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Occupational noise exposure and health impacts among fish harvesters: a systematic review

Om Prakash Yadav[1], Atanu Sarkar[1], Desai Shan[1], Arifur Rahman[1], Lorenzo Moro[2, 3]

[1]Division of Community Health and Humanities, Faculty of Medicine,
Memorial University, St. John's NL A1B 3V6, Canada
[2]Department of Ocean and Naval Architectural Engineering,
Memorial University of Newfoundland, St. John's NL A1B 3X5, Canada
[3]SafetyNet Centre for Occupational Health and Safety Research,
Memorial University of Newfoundland, St. John's NL A1B 5S7, Canada

ABSTRACT

Background: *Occupational noise exposure has been identified as a significant risk factor for fish harvesters. Chronic noise exposure causes hearing and other health problems and undermines the quality of life and well-being. This review paper aims to highlight noise-related auditory and non-auditory health effects among fish harvesters.*

Materials and methods: *A systematic literature search approach was adopted using the following databases: PubMed, Embase, SCOPUS, Web of Science, Google Scholar, and by exploring grey literature. The literature search was conducted in 2020 (between October 15 and November 30). Relevant articles were explored by reviewing title, keywords, and abstract based on the inclusion and exclusion criteria. The full-text critical review of selected papers was made and finalized the most relevant studies.*

Results: *Initial 1,281 records were identified, exploring various databases and additional sources using relevant keywords. Duplicate articles were removed and retrieved 746 articles. After that, a screening of 746 research papers was done based on the selection criteria and finalised 28 articles for full-text review. Finally, articles were filtered based on the study's aim and extracted 17 papers for the final review.*

Conclusions: *Noise-induced hearing loss was considered a significant health risk to fish harvesters across the studies, affecting physical and emotional well-being. The prevalence of hearing loss was observed from 6% to 80%. Other health problems, such as headache, dizziness, annoyance, stress, fatigue, elevated blood pressure, sleep disturbances, and impaired cognitive performance, were also reported. Further research is needed to validate the non-auditory health effects among fish harvesters.*

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Key words: occupational noise exposure, hearing loss, noise-induced hearing loss, tinnitus, sound pressure level, fish harvesters

INTRODUCTION

The fishing industry employs millions of people and plays a significant role in economic growth and development worldwide [1]. Around 60 million people are engaged in the fisheries and aquaculture sectors, and more than half are in fishing [2]. The global fishing fleet covers approximately 5 million vessels, including small non-motorised to large industrial vessels. About two-thirds of total fishing vessels are powered by the motorised engine, and 98% are smaller than 24 m in length overall [2].

The fishing sector involves high risk and frequent occupational-related accidents [3–5]. Fish harvesters face adverse working conditions that affect their health and well-being. Fishing workers are at increased risk of exposure to infectious agents, chemicals and toxins, physical and psychological hazards [5–8].

Dr. Om Prakash Yadav, Division of Community Health and Humanities, Faculty of Medicine, Memorial University, St. John's NL A1B 3V6, Canada, 41 Allandale Road, St. John's, Newfoundland and Labrador, A1B2Z8 Canada, tel/fax: +1 (709)770-6592, e-mail: opyadav@mun.ca

Noise has been identified as a significant physical hazard to fish harvesters [9–11]. On-board noise control regulations at small fishing vessels are inconsistent, fragmented, and often voluntary. The International Labour Organization, International Maritime Organization, and Food and Agriculture Organization of the United Nations have not specified any noise limits for fishing vessels; however, some practical guidelines are described for fish owners/operators and crew members [3]. Organizations in the United States (National Institute of Occupational Safety and Health [NIOSH], Occupational Safety and Health Administration, United States Coast Guard) recommend 8 hours noise exposure limits for commercial fishing boats: 90, 85, and 90 decibel (dB), respectively [12–14]. When the sound level exceeds 85 dB, it is considered harmful to human health, and the impact gets further worsened depending on the duration, systematic exposure, frequency, intensity, and existing risk factors in the exposed population such as gender, ethnicity, individual susceptibility, and the presence of other physical, chemical, and biological agents [15].

Reviews describing occupational noise exposure and its adverse health impacts among fish harvesters are scarce. As per the literature search, no systematic review was conducted to highlight both auditory and non-auditory health effects of noise among fish harvesters. Collective information regarding this issue is highly desirable to researchers, stakeholders, policymakers, private and public organizations working in this field to improve the occupational health and safety regulations and awareness in reducing the risk of noise exposure in fish harvesters.

This review paper provides an overview of noise exposure and its auditory and non-auditory health impacts among fish harvesters. Considering the significance of noise-related health impacts in the fishing population, we proposed the following research question: What are the occupational noise-induced auditory and non-auditory health effects among fish harvesters worldwide? A systematic review was conducted to fill this existing knowledge gap through collecting, compiling, and describing the published evidence to highlight occupational noise exposure and related auditory and non-auditory health problems among fish harvesters.

MATERIALS AND METHODS

PROTOCOL

A protocol and work plan had been developed prior to the review using the guidance provided in the Preferred Reporting Items for Systematic Reviews and Meta-Analysis for the Protocols (PRISMA-P) [16]. For the systematic review, PRISMA statement was used to guide the reporting of results [17].

ELIGIBILITY CRITERIA

Eligibility criteria were established before the literature search following the Population, Intervention (Exposure), Comparator, Outcome, and the Study design (PICOS) framework:

- **Population:** Fish harvesters aged 16 years or older with occupational exposure to noise;
- **Intervention/exposure:** Occupational exposure of noise;
- **Comparator:** Fish harvesters not exposed to noise;
- **Outcomes:** Adverse auditory and non-auditory health effects;
- **Study design:** Any quantitative or qualitative studies, e.g., cross-sectional, reviews, cohort/observational, qualitative studies except case studies/case series, editorial, news articles, conference abstracts, or book reviews.

LITERATURE SEARCH

The search strategy was developed by O.P. and A.R. and peer-reviewed by other writers using the PRESS checklist [18]. Database searches were conducted in PubMed (MEDLINE), Embase SCOPUS, Web of Science, and Google Scholar during October 15 to November 30, 2020, and included human studies published in the English language. A secondary search was also carried out, exploring the "International Maritime Health" journal and the reference list of selected articles. (Full search strategy in the Supplementary file: Suppl. Table S1 and Suppl. S2, see journal website).

STUDY SELECTION, DATA EXTRACTION, QUALITY ASSESSMENT

The PICOS criteria were used to assess the eligibility of the studies. Standardised screening questionnaires were developed before the title/abstract (level 1) and full-text (level 2) screening. Prior to screening both level 1 and level 2, pilot-testing was carried out with the review team (O.P., A.R., A.S., D.S., and L.M.) to refine the screening questionnaires and ensure consistency. A full screening of an article proceeded if at least 70% agreement was received among reviewers.

Pairs of reviewers screened the articles independently for titles and abstracts and full-text articles. Any disagreement between the pairs of reviewers was resolved by the fifth reviewer (L.M.). A standardised form related to the study design (e.g., sample size, study setting), participant characteristics (e.g., age, sex, type of health effects, duration of illness), exposure (e.g., form and duration of noise exposure), and outcomes (e.g., auditory effects, other health effects) was developed for data abstraction, which was pilot tested by reviewers. The same process of levels 1 and 2 reviewing was used for the data abstraction form. The Newcastle Ottawa Scale (NOS) was used to evaluate the quality of the studies [19]. Each variable on the NOS (study sample, methods used, comparability

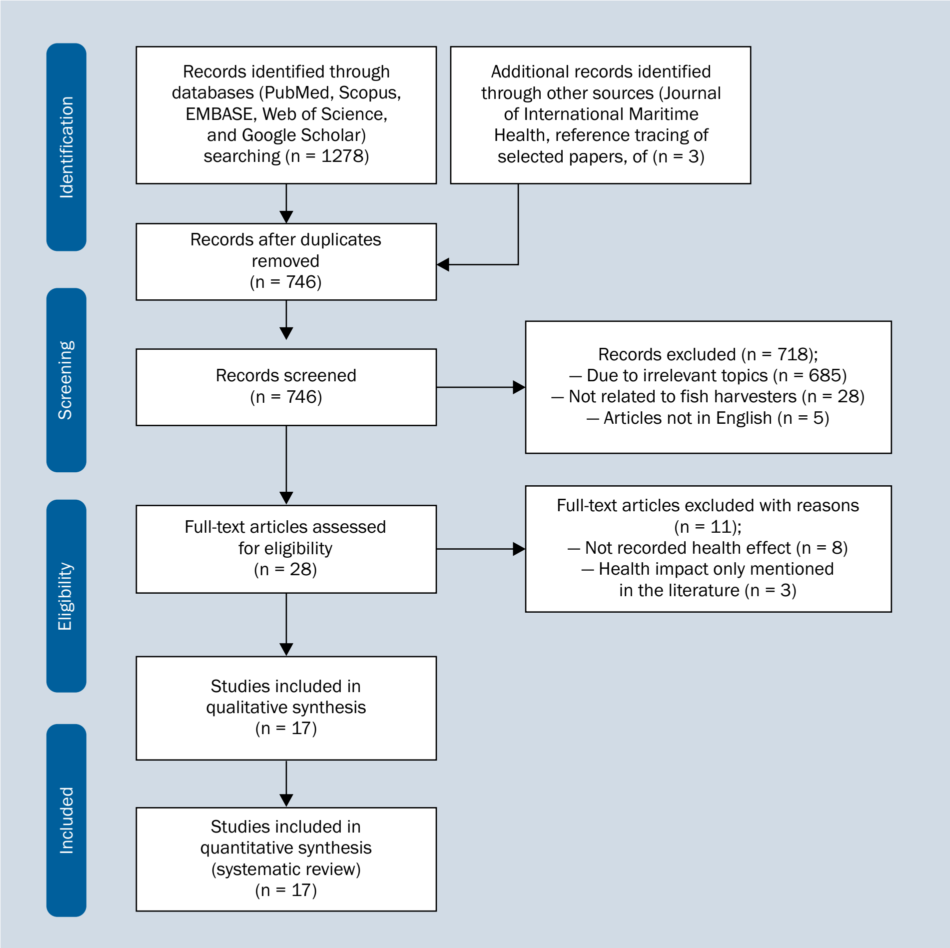

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analysis for the Protocols (PRISMA-P) 2009 flow diagram presenting screening of articles

of groups, and exposures and outcomes of interest) was given a score from 0 to 10, with '10' and '0' indicating the highest and lowest quality, respectively (Suppl. Table S3, see journal website). The reviewers also conducted a pilot-test of the quality appraisal tool prior to completing the appraisal.

DATA SYNTHESIS OF THE INCLUDED STUDIES

Data were synthesized descriptively and presented in tables to provide a summary of the available evidence. The review team considered a meta-analysis; however, due to a lack of detailed outcome information (e.g., effect estimates not provided) and a high degree of heterogeneity in outcomes, quantitative synthesis was not possible.

RESULTS

DESCRIPTION OF RELEVANT ARTICLES

The initial literature search resulted in 1281 articles. After removing 532 duplicates, 746 titles and abstracts were included for the level 1 screening. Of these, 28 were considered potentially relevant documents for further review. After the level 2 screening, 17 publications were included for data synthesis (Fig. 1). Population characteristics, publication year, methods, and major outcomes of various studies selected for the review are summarised in Tables 1 to 3. The majority of study designs were cross-sectional (n = 14; 82.35%) [20–22, 24–28, 30–32, 34–36], followed by reviews (n = 2; 11.76%) [23, 29] and interventional (n = 1; 5.88%) [33]. The included studies were published from 2008 to 2020, and the majority of those were conducted in the United States (n = 5) [21, 23, 33–35]. The remaining were from Brazil (n = 4), Denmark (n = 2), Indonesia (n = 2), and one each from India, Italy, Spain, New Zealand [20, 22, 24–32, 36]. Sample sizes ranged from 13 to 3702 participants [27, 30].

QUALITY APPRAISAL RESULTS

The quality of the studies ranged from satisfactory to good studies because of several methodological limitations. The quality of some studies [22, 24, 27,

Table 1. Studies describing noise exposure levels and auditory health impacts among fish harvesters

Country [Reference]	Year	Demographic information (N, gender, age)	Methods	Outcome
Brazil [20]	2009	141, male, 18–77 years	SPLs, audiometric test, questionnaire survey	• SPLs recorded 38–58 dB (A) and 90–108 Leq dB (A) in vessels with and without an engine, respectively • Hearing impairment (82–90%) and sensorineural hearing loss (26%) in engine room personnel
United States [21]	2016	227, male (191), female (31), ≥ 21 years	SPLs, audiometric testing, comprehensive survey	• Noise level (94.8 to 105 dB (A)) in engine room • NIHL was associated with length of employment (not with age) • Hearing impairment was associated with age (not with length of fishing)
Indonesia [22]	2017	186, male	SPLs, hearing function test, questionnaire survey including regular use of earplugs	• Noise level exceeded the threshold recommended limit (> 85 dB) in around two-third of participants • Hearing loss (60.2%) • > 90% participants did not use earplugs • Significant relationship between earplug use and the degree of hearing loss
United States [23]	2018	52 manuscripts	Assessment of occupational health risk factors	• Noise exposure ranged from 56 to 114 dBA • Noise exposure was considered a global risk irrespective of vessel size
Indonesia [24]	2019	40, male, ≥ 21 years	SPLs, audiometric testing	• Mean noise intensity (101.7 ± 2.342 dB) • Prevalence of hearing loss in 97.50% ears • Positive relationship of hearing loss with age, working period, and noise intensity
Italy [25]	2019	108, male, 49 years (average)	Self-reported health conditions and assessment of noise exposure levels	• Highest SPL (106 and 109 dBA) observed in engine compartment • Lowest SPL (70.5 and 78.8 dBA) was recorded in the sleeping berth • Low-frequency sounds can cause acoustic damage
Brazil [26]	2020	466, male, 18–67 years	SPLs, questionnaire survey and audiological assessment	• SPLs > 80 dBA • Tinnitus (49%) • NIHL (79%) observed in engine-room keepers • NIHL risk increases with the length of employment

NIHL — noise-induced hearing loss; SPL — sound pressure level

30–32, 34] was limited due to selective or non-representatively samples, a reliance on self-reported data, and diagnosis of health outcomes (Suppl. Table S3, see journal website).

NOISE-RELATED AUDITORY AND NON-AUDITORY HEALTH IMPACTS

Table 1 depicts the studies describing noise exposure levels and auditory health impacts among fish harvesters. The studies mentioned the noise exposure levels at various fish vessels' compartments and measured the impact of noise on fish harvesters' hearing ability [20–26]. Table 2 reflects the studies highlighting the potential impact of noise on auditory health through clinical examination, self-reported questionnaires, and literature reviews [27–35]. Table 3 shows the noise-related non-auditory health impacts among fish harvesters, including physical and psychological disorders [22, 23, 25, 30–32, 36].

DISCUSSION

NOISE EXPOSURE LEVEL AND AUDITORY HEALTH

Sound pressure level (SPL) was measured at different parts of the fish vessels using various tools, including the data acquisition system and noise dosimeter. Noise exposure levels ranged from 56 to 114 dB, and the highest noise level was recorded in engine rooms [20–26]. The noise level was detected higher than NIOSH's recommended guidelines in most studies [20–23, 26, 28]. SPL was recorded high in vessels with hydraulic fishing gears, electrical power generators, and an engine [3, 11, 20]. Noise exposure was associated with the load on boat engines irrespective of vessels' size, and engine-related hearing loss was found a significant risk among fish harvesters [23].

Noise-induced hearing loss (NIHL) is one of the most significant health problems observed in fish harvesters and associated with employment length [21, 24, 26]. However, Levin et al. [21] reported that hearing impairment was associated with fish harvesters' age. The prevalence of

Table 2. Studies describing noise related auditory health impacts among fish harvesters

Country [Reference]	Year	Demographic information (N, gender, age)	Methods	Outcome
Denmark [27]	2008	3702, male	Assessment of SHCRs	• Increased risk rates of NIHL in engine room personnel • Duration and length of employment were not associated with the NIHL
Spain [28]	2008	247, male, 40.3 ± 11.5 years	Self-reported medical conditions and lifestyle	• Hearing problems found in 6% of the participants
Denmark [29]	2014	Literature review	Hospital records	• SHCR for NIHL, tinnitus, conductive, and sensorineural hearing loss was 142 (118–171) • Increased rate of hospitalisation rate for hearing impairment
Brazil [30]	2014	13, male, 33–62 years	Assessment of otoneurologic signs and symptoms, vestibular examination	• Hearing loss (76.9%) and tinnitus (61.7%) • Positive cases in vestibular examination (around 39%)
India [31]	2015	63, male, 30–50 years	Otorhinolaryngoogic assessment, audiometry test	• Hearing loss 28.57% • Tinnitus 19.04%
Brazil [42]	2015	30, male, 33–67 years	Assessment of otoneurologic signs and symptoms, vestibular examination	• Tinnitus (66.7%) • Hearing loss (53.3%) • Positive cases in vestibular examination (around 43%)
United States [33]	2016	217 and 206, male, ≥ 21 years	Assessment of NIHL related attitude and belief	• NIHL related behavioural beliefs, normative beliefs, and control beliefs changed significantly
United States [34]	2018	Pre-season survey: 60, male (56), female (4), 19–73 years Mid-season survey: 38, male (35), female (3), 19–73 years	Self-reported hearing loss, audiometric testing	• Self-reported hearing loss (50%) • Physical examination hearing loss (80%)
United States [35]	2018	17,299, male (12,455), female (4844), 18–75 years	Audiometric data analysed from the existing records	• Hearing loss (19.47%)

NIHL — noise-induced hearing loss; SHCR — standard hospital contact ratio

hearing loss ranged from 6% to 80% [28, 34], and engine room personnel affected the most [20, 21, 25–27]. Noise exposure can also result in Sensorineural Hearing Loss (SNHL) and Conductive Hearing Loss (CHL). The prevalence of SNHL was observed at 26% in engine room workers [26]. Standard hospital contact ratio (SHCR) for NIHL was found 119 (95% confidence interval [CI] 85–162) and another study highlighted SHCR for NIHL, tinnitus, CHL, and SNHL was 142 (95% CI 118–171) [27, 29]. Tinnitus, an early sign of NIHL, with a prevalence of 19% to 67%, was recorded as one of the most common otoneurological symptoms, followed by otalgia [26, 30–32].

Attitudes/beliefs among fish harvesters may influence behaviours responsible for fatal and nonfatal injuries. An interventional study reported a significant change in attitude/belief response for noise exposure among shrimp harvesters [33]. Attitude towards the use of Hearing Protection Devices (HPDs) was found inconsistent. Despite the awareness of hearing risk, none of the fishermen used HPDs [20]. More than 90% of fish harvesters were not using earplugs, and out of them, around 65% had hearing loss [22]. Fish harvesters usually skip HPDs, sometimes more than an hour during a shift, and while using HPDs, earmuffs were used longer than earplugs [23].

IMPACT OF NOISE EXPOSURE ON NON-AUDITORY HEALTH

Extra-auditory health effects, including physiological and psychological disorders, are observed in various studies [22, 23, 25, 30–32, 36]. Noise exposure could cause adverse health effects such as increased blood pressure, decrease performance, sleep disturbances, annoyance, and stress [23]. Low-frequency sounds can cause cardiovascular, gastric, and sleeping disorders [25].

With a prevalence of 8%, sleep disturbance is considered the most deleterious non-auditory health effect [30, 31]. Split sleep was observed comparing the last three days of sleep at home and first three days of sleep at sea. Sleepiness ratings were recorded high after sleep at sea, and it reduces sleep quality [36].

Table 3. Studies describing noise related non-auditory health impacts among fish harvesters

Country [Reference]	Year	Demographic information (N, gender, age)	Methods	Outcome
New Zealand [36]	2008	17, male	Assessment of otoneurologic signs and symptoms, vestibular examination	• Split sleep • High sleepiness ratings • Reduced sleep quality
Brazil [30]	2014	13, male, 33–62 years	Assessment of otoneurologic signs and symptoms, vestibular examination	• Dizziness and headache (46.1%) • Fatigue (46.1%) • Depression (23%) • Anxiety (15.3%) • Insomnia (7.7%) • Agitation during sleep (7.7%)
Brazil [32]	2015	30, male, 33–67 years	Assessment of otoneurologic signs and symptoms, vestibular examination	• Dizziness (63.3%) • Fatigue (36.7%) • Anxiety (23.3%) • Depression (16.7%)
India [31]	2015	63, male, 30–50 years	Assessment of otorhinolaryngologic signs and symptoms, audiometry testing	• Headache (38.09%) • Sleep disturbances (7.9%) • Noise exposure acts as a stressor
Italy [25]	2017	108, male, 49 years	Self-reported health conditions	• Low-frequency sounds can cause cardiovascular, gastric, and sleeping disorders
United States [23]	2018	52 manuscripts	Assessment of occupational related health risks	• Physical and psychological disorders can occur

Dizziness and headaches with a prevalence ranged 40–70% were also common conditions trigger due to noise exposure. Other adverse health effects such as fatigue (37–46%), depression (16–23.0%), anxiety (23–15%), insomnia, and agitation during sleep (8%) were also observed among fish harvesters [30–32]. Non-auditory health effects may be associated with many factors, and difficult to differentiate the specific risk factor responsible for the condition.

STRENGTHS AND LIMITATIONS

A systematic literature search criteria [16–18] with relevant databases used to explore the available evidence and minimise the evidence selection and publication bias. We considered the published research, and there may be several other unpublished projects that have not been included in this review. It is challenging to prove a direct relationship between noise and associated non-auditory health conditions due to limited evidence.

CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

The present systematic review covered the published literature on occupational noise exposure and its adverse health impacts among fish harvesters. In most studies, the noise level was recorded higher than the recommended limits suggested by various agencies and organizations. The most common available evidence is hearing loss, which ranged from 19.47% to 60.2%. Mostly engine room personnel affected compare to other crew members. NIHL was considered a significant health risk to fish harvesters across the studies, affecting physical and emotional well-being.

Various methods of controlling on-board noise exposure are recommended, including use of HPDs, regular large scale auditory screening, modifications in the vessels design, adopting new technologies, implementing health promotional programmes, advocating culturally appropriate training programmes, promoting research activities, and translating research findings into common practice. Other areas for future research could be evaluating knowledge, awareness, behaviour, and practices towards noise sources, noise-induced health problems, and preventive approaches.

Conflict of interest: None declared

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