The Relationship Between Noise Intensity and Hearing Loss In Security Workers

Fransiskus Harf Poluan[1*], Vidi Posdo A. Simarmata[2], Ditta Suhita Dewi Asnul[1], Patar Hutagalung[3]

[1]Department of Ear, Nose and Throat, Faculty of Medicine, Universitas Kristen Indonesia
[2]Department of Medical Community, Faculty of Medicine, Universitas Kristen Indonesia
[3]Ministry of Manpower of the Republic of Indonesia

*Email correspondence: fransiskus.poluan@uki.ac.id

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Abstract

Occupational noise exposure is an important risk factor for hearing loss, particularly among workers exposed to elevated noise levels over prolonged periods. To analyze the association between workplace noise intensity and hearing loss among security guards at Jatinegara Station in 2024. This analytical study used a cross-sectional design and included 38 security guards. Workplace noise intensity was measured using a sound level meter, while respondent characteristics, duration of employment, personal protective equipment (PPE) use, and hearing complaints were collected using questionnaires. Associations between noise intensity, age, duration of employment, and hearing loss were analyzed using the Chi-square test or Fisher's exact test when expected cell counts were <5. Crude prevalence ratios (PRs) with 95% confidence intervals (CIs) were calculated for each comparison. Hearing loss was present in 22 of 34 workers (64.7%) exposed to noise levels ≥85 dB and 2 of 4 workers (50.0%) exposed to ≤85 dB. Fisher's exact test showed no significant association between noise intensity and hearing loss (p=0.616; crude PR=1.29, 95% CI: 0.47–3.56). Among workers aged ≥40 years, 7 of 11 (63.6%) had hearing loss compared with 17 of 27 (62.9%) among those aged ≤40 years (p=0.970; crude PR=1.01, 95% CI: 0.59–1.72). Hearing loss occurred in 12 of 18 workers (66.7%) with ≥3 years of service and 12 of 20 (60.0%) with ≤3 years of service (p=0.681; crude PR=1.11, 95% CI: 0.68–1.80). No statistically significant associations were identified between the examined factors and hearing loss. Although the prevalence of hearing loss was numerically higher among workers exposed to ≥85 dB and those with longer employment duration, these differences were not statistically significant. The wide confidence intervals, particularly for noise exposure, indicate substantial uncertainty in the estimates, partly because of the small number of workers in the ≤85 dB exposure group. No significant association was found between noise intensity and hearing loss among security guards at Jatinegara Station. The findings should be interpreted cautiously given the small sample size and the limited number of workers in the ≤85 dB exposure group. Continued efforts to control workplace noise and improve compliance with hearing protection measures remain relevant for occupational hearing-loss prevention.

Keywords: Hearing Loss, Noise Intensity, Security Guards, Risk Factors.

INTRODUCTION

Occupational noise exposure remains one of the leading physical hazards in the workplace and is recognized as an important cause of preventable occupational disease worldwide. Prolonged exposure to excessive noise can result in noise-induced hearing loss (NIHL), an irreversible sensorineural hearing impairment caused by progressive damage to cochlear hair cells. In addition to hearing impairment, chronic noise exposure has been associated with impaired communication, increased stress, reduced work performance, and an increased risk of occupational accidents, ultimately affecting workers' quality of life and

productivity (Brzoska et al., 2022; Greif et al., 2024; Mehrotra et al., 2024; Merijanti, 2022; Plack, 2023; Sun et al., 2025; B. Zhou & Zhang, 2024)

In Indonesia, occupational noise exposure is regulated under Minister of Manpower Regulation No. 5 of 2018 concerning Occupational Safety and Health in the Work Environment, which establishes a noise exposure limit of 85 dB(A) for an 8-hour workday. Exposure above this limit requires implementation of occupational health control measures, including engineering and administrative controls, hearing conservation programs, and the use of appropriate hearing protection devices. Despite these regulatory provisions, occupational noise remains an important health concern in transportation and railway environments, where workers may experience intermittent or continuous high-intensity noise generated by train operations.

PT Kereta Api Indonesia (PT KAI), the national railway operator, employs various occupational groups with differing patterns of noise exposure. Among these, security guards constitute a unique occupational group because they spend prolonged periods stationed on railway platforms, trackside areas, and station entrances where train arrivals, departures, braking, and warning signals generate repeated high-intensity noise (Alessio & Marron, 2023). Unlike train operators or maintenance personnel, whose exposure may vary according to operational tasks, security guards generally remain in these environments throughout their work shifts while simultaneously maintaining situational awareness and communicating with passengers and other staff. Consequently, hearing impairment in this group may not only affect individual health but also compromise communication, emergency response, and overall workplace safety.

Numerous studies have demonstrated an association between occupational noise exposure and hearing loss among industrial and transportation workers. Previous research has also shown that exposure to noise levels exceeding 85 dB(A) increases the risk of hearing impairment, particularly at speech-related and high-frequency hearing thresholds (Demirtaş et al., 2022; Kwon & Lee, 2021; Permatasari, 2025; Śliwińska-Kowalska & Zaborowski, 2017; B. Zhou & Zhang, 2024; J. Zhou et al., 2020). However, much of the available evidence has focused on manufacturing workers, construction workers, airport personnel, and train drivers. Evidence concerning railway security personnel remains limited, despite their routine exposure to railway noise and their important safety responsibilities. Furthermore, limited evidence is available regarding the relationship between workplace noise exposure and self-reported hearing problems among railway security personnel, particularly in relation to the use of hearing protection.

Hearing protection is an important component of occupational hearing conservation because the risk of hearing impairment depends not only on environmental noise exposure but also on the extent to which workers consistently use appropriate personal protective equipment (PPE). Assessing noise exposure together with relevant worker characteristics and PPE use may therefore provide a more comprehensive description of factors associated with hearing complaints in this occupational group. Such information may help identify occupational groups requiring greater attention within workplace hearing-conservation programs (Silva et al., 2023). We hypothesized that security guards exposed to workplace noise levels of ≥85 dB(A) would have a higher prevalence of self-reported hearing loss or hearing complaints than those exposed to ≤85 dB(A). We also explored whether age, duration of employment, and PPE use were associated with reported hearing problems. Because this was an exploratory cross-sectional study, these hypotheses were evaluated as associations rather than as evidence of causality. The present study therefore aimed to analyze the association between workplace noise intensity and self-reported hearing loss among security guards at Jatinegara Station in 2024, while also examining the associations of age, duration of employment, and PPE use with reported hearing loss. The findings are expected to provide occupational health information that can support hearing-conservation efforts and preventive strategies for security personnel who routinely work in railway environments.

METHOD

This analytical observational study employed a cross-sectional design to examine the association between occupational noise exposure and hearing loss among security guards at Jatinegara Railway Station, PT Kereta Api Indonesia (PT KAI), in 2024. The study population consisted of all security guards assigned to Jatinegara Station. A total sampling approach was applied, whereby all eligible workers were invited to participate. Thirty-eight security guards met the inclusion criteria and were included in the study. Eligible participants were actively employed security guards who agreed to participate by providing informed consent. Workers with a documented history of non-occupational ear disease or incomplete questionnaire data were excluded.

Occupational noise exposure was assessed through direct environmental measurements using a Sound Level Meter (SLM). The instrument was calibrated according to the manufacturer's recommendations and applicable measurement standards before data collection. Noise measurements were performed at the participants' work areas during routine operational activities to represent typical occupational exposure. Noise intensity was classified according

to Minister of Manpower Regulation No. 5 of 2018 concerning Occupational Safety and Health in the Work Environment, using a threshold of 85 dB(A) for an 8-hour workday. Noise levels >85 dB(A) were categorized as excessive occupational noise exposure, whereas levels ≤85 dB(A) were categorized as acceptable exposure.

Hearing loss was assessed using a structured questionnaire that evaluated subjective hearing complaints rather than objective audiometric examination. Participants were classified as having or not having hearing loss based on their questionnaire responses. Additional information collected through the questionnaire included age, duration of employment, daily work duration, and compliance with hearing protection device (earplug) use (Health & 2019, n.d.; Maharani et al., 2025; Sataloff & Roehm, 2024; Yin & Chao, 2021). Employment duration was categorized as <3 years or ≥3 years, daily work duration as ≤8 hours or >8 hours, and age as <40 years or ≥40 years.

The study primarily evaluated occupational noise exposure and several occupational characteristics. However, other factors that may influence hearing status, including smoking habits, previous ear disease, recreational noise exposure, ototoxic medication use, chronic medical conditions, and previous occupational noise exposure outside the current workplace, were not systematically collected and therefore could not be controlled in the analysis. These factors should be considered as potential confounders when interpreting the findings.

Data were analyzed using IBM SPSS software. Univariate analysis was performed to summarize the distribution of participant characteristics and study variables. Bivariate associations between noise intensity, age, employment duration, daily work duration, hearing protection device use, and hearing loss were evaluated using the Chi-square test. The strength of statistically significant associations was assessed using the Contingency Coefficient. Statistical significance was defined as a two-sided p-value <0.05.

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Written informed consent was obtained from all participants before data collection, and the confidentiality of participant information was maintained throughout the study. Ethical approval was obtained from the LPPM UKI Ethics Committee (approval No. 055/UKI.LPPM/PPM.00.00/ET.2024). This research was conducted without external funding and was entirely self-funded by the researchers.

RESULTS

This research was conducted at PT KAI Jatinegara. Jatinegara station is a large class A station located between the Jatinegara and Matraman districts, specifically in Pisang Baru sub-

district, Matraman district, East Jakarta City. As one of the railway connections in the Jabodetabek area, this station is served by all trains from various cities on the island of Java, except for trains bound for Bekasi, which require a transit at stations designated by PT KAI. Jatinegara Station opened or began operating in 1910 and has a long history in the development of railways in Indonesia. It has a building in the Dutch colonial style, and to date, it has undergone several renovations to improve comfort and service capacity. Jatinegara Station continues to develop and always strives to improve services to meet passenger needs. In addition to serving passenger needs, Jatinegara Station is also a place of work for many people. One of them is a security guard.

Noise intensity data were collected on the train platform where the security guard was working and in good health. Measurements were conducted using a sound-level meter. Meanwhile, identity data and questionnaires were completed in the waiting room and, in some cases, directly on the train platform while on duty.

A total of 38 security guards participated in the study. Respondent characteristics included sex, age, duration of employment, noise exposure intensity, and use of personal protective equipment. The age and duration-of-employment distributions are presented in Table 1.

Table 1. Respondent Characteristics Based on Age, Education, and Length of Service

Categories	Frequency (n)	Percentage (%)
Age		
≥ 40 years	11	28.9
≤ 40 years	27	71.1
Education		
Elementary School	2	5.3
Junior High School	6	15.8
Senior High School	20	52.6
Bachelor's Degree	10	26.3
Length of Service		
≥ 3 years	18	47.4
≤ 3 years	20	52.6

From the data above, 11 respondents (28.9%) are over 40 years old, and 27 (71.1%) are under 40 years old. Thus, the majority of security guards at Jatinegara Station are under 40 years old. Meanwhile, the age group over 40 years old is the group with the smallest number. Regarding education data, 2 respondents, or approximately 5.3%, had elementary school education; 6 respondents, or approximately 15.8%, had junior high school/Islamic junior high school (MTS); 20 respondents, or approximately 52.6%, had senior high school/vocational high school/Islamic senior high school (MA); and 10 respondents, or approximately 26.3%, had a bachelor's degree (S1). Therefore, the high school/vocational high school/Islamic senior high school (MA) group is the most dominant educational group among Jatinegara Station

security guards. Meanwhile, the elementary school group is the least numerous. Furthermore, with respect to length of service, 18 people (approximately 47.4%) had more than 3 years of experience, whereas 20 people (approximately 52.6%) had less than 3 years of experience. Thus, those with less than 3 years of experience are the dominant group among Jatinegara Station security guards. Meanwhile, those with more than 3 years of experience are the smallest group.

Table 2. Distribution of Hearing Loss Among Security Guards at Jatinegara Station

Variable	Categories	Frequency (n)	Percentage (%)
Hearing Loss	Disorders	24	63.2
	Normal	14	36.8

Table 3. Factors related to hearing loss in security guards at Jatinegara Station

Variable	Categories	Frequency (n)	Percentage (%)
Noise Intensity	≥ 85 dB	34	89.5
	≤ 85 dB	4	10.5
Age	≥ 40 years	11	28.9
	≤ 40 years	27	71.1
Working Period	≥ 3 years	18	47.4
	≤ 3 years	20	52.6
Duration of Noise Exposure in a Day	≥ 8 years	-	-
	≤ 8 years	38	100
Use of Hearing Protection (EAP)	Not Using EAP	38	100
	Using EAP	-	-

Table 4. Distribution of the relationship between noise and hearing loss in security guards at Jatinegara Station

Variable	Categories	Disorders		Normal		Total		CC	*p-value*
		n	%	n	%	n	%		
Noise Intensity	≥ 85 dB	22	64.7	12	35.3	34	100	0.094	0.576
	≤ 85 dB	2	50	2	50	4	100		
Age	≥ 40 years	7	63.6	4	36.4	11	100	0.006	0.970
	≤ 40 years	17	63.0	10	27.0	27	100		
Working Period	≥ 3 years	12	66.7	6	33.3	18	100	0.069	0.681
	≤ 3 years	12	60.0	8	40.0	20	100		

Table 5. Prevalence Ratio (PR) and Statistical Analysis of Risk Factors Associated with Hearing Loss Among Security Guards

Comparison	Hearing loss	Statistical test	p-value	Crude PR	95% CI
≥85 dB vs ≤85 dB	64.7% vs 50.0%	Fisher's exact	0.616	1.29	0.47–3.56
≥40 vs ≤40 years	63.6% vs 62.9%	Chi-square	0.970	1.01	0.59–1.72
≥3 vs ≤3 years of service	66.7% vs 60.0%	Chi-square	0.681	1.11	0.68–1.80

Table 6. Cross-Tabulation Workplace Noise Intensity and Hearing Loss Status for Fisher's Exact Test

Noise intensity	Hearing loss	No hearing loss	Total
≥85 dB	22	12	34
≤85 dB	2	2	4

Because the ≤85 dB group contains only four workers, Fisher's exact test is more appropriate than the Pearson Chi-square test. The Fisher's exact *p*-value is 0.616, rather than the original *p*=0.576.

DISCUSSION

This study investigated the association between occupational noise intensity and hearing loss among security guards at Jatinegara Station. Although a higher proportion of hearing loss was observed among workers exposed to noise levels ≥85 dB, no statistically significant association was identified between noise intensity and hearing loss. Similarly, age and length of service were not significantly associated with hearing loss. Therefore, the findings should be interpreted as indicating no statistically significant relationship between the variables examined and hearing loss in this study, although several variables showed descriptive trends warranting further investigation.

Noise Intensity and Hearing Loss

Occupational noise exposure exceeding 85 dB(A) is widely recognized as a major risk factor for Noise-Induced Hearing Loss (NIHL). Experimental and epidemiological studies have demonstrated that prolonged exposure to excessive noise damages cochlear hair cells, resulting in progressive and irreversible sensorineural hearing loss (Kwon & Lee, 2021; Themann et al., 2023). However, in the present study, the association between workplace noise intensity and hearing loss was not statistically significant (p = 0.576; contingency coefficient = 0.094). Although the prevalence of hearing loss appeared to be higher among workers exposed to noise ≥85 dB(A), this observed difference should be regarded as a descriptive trend rather than evidence of an association.

The absence of a statistically significant relationship differs from several previous studies reporting significant associations between occupational noise exposure and hearing impairment. Several factors may explain this discrepancy. First, the present study included only 38 participants, which limited statistical power and increased the likelihood of a type II error. Second, noise exposure was assessed using environmental measurements at a single point in time rather than cumulative personal exposure over several years. Previous studies have shown that NIHL is more strongly associated with long-term cumulative exposure than with short-term environmental measurements (Chen et al., 2020; Lie et al., 2016; Merijanti, 2022). Third, hearing loss in this study was assessed using a questionnaire rather than pure-tone audiometry, potentially resulting in outcome misclassification and reduced sensitivity for detecting early hearing impairment. Finally, differences in study populations, occupational characteristics,

exposure duration, and hearing assessment methods may also contribute to inconsistencies across studies.

Age and Hearing Loss

No statistically significant association was observed between age and hearing loss ($p = 0.970$). Although workers aged ≥40 years had a slightly higher prevalence of hearing loss than younger workers, the difference was minimal. It should not be interpreted as evidence of an age-related effect. Age-related hearing decline (presbycusis) is a well-established biological process; however, its contribution to hearing impairment may be less apparent in relatively young occupational populations such as those included in this study.

Previous studies have reported that increasing age is associated with a higher prevalence of hearing loss, particularly among workers with prolonged occupational noise exposure (Maharani et al., 2025; Merijanti, 2022; Permatasari, 2025). The discrepancy between our findings and previous reports may reflect the relatively young age distribution of participants, the small sample size, and the inability to account for other determinants of hearing loss, including smoking, recreational noise exposure, chronic diseases, and previous ear disorders. Consequently, the present findings should not be interpreted as indicating that age does not influence hearing loss, but rather that no statistically significant association was detected in this study population.

Work Tenure and Hearing Loss

Workers with a service duration of ≥3 years demonstrated a slightly higher prevalence of hearing loss than those with shorter employment (66.7% vs. 60.0%). However, this difference was not statistically significant ($p = 0.681$), and the contingency coefficient indicated only a very weak relationship. Therefore, although a descriptive trend toward higher hearing complaints with longer employment was observed, the data do not support a statistically significant association.

Longitudinal studies have reported that the risk of NIHL increases substantially after five to ten years of continuous occupational noise exposure (Śliwińska-Kowalska & Zaborowski, 2017). The relatively short duration of employment among many participants in the present study may have limited the cumulative exposure necessary for measurable hearing deterioration. Furthermore, employment duration may not accurately represent cumulative noise exposure because individual work assignments, rotation schedules, and adherence to hearing conservation measures may differ among workers.

Personal Protective Equipment Use and Other Factors

Although the variable for personal protective equipment (PPE) use was analyzed, the results showed no significant association with hearing loss incidence. This could be due to inconsistent compliance with PPE use or the use of PPE that does not meet standards. (Doutres et al., 2022; Eichorn et al., 2024; Silva et al., 2023) emphasized that the effectiveness of PPE depends heavily on the appropriate type, method of use, and duration of use. Furthermore, the weak association between the studied variables and hearing loss suggests the presence of other factors not analyzed, such as exposure to noise outside the workplace, a history of ear disease, use of ototoxic medications, and genetic factors. Research by (Ahmed et al., 2022; Uddin et al., 2023) confirms that noise-induced hearing loss is a multifactorial condition that cannot be explained by a single variable.

Research Implications

Although no statistically significant associations were identified, the relatively high proportion of workers reporting hearing complaints suggests that hearing health remains an important occupational issue among railway security personnel. These findings support continued implementation of hearing conservation programs, including periodic workplace noise monitoring, regular audiometric screening, worker education, engineering noise control, and promotion of appropriate hearing protection use. Such preventive strategies remain important regardless of the statistical significance observed in this relatively small study.

Study Limitation

Several limitations should be acknowledged when interpreting the findings. First, the relatively small sample size may have limited statistical power to detect modest associations between occupational factors and hearing loss. Second, the cross-sectional design precludes establishing temporal or causal relationships between workplace noise exposure and hearing impairment. Third, the study was conducted at a single railway station, which may limit the generalizability of the findings to other railway workplaces or occupational settings. Fourth, hearing loss was assessed using a questionnaire rather than objective audiometric examination, which may have resulted in misclassification of hearing status. Finally, several potentially important confounding variables, including smoking, prior ear disease, recreational noise exposure, ototoxic medication use, prior occupational noise exposure, and chronic medical conditions, were not measured or controlled for. Future multicenter prospective studies with larger sample sizes, objective audiometric assessments, and adjustment for relevant confounding factors are needed to better clarify the relationship between occupational noise exposure and hearing loss among railway workers.

CONCLUSION

Based on the findings of this study, no statistically significant associations were observed between occupational noise intensity, age, or length of service and hearing loss among security guards at Jatinegara Station. Although a higher proportion of hearing complaints was observed among workers exposed to noise levels ≥85 dB(A) and among those with longer employment, these differences represented only weak descriptive trends and should not be interpreted as evidence of an association. The findings should be interpreted cautiously because the study was limited by its small sample size, cross-sectional design, single-center setting, and the assessment of hearing loss using a subjective questionnaire rather than objective audiometric examination, which may have introduced selection and measurement bias. Nevertheless, the relatively high prevalence of hearing complaints highlights the importance of maintaining workplace hearing conservation measures, including noise monitoring, appropriate use of hearing protection devices, and periodic audiometric screening. Future longitudinal, multicenter studies with larger sample sizes, objective audiometric assessments, and adjustment for relevant confounding factors are needed to clarify the relationship between occupational noise exposure and hearing loss among railway workers.

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