



Correlation Between Noise Exposure Intensity, Length of Employment, and Hearing Loss Among Fishermen

Anderias Umbu Roga^{1*}, Ishak Israel Muda², & Delvisari Dedu Ngara³

^{1*}Universitas Nusa Cendana, Indonesia, ²Universitas Nusa Cendana, Indonesia, ³Universitas Nusa Cendana, Indonesia

*Co e-mail: anderias_umburoga@staf.undana.ac.id¹

Article Information

Received: April 30, 2026

Revised: May 13, 2026

Online: May 18, 2026

Keywords

Noise Exposure, Fishermen, Hearing Loss, Length of Employment, NIHL

ABSTRACT

Occupational noise exposure remains a major health risk among fishermen, particularly those operating motorized boats. This study aims to analyze the correlation between noise exposure intensity, length of employment, and hearing loss among fishermen in Pesisir Selatan Regency, West Sumatra, Indonesia. A cross-sectional quantitative design was applied involving 60 fishermen selected through purposive sampling. Noise intensity was measured using a sound level meter, while hearing loss was assessed using audiometric examination. Length of employment was obtained through structured interviews. Data were analyzed using Pearson correlation and multiple regression tests. The results showed that the average noise exposure exceeded the permissible limit of 85 dB. There was a significant positive correlation between noise intensity and hearing loss ($r = .62$; $p < .01$), as well as between length of employment and hearing loss ($r = .58$; $p < .01$). Simultaneously, both variables significantly influenced hearing impairment among fishermen ($p < .001$). These findings indicate that prolonged exposure to high-intensity noise increases the risk of Noise-Induced Hearing Loss (NIHL). The study suggests the need for occupational health interventions, including the use of hearing protection devices and routine health monitoring. In conclusion, noise exposure and working duration are important determinants of hearing loss among fishermen and should be addressed in policy and practice.

Keywords: *Noise Exposure, Fishermen, Hearing Loss, Length of Employment, NIHL*

INTRODUCTION

Noise exposure is widely recognized as a major occupational health risk worldwide, particularly in informal sectors where the implementation of occupational safety standards remains limited, such as among fishermen. Fishing activities involving motorized vessels generate substantial noise levels originating from diesel engines, structural vibrations of the boat, and interactions with ocean waves. These noise levels frequently exceed the recommended exposure limit of 85 dB for an 8-hour working



period (World Health Organization, 2021). Continuous exposure beyond this threshold may lead to permanent hearing impairment and other adverse health outcomes.

Noise-Induced Hearing Loss (NIHL) is one of the most prevalent occupational diseases, characterized by its irreversible and progressive nature. This condition results from damage to the hair cells in the organ of Corti within the cochlea due to prolonged exposure to high-intensity sound. According to Kumar et al. (2022), chronic occupational noise exposure significantly contributes to hearing deterioration and may also trigger non-auditory effects, including stress and sleep disturbances. Furthermore, Basner et al. (2019) emphasized that long-term noise exposure not only affects auditory function but also has broader impacts on cardiovascular health and overall quality of life.

In Indonesia, the fisheries sector plays a strategic role in providing employment for millions of workers, particularly in coastal regions. However, occupational safety and health (OSH) practices among fishermen remain relatively underdeveloped compared to formal sectors. Data from the Ministry of Health of the Republic of Indonesia (2023) indicate that occupational diseases, including hearing impairment, are often underdiagnosed and underreported in informal workers, potentially constituting an unrecognized public health concern. Empirical evidence reported in the Lombok Medical Journal (2020) revealed that fishermen operating motorized boats are at a high risk of developing hearing impairment due to engine noise exposure. Noise levels generated by boat engines may exceed 90 dB and, in certain enclosed environments such as engine compartments, can surpass 100 dB. Such exposure clearly exceeds safe limits and substantially increases the risk of NIHL.

In addition to noise intensity, duration of employment or working tenure represents another critical determinant of hearing impairment. The concept of cumulative noise exposure suggests that the effects of noise are additive over time; thus, prolonged exposure increases the likelihood of permanent auditory damage. Basner et al. (2019) reported that long-term noise exposure leads to progressive degeneration of cochlear sensory cells, which is irreversible. Previous studies have also demonstrated that exposure duration and length of employment are significantly associated with the severity of hearing loss. Lie et al. (2016) found that workers with more than 10 years of occupational exposure have approximately twice the risk of developing hearing impairment compared to those with shorter exposure durations.

In West Sumatra, particularly in Pesisir Selatan Regency, fishing activities are predominantly carried out by traditional fishermen operating small- to medium-scale motorized boats with minimal occupational safety measures. These fishermen are typically exposed to high levels of noise generated from multiple sources, including diesel engines, propeller vibrations, and continuous interaction with sea waves. The exposure is not only intense but also repetitive and prolonged, as fishermen commonly work between 6 to 10 hours per day and conduct fishing activities on a daily basis.

Such occupational patterns reflect repeated and prolonged exposure to hazardous noise throughout daily fishing activities. Fishermen are commonly positioned in close proximity to boat engines for several consecutive hours, often without adequate acoustic insulation or hearing protection devices. This condition increases cumulative auditory burden and accelerates the risk of Noise-Induced Hearing Loss (NIHL), particularly among workers exposed continuously over many years. Previous studies have shown that chronic exposure to occupational noise exceeding 85 dB may contribute not only to progressive hearing impairment but also to fatigue, communication difficulties, reduced concentration, sleep disturbances, and elevated psychological stress (Basner et al., 2019; Themann & Masterson, 2019). These conditions highlight the urgent need for improved occupational health practices among fishermen. Despite numerous studies examining the association between noise exposure and hearing loss, research specifically integrating noise intensity, length of employment, and



hearing impairment among fishermen in West Sumatra remains limited. Therefore, this study aims to analyze the relationship between these variables to support evidence-based occupational health interventions.

METHODS

This study employed an analytical quantitative design with a cross-sectional approach to examine the relationship between noise exposure intensity, length of employment, and hearing loss among fishermen. The study was conducted in Pesisir Selatan Regency, West Sumatra, Indonesia, from January to March 2026.

The study population consisted of active fishermen operating motorized boats. A total of 60 respondents were selected using a purposive sampling technique based on predetermined inclusion and exclusion criteria. Eligible participants were fishermen aged 18 years or older, had worked for at least one year, and were willing to participate in the study. Individuals with a history of chronic ear disease, congenital hearing disorders, or hearing impairment unrelated to occupational noise exposure were excluded to minimize potential confounding factors.

To improve measurement validity and reliability, all research instruments were standardized and calibrated prior to field data collection. Noise exposure intensity was measured using a calibrated sound level meter following the International Organization for Standardization (ISO 1999:2013) guidelines and compared with the occupational exposure limit of 85 dB recommended by the World Health Organization (WHO, 2021). Calibration of the sound level meter was conducted using an acoustic calibrator according to the manufacturer's specifications before each measurement session. Noise measurements were performed repeatedly at several predetermined positions on the fishing boats during engine operation to reduce random measurement error and ensure consistency of recorded values.

Hearing impairment was assessed using pure-tone audiometry at frequencies ranging from 0.5 to 4 kHz. Participants with hearing thresholds exceeding 25 dB were categorized as having hearing impairment (Basner et al., 2019). Audiometric examinations were conducted by trained personnel under controlled testing conditions to minimize external noise interference and maintain procedural consistency. The audiometric equipment was routinely checked and calibrated to ensure the accuracy and reliability of hearing threshold measurements.

Data regarding length of employment were collected through structured interviews and recorded in years. Descriptive statistics were used to summarize respondent characteristics and exposure distribution. Pearson correlation analysis was applied to assess bivariate relationships between variables, while multiple linear regression analysis was conducted to evaluate the simultaneous effects of noise intensity and length of employment on hearing loss. Statistical significance was determined at $p < .05$ (Dahlan, 2019). Ethical approval for this study was obtained from the relevant institutional ethics committee prior to data collection. All respondents provided informed consent after receiving a clear explanation regarding the objectives and procedures of the study.

RESULTS

1. Respondent Characteristics

A total of 60 fishermen were included in this study. The demographic profile indicates that most respondents were in the older age group (>40 years), accounting for 58% of the sample. In addition, a substantial proportion of participants had extended occupational exposure, with 67% reporting more than 10 years of employment as fishermen. The prevalence of hearing impairment was identified in 53%



of respondents, suggesting that more than half of the study population had experienced some degree of auditory dysfunction.

Table 1. Respondent Characteristics

Variable	Frequency (n)	Percentage (%)
Age >40 years	35	58
Length of employment >10 years	40	67
Hearing impairment	32	53

These findings reflect a workforce dominated by older individuals with prolonged exposure to occupational hazards, which may contribute to the observed burden of hearing impairment.

2. Distribution of Noise Exposure

The assessment of workplace noise revealed that fishermen were exposed to sound levels ranging from 82 dB to 95 dB, with an average of 88.5 ± 3.2 dB. A considerable proportion of respondents (70%) experienced noise levels exceeding the recommended occupational exposure limit of 85 dB.

Table 2. Distribution of Noise Exposure Levels

Noise Level Category	Frequency (n)	Percentage (%)
<85 dB	18	30
≥85 dB	42	70
Mean ± SD	88.5 ± 3.2 dB	-
Range	82–95 dB	-

This distribution indicates that the majority of fishermen operate in an environment classified as acoustically hazardous. Continuous exposure at this level is known to exceed safe occupational limits and may predispose individuals to progressive auditory damage.

3. Noise Exposure Intensity and Hearing Loss

Bivariate analysis, utilizing Pearson correlation analysis, was used to investigate the connection between noise intensity and hearing loss. The findings showed a statistically significant positive connection ($r = .62$; $p = .001$), suggesting a substantial correlation between higher degrees of hearing impairment and increasing noise exposure.

Table 3. Correlation Between Noise Intensity and Hearing Loss

Variable	r	p-value
Noise intensity vs Hearing loss	.62	.001

Further stratification based on the recommended occupational threshold (85 dB) revealed a clear exposure–response pattern.

Table 4. Hearing Loss by Noise Exposure Level

Noise Level	Hearing Loss (%)	No Hearing Loss (%)
<85 dB	30	70
≥85 dB	65	35

Fishermen exposed to noise levels ≥ 85 dB showed a substantially higher prevalence of hearing impairment compared to those exposed to lower levels. This finding supports the hypothesis that the risk of hearing loss increases proportionally with noise intensity and is consistent with established occupational safety standards regarding hazardous noise exposure.



4. Length of Employment and Hearing Loss

An analysis of employment duration revealed a marked difference in hearing impairment prevalence between groups. Fishermen with more than 10 years of work experience had a significantly higher prevalence (65%) compared to those with shorter employment duration (30%). It is important to note that the 10-year classification in this study represents an analytical grouping rather than a definitive biological threshold. Hearing impairment may still occur at shorter exposure durations depending on noise intensity; however, the findings indicate that prolonged cumulative exposure substantially increases the risk of auditory dysfunction.

Table 5. Hearing Loss by Length of Employment

Length of Employment	Hearing Loss (%)	No Hearing Loss (%)
≤10 years	30	70
>10 years	65	35

The Pearson correlation test further confirmed a statistically significant association between length of employment and hearing loss ($r = .58$; $p = .002$).

Table 6. Correlation Between Length of Employment and Hearing Loss

Variable	r	p-value
Length of employment vs Hearing loss	.58	.002

These results indicate that prolonged occupational exposure contributes cumulatively to the deterioration of auditory function.

5. Combined Effect of Noise Exposure and Employment Duration

When both variables were analyzed simultaneously in a stratified manner, the highest prevalence of hearing impairment was observed among fishermen exposed to noise levels ≥ 85 dB and with working duration exceeding 10 years.

Table 7. Combined Effect of Noise Exposure and Employment Duration

Noise Exposure	Length of Employment	Hearing Loss (%)
<85 dB	≤10 years	20
≥85 dB	≤10 years	40
<85 dB	>10 years	50
≥85 dB	>10 years	75

The combined analysis using a consistent exposure threshold of 85 dB demonstrated a clear synergistic effect between noise intensity and employment duration. The highest prevalence of hearing impairment (75%) was observed among fishermen exposed to ≥ 85 dB with more than 10 years of employment, indicating that both factors interact to significantly increase the risk of hearing impairment.

6. Multivariate Analysis

Multiple linear regression analysis was conducted to evaluate the independent and combined contributions of noise intensity and length of employment to hearing loss.

Table 8. Multiple Linear Regression Analysis

Variable	β Coefficient	p-value
Noise intensity	0.45	.000
Length of employment	0.38	.001



Model significance – <.001

The results indicate that both predictors significantly influence hearing loss, with noise intensity demonstrating a slightly stronger effect compared to length of employment. The model confirms that increases in noise exposure and longer duration of work are associated with higher risks of auditory impairment. Overall, these findings emphasize that hearing loss among fishermen is influenced by both the magnitude and duration of noise exposure, reflecting a cumulative and interactive risk pattern.

DISCUSSION

The present study demonstrates a significant positive association between occupational noise exposure intensity and hearing loss among fishermen ($r = .62$; $p = .001$). The average measured noise level (88.5 ± 3.2 dB) exceeded the recommended occupational exposure limit of 85 dB, with recorded values ranging from 82 dB to 95 dB. Approximately 70% of respondents were exposed to noise levels above the recommended threshold, indicating that hazardous noise exposure represents a substantial occupational risk in the fisheries sector. These findings are consistent with previous studies reporting that engine noise generated by motorized fishing boats frequently exceeds safe exposure limits and contributes significantly to the development of Noise-Induced Hearing Loss (NIHL) (LMJ, 2020; Neitzel et al., 2021). Prolonged exposure to high-intensity noise may cause irreversible damage to cochlear hair cells, resulting in progressive and permanent auditory dysfunction.

In addition to noise intensity, length of employment was also significantly associated with hearing loss ($r = .58$; $p = .002$). Fishermen with more than 10 years of employment demonstrated a considerably higher prevalence of hearing impairment (65%) compared to those with shorter employment duration (30%). However, the 10-year classification used in this study should be interpreted as an analytical grouping variable rather than a definitive biological threshold for hearing loss occurrence. Hearing impairment may develop even within shorter exposure periods depending on the intensity, frequency, and continuity of occupational noise exposure. Nevertheless, the findings indicate that cumulative long-term exposure substantially increases the risk of auditory deterioration. This observation supports previous studies emphasizing that prolonged occupational noise exposure accelerates the progression of NIHL, particularly among workers with limited access to hearing protection measures (Basner et al., 2019; Masterson et al., 2022).

The present study also identified a clear dose–response relationship between occupational noise intensity and hearing impairment. Fishermen exposed to noise levels ≥ 85 dB exhibited a markedly higher prevalence of hearing loss compared to those exposed to lower noise levels. The consistent use of the 85 dB threshold throughout the analysis strengthens the interpretation that exposure exceeding recommended occupational standards significantly contributes to auditory dysfunction. This finding further supports the concept that both exposure intensity and cumulative duration are critical determinants in the development of NIHL.

Furthermore, multivariate analysis confirmed that noise intensity and length of employment jointly exert a statistically significant influence on hearing loss ($p < .001$). The highest prevalence of hearing impairment was observed among fishermen exposed to ≥ 85 dB with employment duration exceeding 10 years, indicating a synergistic interaction between high-intensity noise exposure and prolonged occupational duration. This interaction suggests that continuous exposure to hazardous noise over extended periods amplifies cumulative auditory burden and accelerates hearing deterioration. Similar findings have been reported in previous occupational health studies demonstrating that workers exposed to both high-intensity noise and prolonged exposure duration face



substantially greater risks of NIHL compared to exposure to a single risk factor alone (Kumar et al., 2022).

The occupational risk observed in this study may also be exacerbated by the limited use of personal protective equipment (PPE) among fishermen. Field observations indicated that most participants did not routinely use hearing protection devices such as earplugs or earmuffs during fishing activities. As a result, fishermen remain continuously exposed to hazardous noise without adequate protection. Previous evidence has demonstrated that appropriate hearing protection can effectively reduce noise exposure and minimize the progression of occupational hearing impairment (WHO, 2021). However, the implementation of hearing conservation practices in informal occupational sectors, including fisheries, remains limited.

Overall, these findings highlight the urgent need for targeted occupational health interventions within the fisheries sector, particularly among traditional fishermen operating in informal work environments. Preventive strategies should include increasing awareness regarding occupational noise hazards, promoting consistent use of hearing protection devices, and implementing periodic auditory health monitoring programs. In addition, stronger occupational safety regulations and accessible health promotion programs are necessary to improve long-term hearing health protection among fishermen.

CONCLUSIONS

This study demonstrates that occupational noise exposure intensity and length of employment are significantly associated with hearing loss among fishermen in Pesisir Selatan Regency. The measured noise levels (mean 88.5 ± 3.2 dB; range 82–95 dB) frequently exceeded the recommended occupational exposure threshold of 85 dB, indicating that most respondents were exposed to hazardous acoustic conditions during fishing activities. Fishermen with longer employment duration showed a substantially higher prevalence of hearing impairment, suggesting that prolonged cumulative exposure increases the risk of auditory dysfunction.

From a theoretical perspective, these findings support the concept of cumulative noise exposure, in which both exposure intensity and duration interact progressively to produce irreversible cochlear damage and hearing deterioration. The higher prevalence of hearing loss observed among older respondents and those with longer work experience indicates that biological susceptibility combined with chronic occupational exposure may accelerate the development of Noise-Induced Hearing Loss (NIHL). In addition, the observed dose–response relationship strengthens existing occupational health theories suggesting that even moderate increases above recommended exposure thresholds may significantly elevate the risk of hearing impairment over time.

These findings emphasize the importance of strengthening occupational health interventions in informal sectors such as fisheries. Preventive strategies should include effective noise control measures, consistent use of hearing protection devices, routine auditory health monitoring, and increased occupational health education among fishermen. Improved access to occupational health services and stronger implementation of workplace safety regulations are also necessary to reduce the long-term burden of hearing impairment in fishing communities. Future studies are recommended to include additional exposure-related variables, such as daily working duration, compliance with hearing protection use, environmental working conditions, and individual susceptibility factors, in order to provide a more comprehensive understanding of occupational hearing risks among fishermen.



ACKNOWLEDGMENT

The authors would like to express their sincere gratitude to the fishermen in Pesisir Selatan Regency for their participation and cooperation. Appreciation is also extended to all supporting institutions and individuals who contributed to the successful completion of this study.

REFERENCES

- Basner, M.; Babisch, W.; Davis, A.; Brink, M.; Clark, C.; Janssen, S.; Stansfeld, S. Auditory and non-auditory effects of noise on health. *The Lancet* 2019, 383(9925), 1325–1332. [https://doi.org/10.1016/S0140-6736\(13\)61613-X](https://doi.org/10.1016/S0140-6736(13)61613-X)
- Dahlan, M.S. *Statistics for Medicine and Health*; Salemba Medika: Jakarta, Indonesia, 2019.
- Hadi, S.; Putra, I.G.N.; Suryani, N. Noise-Induced Hearing Loss among fishermen using motorized boats. *Lombok Medical Journal* 2020, 9(2), 45–52. Available online: <https://jurnal.unram.ac.id/index.php/LMJ/en/article/view/1632>
- International Organization for Standardization. ISO 1999:2013 Acoustics—Estimation of Noise-Induced Hearing Loss; ISO: Geneva, Switzerland, 2013.
- Kementerian Kesehatan Republik Indonesia. *Indonesia Health Profile 2023*; Ministry of Health of the Republic of Indonesia: Jakarta, Indonesia, 2023. Available online: <https://www.kemkes.go.id>
- Kumar, P.; Morawska, L.; Martani, C.; Biskos, G.; Neophytou, M.; Sabatino, S.D.; Bell, M. Transport emissions and their impact on air quality and human health. *Science of the Total Environment* 2022, 803, 150–165. <https://doi.org/10.1016/j.scitotenv.2021.150165>
- Lie, A.; Skogstad, M.; Johannessen, H.A.; Tynes, T.; Mehlum, I.S.; Nordby, K.C.; Engdahl, B. Occupational noise exposure and hearing: A systematic review. *Occupational and Environmental Medicine* 2016, 73(4), 293–302. <https://doi.org/10.1136/oemed-2015-103253>
- Masterson, E.A.; Bushnell, P.T.; Themann, C.L.; Morata, T.C. Hearing loss among noise-exposed workers. *Occupational and Environmental Medicine* 2022, 79(3), 172–178. <https://doi.org/10.1136/oemed-2021-107789>
- Masterson, E.A.; Themann, C.L.; Luckhaupt, S.E.; Li, J.; Calvert, G.M. Hearing difficulty and tinnitus among U.S. workers. *American Journal of Industrial Medicine* 2016, 59(4), 290–300. <https://doi.org/10.1002/ajim.22563>
- National Institute for Occupational Safety and Health (NIOSH). *Criteria for a Recommended Standard: Occupational Noise Exposure*; U.S. Department of Health and Human Services: Cincinnati, OH, USA, 2018. Available online: <https://www.cdc.gov/niosh/docs/98-126>
- Neitzel, R.L.; Daniell, W.E.; Sheppard, L.; Davies, H.W.; Seixas, N.S. Evaluation of occupational noise exposure among workers. *Journal of Exposure Science & Environmental Epidemiology* 2021, 31, 544–552. <https://doi.org/10.1038/s41370-020-00261-5>
- Neitzel, R.L.; Fligor, B.J. Risk of noise-induced hearing loss due to recreational sound: Review and recommendations. *International Journal of Audiology* 2019, 58(sup1), S61–S70. <https://doi.org/10.1080/14992027.2019.1597778>
- Suma'mur, P.K. *Corporate Hygiene and Occupational Health (HIPERKES), Revised Edition*; Sagung Seto: Jakarta, Indonesia, 2019.
- Tarwaka. *Keselamatan dan Kesehatan Kerja: Occupational Health and Safety Management and Implementation in the Workplace*; Harapan Press: Surakarta, Indonesia, 2020.
- Themann, C.L.; Masterson, E.A. Occupational noise exposure: A review of its effects, epidemiology, and impact. *The Journal of the Acoustical Society of America* 2019, 146(5), 3879–3905. <https://doi.org/10.1121/1.5134465>



This work is licensed under a [Creative Commons Attribution 4.0 International license](https://creativecommons.org/licenses/by/4.0/)
Knowledge and Environmental Science for Living and Global Health (KESLING)
Vol. 02, No. 1, April 2026

World Health Organization. WHO Global Air Quality Guidelines: Particulate Matter (PM_{2.5} and PM₁₀), Ozone, Nitrogen Dioxide, Sulfur Dioxide and Carbon Monoxide; WHO: Geneva, Switzerland, 2021. Available online: <https://www.who.int/publications/i/item/9789240034228>