.1%) had the adverse noise dose, TWA-8 hours over 85 dBA (Table 3). Working in the environment where TWA8 exceeds 85 dBA means the noise was in harmful level and it would lead to some harmful effects on health such as hearing reduction, deafness or non-auditory effect such as annoyance, sleep disturbance, increased the occurrence of hypertension and cardiovascular disease.[4-6]

Hypertension

Based on blood pressure measurement, hypertension prevalence was 28.9%. This prevalence was higher than average prevalence of Vietnamese adults in "National survey of risk factors for non-communicable diseases" in 2015 with 18.9%.[14] The reason of these differences could be the diagnosis cut-off point and different characteristics of participants in the research. In national survey, they used cut-off point for hypertension diagnosis 140 mmHg systolic or 90 mmHg disastolic, higher than 130/80 in this research and it leads to higher prevalence of hypertension in this research. Besides, fishermen's exposure with many risk factors for hypertension such as salty diet; alcohol, tobacco consumption at abuse level could have contributed to the results in this study.[15,16]

Comparing with the previous literature, hypertenstion of fishermen varied worldwide from 15% to 70%. We found that hypertension prevalence varies in different countries, such as 24.5% in Indian research or only 15% hypertensive fishermen in Nigerian research on 400 fishermen.[17,18] Our results were lower than hypertension among Danish seafarers (44.7%). This could be due to the different characteristic of Asian and Nordic people.[19] In our study, compared with research in Brazil with fishermen who were over 40 years old, the prevalence of hypertensive participants was extremely higher, with 70%.[20] This difference is understandable because hypertension risk increases with age; higher age is associated with higher risk of hypertension and vice versa.[21-23]

Relationship between Noise Exposure and Hypertension

Result in Table 4, showed that there was insignificant difference between noise exposure and hypertension. Several hypotheses mentioned relation between exposure with noise at harmful level and increased blood pressure index leads to hypertension, but epidemiological evidence was still limited. Many standpoints supported or opposed this hypothesis with specific studies.

On this research results, several reasons could explain these issues; limitation in sample size was one of some acceptable reasons. Beside it, lack of noise dosimeter, error during sound measurement and exposure time report as well as absence of individual confounder data, adds to the risk of bias could affect to research results. In fact, opinions on weak relationship between noise exposure and hypertension or argument that noise only caused the increase in blood pressure and did not lead to hypertension as well as no significant relationship between two variables were mentioned in several researches.[24-27]

On the other hand, opinion of not having statistically significant relation between noise and hypertension was given by several researchers. *Gan et al*. proved the evidence was not consistent to support the association between occupational noise exposure and blood pressure after conducting research in 4,548 participants.[28] After reviewing 43 epidemiologic studies on noise exposure and cardiovascular diseases, another author suggested that noise exposure could contribute to the prevalence of cardiovascular disease but evidence of this relationship was still inconclusive because of confounder bias[29] or an idea on no significant difference in blood pressure and heart rate before and after the exposure from research on 50 workers in a steel company.[30]

Conclusion and Recommendation

In conclusion, majority of fishermen working on offshore fishing ship in Thua Thien Hue province were exposed to noise in harmful level. It is recommended to apply some engineering controls to reduce noise's harmful. Solution could be building bulkhead, doors or replace old wall with sound insulation materials between Engine room and nearby locations; re-design the exhaust pipes far from the captain's cabin area to reduce the noise from Engine room. Administrative control may include reschedule of working hours to reduce the exposure to high noise level and increase the exposure to low noise levels such as resting area or front deck for crew members at location with high noise levels. However, it is not feasible for applying the reschedule of working hours to the captains and mechanics who spend almost their time in the Engine room. Therefore, PPE including earplugs effectively reduce the noise impact for them despite its limitation on verbal communication is essential for the captains and mechanics.

Prevalence of hypertension in fishermen was at a high level when comparing to other occupations. Changing lifestyle behavior is essential to minimize this issue. Although relationship between hypertension and TWA8> 85 dBA was not found because many factors could impact blood pressure, such as age and years of experience but the harmful effects of continued exposure to noise for a

ISSN: 2319-9113
DOI: https://doi.org/10.24321/2319.9113.202001

long time could not be denied. Further follow up studies which apply noise dosimeter are needed to provide a comprehensive on this relationship.

Limitation

The study had various limitations which might have implications to research results. Data was collected on the sea during offshore trip which took a long time and noise dosimeter could not be used for noise measuring. These could reduce data's accuracy. Some minor changes in ship and wind speed could lead to changes in noise measurement and, finally, some questions could be affected by recall bias.

Acknowledgement

I send my gratitude to Director Board in Phu Vang District Health Center, Mr. Than Minh Tri, Mr. Nguyen Hoang Minh, ship captain Nguyen Thanh Do and his sister

Mai Nguyen for their support in data collection. Finally, my deepest acknowledgements are sent to family for their unconditional support.

Conflict of Interest: None

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ISSN: 2319-9113
DOI: https://doi.org/10.24321/2319.9113.202001

		Date: ___/____/2018	
A. Basic characteristic of participant			
A1.	Number ID		
A2.	Year of birth		
A3.	What is the ***highest level*** of education you have complete?	1 2 3 4 5 6	Illiteracy / No formal schooling Literacy Primary school complete Secondary school complete High school complete College/University and higher
A4.	Do you have health insurance for ***this year***?	1 2 3	Have (skip to A6) Don't have Used to have
A5.	Why don't you buy health insurance?	1 2 3 4	High price Not necessary Don't have information Other, _____
A6.	Average monthly income	..... vnđ	
A7.	Height	_____ cm	
A8.	Weight	_____ kg	
B. LIFE BEHAVIOR OF PARTICIPANT			
B1	Do you smoke any tobacco products?	1 2 3	Yes Used to, stop for _____ years ***(skip to B4)*** No ***(skip to B4)***
B2	Why kind of cigarette do you usually use?	1 2 3 4 5	Filter cigarette Electricity cigarette Handmade cigarette Betel Other, _____
B3.	How long have you smoked?	_____ years _____ months	

ISSN: 2319-9113
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B4.	Have you ever consumed an alcoholic drink?	1 2	Yes No ***(skip to B8)***
B5.	During ***past 12 months***, how frequently have you had at least one alcoholic drink?	1 2 3 4 5	Daily 5-6 days/week 1-4 days/week 1-3 days/month Less than once a month
B6.	During the ***past 30 days***, how many occasions did you have at least one alcoholic drink?	1 2 3	_____ times Don't remember Refuse
B7.	During the ***past 30 days***, when you drank alcohol, on average, how many ***standard alcoholic*** drinks did you have during one drinking occasion?	*Write down average alcohol consumption and exchange to* ***standard alcoholic drink***	
B8.	Are you diabetes?	1 2 3	Yes, diagnosis by _____ No Don't know
B9.	In a ***typical week***, on how many days do you eat fruit?	1 2	Number of day: _____ Don't know
B10.	In a ***typical week***, on how many days do you eat vegetable?	1 2	Number of day: _____ Don't know
B11.	What type of oil or fat is most often used for meal preparation in your household?	1 2 3 4	Vegetable oil Lard/suet/pig fat Other, _____ Don't know
B12.	Do you have a salty diet? (>5g salt~1 teaspoon/day)	1 2	Normal Don't know
B13.	Do you always add fish source in your meal?	1 2	Yes No
B14.	Do you have any disease? Which health facility give diagnosis? and when?		

	Disease	Health facility	Time
14a			

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DOI: https://doi.org/10.24321/2319.9113.202001

14b			
14c			
14d			
14e			

C. BLOOD PRESSURE			
C1.	ID of physician		
C2.	During the ***past two weeks***, have you been treated for raised blood pressure with drugs (medication) prescribed by a doctor or other health worker?	1 2	Yes No
C3.	Reading 1	Systolic (mmHg): __ __ __	
		Diastolic (mmHg): __ __ __	
C4.	Reading 2	Systolic (mmHg): __ __ __	
		Diastolic (mmHg): __ __ __	
C5.	Reading 3	Systolic (mmHg): __ __ __	
		Diastolic (mmHg): __ __ __	

D. STRESS STATUS (ask for ***last month***)						
	0 = Never 1 = Almost Never 2 = Sometimes 3 = Fairly Often 4 = Very Often					
D1.	In the last month, how often have you been upset because of something that happened unexpectedly?	0	1	2	3	4
D2.	In the last month, how often have you felt that you were unable to control the important things in your life?	0	1	2	3	4
D3.	In the last month, how often have you felt nervous and "stressed"?	0	1	2	3	4
D4.	In the last month, how often have you felt confident about your ability to handle your personal problems?	0	1	2	3	4
D5.	In the last month, how often have you felt that things were going your way?	0	1	2	3	4
D6.	In the last month, how often have you found that you could not cope with all the things that you had to do?	0	1	2	3	4
D7.	In the last month, how often have you been able to control irritations in your life?	0	1	2	3	4
D8.	In the last month, how often have you felt that you were on top of things?	0	1	2	3	4
D9.	In the last month, how often have you been angered because of things that were outside of your control?	0	1	2	3	4

ISSN: 2319-9113
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D10.	In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	0	1	2	3	4

NOISE MEASUREMENT				
E. FOR SHIP:				
E1.	Ship ID			
E2.	Engine power	_____ CV/HP		
E3.	How many fishermen usually work during each offshore trip?			
Sound pressure level in each position				
	Position	#1	#2	#3
E4.	Engine room			
E5.	Mechanic location			
E6.	On front deck			
E7.	Under deck			
E8.	Other			
F. FOR FISHERMEN:				
F1.	How long have you worked as a fisherman?	_____ years ____ month		
F2.	How long do you work in this ship?	_____ years ____ month		
F3.	How often do you join in offshore trip?	_____ / month (average)		
F4.	In a typical month, how many day do you spend for offshore trip?	_____ days/month		
F5.	How long does each offshore trip take?	_____ days (average)		
F6.	Duration of each working day with offshore trip	_____ hours (average)		
F7.	What is you **main** position/duty on ship?	1 Captain 2 Mechanic 3 Normal fishermen 4 Other, _____		
In a common day, how long do you take in each position/location with total time in **F5**?				
F8.	Driving cabin	_____ hours _____ mins		
F9.	Engine room	_____ hours _____ mins		
F10.	Deck	_____ hours _____ mins		
F11	Resting area	_____ hours _____ mins		
Total ***(have to fit with F5.)***				

ISSN: 2319-9113
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F12.	Do you think you are exposure with high level of noise?	1 2 3	Yes No Don´t know
F13.	Do you know any harmful of noise?	1 2	Yes No (skip to
F14.	What kind of noise's harmful do you know? *(multiple choice)*	1 2 3 4 5 6 7	Hearing loss Ear damage Annoyance Hypertension Stress Others, _____ Don't know
F15.	Which source do you have their information? *(multiple choice)*	1 2 3 4 5 6 7	TV/radio/Internet Family Friend Colleague as a fishermen Health staff Book, newspaper Other, _____
F16.	Do you know sound standard for occupational noise?	1 2	Yes, _____ dB No
F17.	Overall, do you feel sound level in this ship is exceed?	1 2 3	Yes No No idea/Don't know
F18.	Do you use any PPE for yourself protection?	1 2	Yes, it is _____ No
F19.	What are your demands on health care aspect?		_____ _____ _____ _____
F20	Do you work at **ANOTHER** noisy job, such as in construction, farming, a factory, lawn service, carwash, or other indoor or outdoor job working around loud equipment or machinery? By noisy job, we mean sounds so loud that you had to shout or speak in a raised voice to be heard at arm's length. ☐ Yes ☐ No *(if no, skip to F21.)*		

ISSN: 2319-9113
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	If you worked a noisy job, please estimate the number of hours you worked in a typical week: _____ hours worked per typical week this summer
F21	Do you live in a noisy place that make you feel annoyance or uncomfortable with it? ☐ Yes ☐ No *(if no, stop interviewing.)* If yes, please describe this noisy place and its noise source: _____ If you live with a noisy place, please estimate duration of exposure in a typical day: _____ hours exposure per typical day.

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