Journal Syifa Sciences and Clinical Research (JSSCR)
Volume 8 Number 1, 2026
Journal Homepage: http://ejurnal.unq.ac.id/index.php/jsscr, E-ISSN: 2656-9612 P-ISSN:2656-8187
DOI: https://doi.org/10.37311/jsscr.v8i1.36952

Noise exposure, work duration, and hearing loss in a palm-oil mill: a cross-sectional study

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ABSTRACT

Occupational noise exposure remains an important hazard in industrial settings and is associated with an increased risk of hearing impairment. This study aimed to estimate the prevalence of hearing loss and to examine its association with workplace noise intensity and job tenure among palm-oil mill workers. An analytical cross-sectional study was conducted involving 95 workers selected through total sampling. Noise intensity was measured at 12 workstations using a sound level meter and categorized as <85 dB or ≥85 dB, while hearing status was assessed using the ScreenOut hearing screening application. Hearing loss was identified in 9 of 95 workers (9.5%), with a mean age of 47 ± SD years. Among workers exposed to noise ≥85 dB (n = 28), hearing loss occurred more frequently than among those exposed to <85 dB (n = 67), and this association was statistically significant (χ^2 test, p = 0.01; odds ratio [OR] = 5.82; 95% CI: 1.34–25.26). In contrast, job tenure ≥20 years (n = 58) was not significantly associated with hearing loss compared with <20 years (n = 37) (p = 0.283; OR = 1.41; 95% CI: 0.67–2.99). These findings indicate that higher noise intensity is associated with increased odds of hearing loss in this workforce, highlighting the importance of noise control measures, consistent use of personal protective equipment, and regular hearing screening in high-noise industrial environments.

Keywords:
Noise-induced hearing loss; Palm-oil mill; Cross-sectional; Audiometric screening; PPE

Received:	*Accepted:*	*Online:*
2025-12-26	*2026-02-23*	*2026-02-24*

1. Introduction

Noise is any unwanted sound originating from production process equipment and/or work tools that, at certain levels, can cause hearing loss. The permissible noise exposure limit in the workplace for an 8-hour work shift is 85 dB. The Threshold Limit Value (TLV) is a standard for hazardous factors in the workplace, representing the time-weighted average (TWA) of concentration or intensity that can be tolerated by workers without causing illness or health disorders during daily work, provided that exposure does not exceed 8 hours per day or 40 hours per week[1].

The morbidity caused by noise exposure varies across countries, ranging from 15.9% in Brazil to 56.8% among workers in gas companies in the United States[2].

Indonesia is one of the four countries with the highest prevalence of noise-induced hearing loss in Southeast Asia, with a rate of 4.6% [3]. A survey found that 74.5% of Indonesian construction workers were exposed to noise, with a 51% prevalence of hearing loss complaints[4].

Understanding how work-related hearing loss is distributed among industries is crucial for targeting prevention efforts. The NIOSH Occupational Hearing Loss Surveillance Project compiled more than 15 million anonymized audiograms from private sector employees, all tested due to workplace noise regulations. According to the project, around 16% of workers exposed to noise experience significant hearing loss that interferes with speech comprehension and daily life. The prevalence and incidence of occupational hearing loss vary significantly across industries. Research shows that sectors like Mining, Construction, and Manufacturing regularly experience the highest levels of noise exposure and associated hearing loss. These high rates remain even after adjusting for variables such as age and gender [5].

Multiple studies across different countries and industries have shown that occupational noise exposure significantly contributes to hearing loss, especially among older workers and those exposed to high-intensity or impulse noise. However, improvements in hearing protection use and noise regulations over time have led to reduced hearing loss in younger workers. Longitudinal and cross-sectional studies also suggest that the greatest hearing loss tends to occur within the first few years of exposure, and that impulse noise may cause greater damage than continuous noise. While some studies found minimal differences due to improved preventive measures, others emphasize the persistent risk of hearing loss, especially at exposure levels above 85 dB [6].

Occupational hearing loss refers to the permanent partial or complete loss of hearing in one or both ears due to continuous noise exposure in the workplace. Noise-induced hearing loss does not occur suddenly; rather, it develops gradually over time. As a result, many individuals remain unaware of their hearing loss for an extended period. This condition happens due to the adaptive mechanism of the auditory system. Exposure to high-intensity noise over an extended period can cause damage to the cilia hair cells of the organ of Corti. The stereocilia in the outer hair cells become less rigid, making them less responsive to stimuli. In the early stages, the affected area is the basal region. The higher the intensity and duration of noise exposure, the more severe the damage to the stereocilia of the organ of Corti. Once the hair cells die, they are replaced by scar tissue [7].

Several risk factors affect the severity of hearing loss caused by noise exposure, including noise intensity, frequency, daily exposure duration, individual sensitivity, age, and other factors that contribute to deafness, inconsistent use of personal protective equipment (PPE) such as earplugs or earmuffs, long working hours, and lack of occupational safety training.Noise-induced hearing loss cannot be cured, but it can be prevented before it occurs. Hearing loss caused by workplace noise exposure can be prevented through various control interventions, (e.g., reducing noise from industrial machines), implementing administrative controls (e.g., limiting workers' time spent in noisy environments), monitoring noise levels, conducting regular audiometric testing, and enforcing mandatory use of personal protective equipment (PPE) [7],[8].

Noise-induced hearing loss is irreversible, and there is no effective medical treatment, underlining the importance of preventive measures such as noise control, protective equipment use, exposure time reduction, routine noise monitoring and audiometric surveillance, particularly for newly exposed workers. Despite variability

among studies due to differences in demographics, industry type, and publication year, the sensitivity analysis confirmed the robustness of the results. The findings provide valuable guidance for improving occupational health strategies to prevent noise-induced hearing damage [9],[10].

Several hearing loss prevention programs can be implemented through the following measures : eliminating noise sources from the workplace, replacing equipment, materials, and work processes that generate noise, installing barriers, sound dampers, or partial or complete enclosures for machinery, regulating or limiting noise exposure and adjusting work schedules, using appropriate personal protective equipment (PPE) such as earplugs or earmuffs, implementing other control measures in accordance with advancements in science and technology, re-evaluating noise exposure regulations, implementing more effective noise control measures, and raising awareness among employers about the hidden risks of long-term exposure to moderate noise levels and education on hearing conservation [1],[11],[12].

Accordingly, this study aims to estimate the prevalence of hearing loss among palm-oil mill workers and to examine its association with measured occupational noise intensity (≥85 vs <85 dB) and job tenure. By providing quantitative evidence on the burden of hearing loss and its relationship with key occupational risk factors, this study is expected to contribute to a better understanding of noise-related health risks in palm-oil milling environments and to inform the development of targeted preventive and occupational health interventions for this workforce.

2. Methods

Participant characteristics and research design

This study was an analytical study using a cross-sectional method. Data collection was conducted from January to March 2025. The population in this research included all employees at the Lubuk Dalam Palm Oil Mill (PKS Lubuk Dalam). The inclusion criteria for this study were employees who had worked for more than one year, were willing to participate as respondents and signed an informed consent form. The exclusion criteria included workers with a history of hearing impairment prior to employment at the factory (congenital, trauma, ENT diseases, etc.), workers currently experiencing acute ear infections or any medical condition that may affect the results of hearing examination during data collection and uncooperative workers or those who refuse to undergo examination.

Sampling procedures

The sample was selected using a total sampling technique for respondents who met the inclusion criteria and were not part of the exclusion criteria. The steps for determining the sample are as follows obtain a list of employee names and job positions from the HR or personnel department, screen the employees based on length of service and work location (exposure to noise), approach all potential participants and explain the purpose and procedures of the study, collect informed consent and re-screen based on exclusion criteria and conduct hearing examinations and measure workplace noise levels.

Sample size, power, and precision

Intended sample size was 136 workers. Actual sample size was 95 workers due to non-response and incomplete data. The sample size was determined using total sampling, involving all eligible workers exposed to noise in the production unit who met the inclusion criteria. Of the 136 workers initially intended to be included in the

study, 95 participants were ultimately included in the final analysis. A total of 41 workers were not included, consisting of individuals who declined to participate and those with incomplete or missing data that did not meet the inclusion criteria.

Explanation of any interim analyses and stopping rules.

Data collection was conducted by directly measuring noise levels using a sound level meter. Noise intensity measurements were taken at 12 workstations, and the results were classified as exceeding the permissible threshold (>85 dB) or not exceeding the permissible threshold (<85 dB). Meanwhile, the length of the work period was assessed using a questionnaire, categorizing respondents into < 20 years of service and ≥ 20 years of service. Data on hearing loss among employees was obtained through hearing examinations conducted on all participating employees with the assistance of the Screen-Out application. The results of the hearing function assessment were categorized as normal or hearing loss. The ScreenOut application has demonstrated satisfactory validity as a hearing screening tool when compared with conventional pure-tone audiometry, which is considered the gold standard for hearing assessment. Validation studies have shown that ScreenOut provides strong agreement with standard audiometric thresholds across key frequencies (500–4000 Hz), with reported sensitivity of approximately 90.9% and specificity of 98.9% for the detection of hearing loss. These findings indicate that ScreenOut is capable of accurately identifying individuals with and without hearing impairment in screening settings [13].

Measures and covariates

The primary variable in this study was hearing loss, which was assessed through Screen-Out application. Secondary variables included noise intensity measured in the workplace environment and length of employment (work duration) of the participants. In addition, several covariates were considered, such as the age of the workers, history of ear, nose, and throat (ENT) disorders, and use of personal protective equipment (PPE) such as earplugs or earmuffs. These covariates were included to control for potential confounding factors that may influence the relationship between noise exposure and hearing loss.

Data analysis

Data were analyzed using univariate and bivariate analyses. The results of the univariate analysis were presented in the form of graphs and frequency distribution tables. Meanwhile, the bivariate analysis was conducted using the Chi-Square method to determine whether there was a significant relationship between the dependent and independent variables.

Ethical Approval

This study was approved by the Ethics Committee of University of Abdurrab (Approval No. 465/KEP-UNIVRAB/II/2025).

3. Results and Discussion

Characteristics of the respondents

Actual sample size in this research was 95 workers. According to the characteristics of the respondents in this survey, the respondents are in the 17–55 age range, with a median age of 47. Approximately 92.6% of responders were male. As many as 78.9% of the respondents in this study are high school education level. 61.05% of the respondents have been working for more than 20 years. The distribution of the respondents' sociodemographic details is shown in **Table 1**.

Table 1. Characteristics of the respondents

characteristics	n	%
Age		
17-24	7	7.4
25-35	10	10.5
36-45	26	27.4
46-55	52	54.7
Total	95	100
Sex		
Male	88	92.6
Female	7	7.4
Total	95	100
Education		
SD/SMP	11	11.6
SMA	75	78.9
Tertiary	9	9.5
Total	95	100

Noise intensity, length of working period and hearing function result

The results of the noise intensity measurements, hearing function examination results and length of working period at the Lubuk Dalam Palm Oil Mill details are shown in **Table 2**.

Table 2. Noise Intensity Measurement Results

characteristics	n	%
Noise intensity		
< 85 dB	67	70.5
≥ 85 dB	28	29.5
Total	**95**	**100**
Length of working period		
< 20 years		
≥ 20 years	37	38.95
Total	58	61.05
	95	**100**
Hearing function		
Normal	86	90.5
Hearing loss	9	9.5
Total	**95**	**100**

Among the 95 workers included in the analysis, most were exposed to noise levels below 85 dB, while less than one third experienced noise intensity ≥85 dB. A greater proportion of participants had a job tenure of 20 years or more compared with those working for less than 20 years. Overall, the majority of workers demonstrated normal hearing function, with only a small proportion identified as having hearing loss. This figure is lower compared to the studies conducted by Marlina et al. (27.3%) and Amalia et al. (44.4%). The variation in hearing loss rates may be affected by several risk factors, including noise intensity, duration of exposure, length of employment, and other contributing factors [14], [15].

The incidence of hearing loss among factory workers is one of the occupational risks associated with workplace noise exposure. The most commonly reported health impact of noise exposure among workers is hearing loss. The early sign of noise-induced hearing loss is an increase in hearing threshold (threshold shift), which may be

accompanied by tinnitus. Since hearing loss typically occurs gradually, affected workers often do not realize changes in their hearing ability until a significant threshold shift has occurred [16], [17].

Relationship between noise intensity and the incidence of hearing loss

The study results were analyzed using a bivariate approach with the Chi-Square test. The analysis revealed a significant relationship between noise intensity and the incidence of hearing loss among workers at the Lubuk Dalam Palm Oil Mill (p-value = 0.01, < 0.05). Relationship between noise intensity and the incidence of hearing loss details is shown in **Table 3**.

Table 3. Relationship Between Noise Intensity and the Incidence of Hearing Loss

Noise Intensity	Normal Hearing		Hearing Loss		OR (95% CI)	*P-value*
	n	%	**n**	%		
< 85 dB	64	67.4	3	3.2	1.00	0.01
≥ 85 dB	22	23.1	6	6.3	5.82 (1.34-25.26)	
Total	86		9			

The data analysis results indicate a significant relationship between noise intensity and the incidence of hearing loss among workers at the Lubuk Dalam Palm Oil Mill (p-value = 0.01). Risk estimate analysis further indicated that workers exposed to noise levels ≥85 dB had substantially higher odds of hearing loss compared with those exposed to noise levels <85 dB (OR = 5.82; 95% CI: 1.34–25.26). This finding is consistent with the study conducted by Maulana et al., which examined textile factory workers in West Java, as well as the study by Marlina et al., on workers in a steel processing plant [14],[18].

Noise-induced hearing loss or exposure to loud sounds is typically caused by damage to the hair cells in the organ of Corti. These hair cells function as mechanical-electrical transducers, converting sound vibrations into electrical signals that are transmitted to the brain. This damage is generally irreversible, as hair cells cannot regenerate, resulting in permanent hearing loss [19].

A study demonstrated significant reductions in Transient-Evoked Otoacoustic Emissions amplitudes and Contralateral Acoustic Stimulation Suppression activity in the exposed group, indicating damage to the outer hair cells and medial olivocochlear bundle. The dysfunction of CAS did not significantly differ by duration of noise exposure, suggesting it may serve as a predictive marker for susceptibility rather than a result of prolonged exposure [20].

Exposure to loud noise can cause both Temporary Threshold Shift (TTS) and Permanent Threshold Shift (PTS). Prolonged and excessive noise exposure can disrupt sound transmission to the brain at both low and high frequencies. Changes in the stria vascularis are likely to reduce endocochlear function, thereby impairing the cochlea's ability to amplify sound signals and increase the hearing threshold [19].

Relationship between length of working period and the incidence of hearing loss

The analysis of the relationship between the length of the work period and the incidence of hearing loss among palm oil mill workers showed no significant association (p-value = 0.283, > 0.05). Relationship between the work period and the incidence of hearing loss details is shown in **Table 4**.

Table 4. Relationship between the work period and the incidence of hearing loss

Work Period	Normal Hearing		Hearing Loss			
	n	%	n	%	OR (95% CI)	P value
< 20 years	32	33.7	5	5.3	1.00 (Ref)	0.283
≥ 20 years	54	56.8	4	4.2	1.41 (0.67–2.99)	
Total	86	90.5	9	9.5		

The main finding of this study is that job tenure was not significantly associated with hearing loss among workers at the Lubuk Dalam Palm Oil Mill. Risk estimate analysis further supported this finding. Workers with a job tenure of ≥20 years had higher odds of hearing loss compared with those with <20 years of employment (OR = 1.41; 95% CI: 0.67–2.99); however, the confidence interval crossed unity, indicating that the association was not statistically significant. These results suggest that, in this study population, job tenure alone was not significantly associated with the occurrence of hearing loss.This result is consistent with previous studies by Amalia et al. and Ambar et al., which likewise reported no significant association between duration of employment and the incidence of hearing loss [15],[21].

However, other studies have reported contrasting findings. Longitudinal research has demonstrated significant deterioration in hearing thresholds over time among noise-exposed workers, particularly at high frequencies (3,000–6,000 Hz), suggesting progressive noise-induced hearing loss within the first few years of exposure[22]. Similarly, a study among aluminium plant workers in Dubai identified job duration and noise intensity as important contributors to hearing loss, with age and noise level emerging as the strongest predictors in multivariable analysis [23].

This discrepancy may be caused by various factors, such as noise intensity, the use of personal protective equipment (PPE), specific workplace conditions, and age. Continuous noise exposure, even at levels below 85 dBA, may cause greater hearing loss than intermittent exposure, likely due to inadequate recovery time between shifts [24]. Additionally, workers at the Lubuk Dalam Palm Oil Mill undergo periodic job rotations, meaning that employees do not remain in the same work environment for extended periods.

The outcome of this study is based on a screening assessment, and pure-tone audiometry is acknowledged as the diagnostic gold standard for hearing loss. The lack of association with job tenure may be explained by factors such as job rotation across work areas, adequate uptake and consistent use of personal protective equipment, and the healthy worker effect. Future studies should adopt longitudinal designs with larger, more diverse samples, incorporate detailed assessments of PPE use and additional risk factors, and be complemented by workplace measures such as regular hearing examinations, strict noise monitoring, and strengthened enforcement of hearing protection to reduce occupational hearing loss.

This study has several limitations. First, the cross-sectional design does not allow the establishment of a causal relationship between noise exposure and hearing loss, as the data were collected at a single point in time. Second, the number of participants was lower than the intended sample size due to non-response and incomplete data, which may have affected the generalizability of the findings. Third, the use of self-reported questionnaires for certain variables, such as the duration of work and use of personal protective equipment (PPE), may have introduced recall bias. Additionally, the study

did not assess the consistency and frequency of PPE usage or consider genetic predisposition to hearing loss, which could influence the outcomes.

4. Conclusion

This study concludes that there is a significant relationship between noise intensity and the incidence of hearing loss among workers at the Lubuk Dalam Palm Oil Mill. Noise intensity ≥85 dB was associated with higher odds of hearing loss, whereas job tenure was not. These findings reinforce the need for engineering noise control, strict PPE adherence, regular audiometric screening, and assignment policies that minimise time in high-noise areas.

Acknowledgements:

The authors would like to express their sincere gratitude to Abdurrab foundation for the financial support provided for this research. This support was instrumental in the successful completion of the study.

Conflicts of Interest:

The authors declare no conflict of interest regarding the publication of this paper.

References

[1] Ministry of Manpower of the Republic of Indonesia, "Regulation of the Minister of Manpower of the Republic of Indonesia No. 5 of 2018 on Occupational Safety and Health (OSH) in the Work Environment," 2018. [Online]. Available: https://peraturan.go.id/id/permenaker-no-5-tahun-2018

[2] A. D. Hidayat and A. Adam, "Association between hearing impairment and noise exposure: A positivistic approach based on prior studies (literature review)," *Jurnal Ilmiah Kajian Multidisipliner*, vol. 8, no. 4, pp. 156–162, 2024. [Online]. Available: https://zenodo.org/records/11056155/files/156-162.pdf

[3] Ministry of Health of the Republic of Indonesia, "Decree of the Minister of Health No. 879/Menkes/SK/XI/2006 on the National Strategic Plan for Hearing Impairment and Deafness Control to Achieve Sound Hearing 2030," 2006. [Online]. Available: https://www.yumpu.com/id/document/view/47791876/kmk-879-2006-renstranas-gangguan-pendengaran-dan-ketulian

[4] E. Ambar and A. Suraya, "Prevalence and risk factors of hearing impairment among Indonesian construction industry workers," *Binawan Student Journal*, vol. 4, no. 2, pp. 14–20, 2022. [Online]. Available: https://doi.org/10.54771/bsj.v4i2.459

[5] C. L. Themann and E. A. Masterson, "Occupational noise exposure: A review of its effects, epidemiology, and impact with recommendations for reducing its burden," *J. Acoust. Soc. Am.*, vol. 146, no. 5, pp. 3879–3905, 2019. [Online]. Available: https://doi.org/10.1121/1.5134465

[6] A. Lie *et al.*, "Occupational noise exposure and hearing: A systematic review," *Int. Arch. Occup. Environ. Health*, vol. 89, no. 3, pp. 351–372, 2016. [Online]. Available: https://doi.org/10.1007/s00420-015-1083-5

[7] F. E. B. Setyawan, "Prevention of noise induced hearing loss in worker: A literature review," *Jurnal Kedokteran dan Kesehatan Indonesia*, 2021. [Online]. Available: https://doi.org/10.20885/jkki.vol12.iss2.art12

[8] World Health Organization and International Labour Organization, *WHO/ILO Joint Estimates of the Work-related Burden of Disease and Injury, 2000–2016: Global*

Monitoring Report, 2021. [Online]. Available: https://www.who.int/publications/i/item/9789240034945

[9] A. C. Pelegrin, L. Canuet, Á. A. Rodríguez, and M. P. A. Morales, "Predictive factors of occupational noise-induced hearing loss in Spanish workers: A prospective study," *Noise Health*, vol. 17, no. 78, pp. 343–349, 2015. [Online]. Available: https://doi.org/10.4103/1463-1741.165064

[10] P. Yang, H. Xie, Y. Li, and K. Jin, "The effect of noise exposure on high-frequency hearing loss among Chinese workers: A meta-analysis," *Healthcare (MDPI)*, vol. 11, no. 8, Art. no. 1079, 2023. [Online]. Available: https://doi.org/10.3390/healthcare11081079

[11] Ö. Gedik Toker, N. Tas Elibol, E. Kuru, Z. Görmezoğlu, A. Görener, and K. Toker, "Industrial noise: Impacts on workers' health and performance below permissible limits," *BMC Public Health*, vol. 25, Art. no. 1615, 2025. [Online]. Available: https://doi.org/10.1186/s12889-025-22732-1

[12] H. Ismail *et al.*, "Noise-induced hearing loss among manufacturing factory workers in Kuching, Sarawak: Prevalence and associated risk factors," 2023. [Online]. Available: https://e-mjm.org/2023/v78n5/noise-induced-hearing-loss.pdf

[13] H. Ismail *et al.*, "Noise-induced hearing loss among manufacturing factory workers in Kuching, Sarawak: Prevalence and associated risk factors," 2023. [Online]. Available: https://e-mjm.org/2023/v78n5/noise-induced-hearing-loss.pdf

[14] S. Marlina, A. Suwondo, and S. Jayanti, "Risk factor analysis of sensorineural hearing loss among workers at PT X Semarang," 2016. [Online]. Available: https://ejournal3.undip.ac.id/index.php/jkm/article/view/11835

[15] A. S. Kantu, H. Jusuf, and E. Prasetya, "Noise level, work duration, and tenure associated with hearing-loss complaints among workers at KMP Moinit, Gorontalo ferry port," *Public Health and Surveillance Review*, vol. 1, no. 1, 2022. [Online]. Available: https://doi.org/10.56796/phsr.v1i1.16410

[16] L. Huang *et al.*, "Noise exposure, hearing loss and cognitive impairment: A cross-sectional study based on an occupational health surveillance cohort in China," *Front. Public Health*, vol. 13, 2025. [Online]. Available: https://doi.org/10.3389/fpubh.2025.1455340

[17] M. Concha-Barrientos, D. Campbell-Lendrum, and K. Steenland, *Occupational Noise: Assessing the Burden of Disease from Work-related Hearing Impairment at National and Local Levels*. Geneva, Switzerland: World Health Organization, 2004. [Online]. Available: https://www.who.int/publications/i/item/9241591927

[18] M. I. Maulana, M. T. Anggraini, and M. R. Setiawan, "Association of noise intensity and hearing protection device use with hearing impairment among textile factory workers," *Jurnal Ilmiah Kesehatan*, vol. 21, no. 3, pp. 12–16, 2022. [Online]. Available: https://tekunlib.poltekun.ac.id/index.php?id=1327&p=show_detail

[19] K.-H. Chen, S.-B. Su, and K.-T. Chen, "An overview of occupational noise-induced hearing loss among workers: Epidemiology, pathogenesis, and preventive measures," *J. Chin. Med. Assoc.* (via BioMed Central platform), 2020. [Online]. Available: https://doi.org/10.1186/s12199-020-00906-0

[20] E. Nada, W. M. Ebraheem, and S. Sheta, "Noise-induced hearing loss among workers in textile factory," *Egyptian Journal of Otolaryngology*, vol. 30, no. 3, pp. 243–248, 2014. [Online]. Available: https://doi.org/10.4103/1012-5574.138484

[21] E. Ambar and A. Suraya, "Prevalence and risk factors of hearing impairment among Indonesian construction industry workers," 2022. [Online]. Available: https://doi.org/10.54771/bsj.v4i2.459

[22] B. Zhou and J. Zhang, "Occupational epidemiological characteristics of noise-induced hearing loss and the impact of combined exposure to noise and dust on workers' hearing: A retrospective study," *Front. Public Health*, vol. 12, 2024. [Online]. Available: https://doi.org/10.3389/fpubh.2024.1488065

[23] E. M. M. Elsawaf *et al*., "Occupational history and intensity of exposure to noise as a risk factor for hearing loss among plant workers in aluminum industry in Dubai," 2015. [Online]. Available: https://files.aiscience.org/journal/article/pdf/70250017.pdf

[24] I.-S. Chung, I. M. Chu, and M. R. Cullen, "Hearing effects from intermittent and continuous noise exposure in a study of Korean factory workers and firefighters," *BMC Public Health*, vol. 12, Art. no. 87, 2012. [Online]. Available: https://doi.org/10.1186/1471-2458-12-87