

Workers' Characteristics of Hearing Loss at Soekarno-Hatta International Airport, Indonesia

Andrew Ebeneizer Timanta, Budi Haryanto, Ririn Arminsih Wulandari*

Department of Environmental Health, Faculty of Public Health, Universitas Indonesia, Depok, Indonesia

Abstract

This study aimed to analyze the characteristics and factors of worker behavior, including age, the use of ear protection, work duration, a history of diabetes mellitus or hypertension, work rotation, and noise hazards involved in hearing loss in PT. X at Soekarno-Hatta International Airport, Indonesia. A cross-sectional study from May 2017 to June 2017 involved 73 workers in the power service area (TZ Unit) exposed to noise levels <85 dBA and ≥85 dBA, using an audiometry test for hearing loss and Sound Level Meter for noise hazards was conducted. The Chi-square test showed a significant correlation between age (OR 8.4, 95% CI = 1.6–44.1), work duration (OR 7.6, 95% CI = 0.9–67.2), and the use of ear protection (OR 7.8, 95% CI = 1.4–44.2) with hearing loss in workers in the power service area. The multivariate analysis revealed that workers exposed to a noise level of 85 dBA had a 1.7 times greater risk of hearing loss than workers exposed to a noise level of <85 dBA after controlling for age, work duration, use of ear protection, medical history, and work rotation.

Keywords: airport, hearing loss, noise, workers

Introduction

Hearing loss incidence is a serious problem globally. In 2018, the World Health Organization suggested that more than 466 million people worldwide were living with disabling hearing loss.¹ It is estimated that the number will increase to 630 million by 2030 and surpass 900 million by 2050.² Among the regions, Southeast Asia had the second-largest number of people with moderate to profound hearing loss, with an estimated 103.4 million people in 2019.³ While, the estimated prevalence of hearing loss in Indonesia was 4.2%, affecting about 9 million people across all age groups.⁴

Loud noise is a physical pollutant that can become an environmental health problem and can cause health problems, especially hearing loss, if its intensity exceeds a threshold value.⁵ Loud noise negatively impacts industries and workers.⁶ The non-auditory noise impacts are stress, impaired communication, reduced concentration, and decreased work productivity.⁷ Hearing loss prevalence in the group of workers exposed to a noise level of >85 dBA was higher than in the general population.⁵ A study on the aircraft maintenance, repair, and overhaul (MRO) industry in Saudi Arabia showed that of the 200 workers exposed to noise levels of 89.3-93.4 dBA for 8 hours per day, 32.5% experienced hearing loss due to

the noise.⁸

Based on the Regulation of the Indonesian Ministry of Manpower and Transmigration No. PER.13/MEN/X/2011, a noise threshold value (NAV) is set to 1 to 8 hours daily for noise intensity between 85 and 94 dBA.⁹ However, one area where the threshold value is often exceeded is the airport area.¹⁰ PT. X at Soekarno Hatta International Airport, Indonesia, provides aircraft maintenance services for various types of airlines and is one of Asia's largest international aircraft maintenance facilities. It has four hangars with an area of 972,123 m². Aircraft maintenance services provided by PT. X include line maintenance, base maintenance, component maintenance, engineering service, material service, engine maintenance, and power service.

During aircraft maintenance, PT. X uses machines and mechanical equipment that produce noise with fairly high intensity. Previous measurements conducted by PT. X show that the power service area (TZ Unit) has the highest noise level compared with other work areas, which comes from work activities such as welding, dressing, machining lathe work, plasma coating, and indoor high-velocity oxygen fuel (HVOF) coating. If the noise intensity is not handled properly, it will pose a risk to human health (auditory or non-auditory disturbances).

Correspondence*: Ririn Arminsih Wulandari, Department of Environmental Health, Faculty of Public Health, Universitas Indonesia, Kampus UI Depok 16424, Depok City, Indonesia. E-mail: ririn.arminsih@gmail.com, Phone: +62 21-7863479

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Thus, this study aimed to analyze the characteristics and factors of worker behavior, such as age, the use of ear protection, work duration, a history of diabetes mellitus or hypertension, work rotation, involved in noise hazards with hearing loss in PT. X workers at Soekarno Hatta International Airport.

Method

This study used a cross-sectional quantitative method conducted at PT. X from May to June 2017. The criteria for workers to be included in this study were (a) working in the sample point production unit, (b) having a healthy physical condition, and (c) actively working at the time this research was conducted. Excluded from this study if the workers were (a) foreign employees or expatriates, (b) respondents who refused to be sampled, (c) respondents who were not working or who were on leave at the time the study was conducted, and (d) respondents who were not available at the time the study was conducted.

The study population consisted of all workers at PT. X in the power service area (TZ Unit), specifically in the office and non-office areas around the TZP-3 unit, totaling 78 people (morning and evening shifts). The number of samples in this study was determined based on the two-sided hypothesis formula for population proportions. However, only 73 people could be used as samples because five workers were absent. The participants who met the inclusion criteria were workers working in the sample point work area at PT. X. The TZ Unit was chosen because it has the highest noise level compared with other work areas at PT. X.

The noise intensity level was measured with a calibrated sound level meter (SLM) type SD-200 produced by 3M. The measurements were taken at 39 area points, of which 32 were non-office points, and 7 were points at the TZP-3 Unit office. Each point was measured for 10

minutes, automatically displaying the L equivalent result (average value) in dBA and providing information on the area’s minimum and maximum noise values.

The audiometric examination used a calibrated Interacoustics AD-226 audiometer. The measurements used the American National Standard Institute (ANSI) S3.1-1999 as a reference. In addition, the data collection about the influence of workers’ characteristics and behavior on the impact of noise was done by filling out a questionnaire based on a ten-minute interview held by the authors to obtain information/data from the participants. The attached data from the questionnaire includes age, the use of ear protection as personal protective equipment (PPE), work duration, history of diabetes mellitus (DM) or hypertension, and work rotation.

Results

Analysis showed no statistically significant correlation (p-value = 0.233) between a noise level of ≥85 dBA and hearing loss in workers. The odds ratio (OR) value showed that workers exposed to noise levels of <85 dBA had a 0.2 times greater risk of experiencing hearing loss than workers exposed to noise levels of ≥85 dBA. While, workers’ age and hearing loss showed a statistically significant correlation (p-value = 0.016). The OR value indicated that workers aged ≥40 years had an 8.4 times greater risk of experiencing hearing loss than workers aged <40 years.

Analysis of workers’ work duration and hearing loss showed a statistically significant correlation (p-value = 0.05) between the two variables. The OR value indicated that workers working for ≥4 years had a 7.6 times greater risk of experiencing hearing loss than those working for <4 years (Table 1). The frequency of using PPE showed a statistically significant correlation (p-value = 0.018) with hearing loss. The OR value showed that

Table 1. Characteristics, Noise Level, and Hearing Loss of Workers at PT. X

Variable	Category	Hearing Loss				Total	OR (95% CI)	p-value
		Yes		No				
		n	%	n	%			
Noise level	≥85 dBA	2	5.0	38	95.0	40	0.2 (0.1–1.6)	0.233
	<85 dBA	5	15.2	28	84.8			
Age	≥40 years	4	30.8	9	69.2	13	8.4 (1.6–44.1)	0.016
	<40 years	3	5.0	57	95.0	60		
Work duration	≥4 years	6	17.1	29	82.9	35	7.6 (0.9–77.2)	0.05
	<4 years	1	2.6	37	97.3	38		
Use of PPE	No	5	23.8	16	76.2	21	7.8 (1.4–44.2)	0.018
	Yes	2	3.8	50	96.2	52		
Work rotation	No	4	16.0	21	84.0	25	2.9 (0.6–14.0)	0.222
	Yes	3	6.3	45	93.8	48		
Record of DM and hypertension	Yes	2	40.0	3	60.0	5	8.4 (1.1–62.5)	0.069
	No	5	7.4	63	92.6	68		

Notes: OR = Odd Ratio, CI = Confidence Interval, PPE = Personal Protective Equipment, DM = Diabetes Mellitus

workers who did not wear ear PPE had a 7.8 times greater risk of experiencing hearing loss than workers who used PPE (Table 1).

The variables of work rotation and hearing loss showed no statistically significant correlation (p -value = 0.222) between each other. The OR value showed that workers who did not do job rotation had a 2.9 times greater risk of experiencing hearing loss than those who did (Table 1). Table 1 also shows no statistically significant correlation (p -value = 0.069) between a DM or hypertension history and hearing loss in workers. The OR value indicated that workers with a history of DM or hypertension had an 8.4 times greater risk of experiencing hearing loss than workers with no history of DM or hypertension.

Two methods were used to build a multivariate model. The first method was a scientific approach, and the second evaluated the p -values (<0.25). However, when the selection was made, a variable with a p -value of >0.25 will likely be filtered out of the multivariate model, although it could be that the variable interacts with the dependent variable. The multivariate model consisted of six independent variables: noise level, use of PPE, work duration, age, work rotation, and history of DM or hypertension.

The final analysis model (Table 2) contained two main independent variables: noise level and confounding variables, such as age, work duration, use of PPE, a history of DM or hypertension, and work rotation. After the final model was obtained, the interactions between the noise level and work rotation, the use of PPE and work duration, and work rotation and the use of PPE were analyzed.

These analyses were done because these variables may interact, but after analyzing the model, it was found that they had no interactions. The analysis results revealed that workers who worked in areas with noise levels of ≥ 85 dBA had a 1.7 times greater risk of experiencing hearing loss than those who worked in areas with noise levels of <85 dBA, after controlling for age, work duration, use of PPE, a record of DM or hypertension, and work rotation.

Discussion

Noise and Hearing Loss

The results showed no significant correlation between noise level and hearing loss. The results also revealed that 71.2% of workers in the Power Service Area used PPE during work, meaning that many, but not all, workers were aware that protecting themselves from noise hazards is important. Based on observations, the workers were informed about health and safety every day before work started. This habit was useful in increasing workers' knowledge of various hazards in the workplace, including the dangers of noise. Therefore, workers became well-ed-

Table 2. Final Model

Independent Variable	OR	95% CI	p-value
Noise level	1.7	0.1–21.5	0.701
Use of PPE	4.8	0.4–61.5	0.228
Work duration	4.2	0.4–47.9	0.246
Age	3.4	0.5–39.2	0.333
Work rotation	3.5	0.5–24.4	0.2
Record of DM or hypertension	1.1	0.1–17.8	0.973

Notes: OR = Odd Ratio, CI = Confidence Interval, PPE = Personal Protective Equipment, DM = Diabetes Mellitus

ucated and aware of using PPE to minimize noise hazards. The PPE used in the Power Service Area was the 3M Ultrafit Earplug, with a noise reduction of up to 25 dBA when used according to the instructions. In addition to earplugs, the 3M Optime 105 Earmuffs, with a noise reduction of up to 30 dBA, were used as instructed.

Age and Hearing Loss

The analysis results showed that the average age of workers in the PT. X Power Service Area in the TZP-3 Unit was 29.5 years. In addition to a significant correlation between age and hearing loss, the OR value indicated that workers in the Power Service Area aged ≥ 40 years had an 8.4 times greater risk of experiencing hearing loss than workers aged <40 years. This result was in line with a study on the metal workshop, which showed a significantly higher risk of hearing loss among workers aged 45–66 years (AOR = 3.8; 95% CI = 1.5–9.5) compared to workers less than 30 years old.¹¹ Further, a study in the palm oil mills also showed that older age is a significant factor associated with hearing loss among noise-exposed workers (p -value = 0.001).¹²

In addition, hearing function will gradually and progressively decline with age. A study by the Indonesian Ministry of Health stated that people aged ≥ 40 years are more susceptible to hearing loss due to noise because of the gradual and progressive age-related decline in hearing function.¹³ It is known from the previous study by Wattamwar, *et al.*, that hearing loss naturally occurs with the increase of age due to a worsening in the hearing threshold.¹⁴

As age increases and cannot be controlled, a set retirement age limit is necessary. As regulated in the Regulation of the Minister of Manpower and Transmigration Number 29 of 2015, the retirement age was 57 years in 2015.¹⁵ With this age limit, workers who have reached retirement age and experience much physical decline no longer have to be exposed to physical and mental harmful environmental conditions and can enjoy old age with the social security that the company pro-

vides.¹⁶

Work Duration and Hearing Loss

This study's results showed that of the 73 respondents, 38 people (52.1%) have worked in the Power Service Area for less than four years, and 35 people (47.9%) for more than four years. In addition to a significant correlation between work duration and hearing loss, the OR value indicated that workers in the power service area with a work duration of ≥ 4 years had a 7.6 times greater risk of experiencing hearing loss than workers with a work duration of < 4 years. This result was in line with a study on workers at a textile mill in Myanmar, which showed a significantly higher risk (OR = 6.07; 95% CI = 2.9–12.3) on workers with longer work duration.¹⁷ A study of Malaysian airport also showed a significant correlation between a work duration of more than four years and hearing loss (OR = 2.1; 95% CI = 1.4–4.7).¹⁸

According to the Encyclopedia of Occupational Health & Safety, hearing loss due to noise will be seen in a person after working in a noisy environment for approximately 3-4 years.¹⁸ Another study also explains that long working hours in noisy places, such as airports, seaports, and construction sites, lead to a high risk of hearing loss after working for 2-4 years.¹⁰ The longer the working period, the greater the risk of hearing loss.

Most employees (52.1%) working for less than four years were mechanics with an outsourcing status, who most likely would move jobs when their contract expired; therefore, the turnover rate for new workers was relatively high. They worked in the power service area for about 1 to 9 months. On the other hand, some workers were known to have worked for > 10 years because most PT. X employees used to work for the parent company of PT. X.

Use of Personal Protective Equipment and Hearing Loss

Of the 73 respondents, 52 (71.2%) used PPE during work, and 21 (28.8%) did not. Some employees worked indoors or in the office, so PPE was not mandatory for them. However, based on observations, many employees did not use PPE when they went to the field or noisy areas because they stayed there for only a short time (15-30 minutes). The statistical analysis results showed a statistically significant correlation between the frequency of using PPE and hearing loss in workers. A previous study supports this result, showing a correlation between industrial workers exposed to noise but did not use PPE and hearing loss (p-value = 0.002).¹⁹ Also, this study revealed that workers who did not use PPE had a 3.35 times greater hearing loss risk than those who did. A study by Puspitasari, too, showed that people who did not use PPE at work were 2.27 times more likely to de-

velop hearing loss than those who did.²⁰

In addition to a significant correlation between the use of PPE and hearing loss, the OR value indicated that workers in the power service area who did not wear PPE had a 7.8 times greater risk of experiencing hearing loss than those who did. Regarding the type of ear protection used in the power service area, 54.8% of workers used earplugs, and 16.4% used earplugs and earmuffs. Many workers use earplugs because, technically, earplugs are used in places with low-frequency noise, such as welding and dressing work areas. Earplugs are made from various materials, such as PVC foam, polyurethane, polyethylene, and silicone.²¹ Functionally, earplugs can reduce noise by 8-30 dBA and are used for ear protection at noise levels of up to 100 dBA.²¹

PPE replacement in PT. X has not been mandated. Hence, the workers must wait for new PPE until it is damaged or lost. However, 32.1% of workers replaced their PPE every month by themselves, and 30.2% used their PPE until it was damaged, after which they returned it. Ideally, the power service area earplugs should be replaced every 2-3 months, depending on the type and environment.^{22,23} Earplugs should be replaced immediately if they shrink, enlarge, harden, weaken, or tear.²⁴ Ideally, earmuffs should be replaced at least once a year or when the earmuffs have become stiff and cracked.²⁴

Based on observations, many earplugs were often lost in the power service area, so workers often replaced them within one month. PPE can be damaged over time, especially the seal section. It will harden and not function effectively, thus not protecting the hearing organ optimally from noise. Integrated health care should be available not only in occupational situations but also in environmental health settings.²⁵

Conclusion

There was a significant correlation between age, work duration, and the use of ear protection devices (PPE) with hearing loss in workers in the power service area. Workers exposed to a noise level of ≥ 85 dBA had a 1.7 times greater risk of hearing loss than workers exposed to a < 85 dBA after controlling for age, work duration, use of PPE, medical record, and job rotation.

Abbreviations

MRO: Maintenance, Repair, and Overhaul; PPE: Personal Protective Equipment; DM: Diabetes Mellitus.

Ethics Approval and Consent to Participate

The study was conducted following the Declaration of Helsinki and approved by the Ethics Commission for Health Research, Faculty of Public Health, Universitas Indonesia (license Number 280/UN2.F10/PPM.00.02/2017 obtained from the institution for the research project).

Competing Interest

The authors declare that there are no significant competing financial, professional, or personal interests that might have affected the performance or presentation of the work described in this manuscript.

Availability of Data and Materials

Data and information used as study materials can be obtained from the corresponding author upon reasonable request.

Authors' Contribution

RAW was responsible for creating the ideas, conducting the analysis, and preparing the manuscript. AET performed the formal analysis, conducted the investigation, interpreted the results, and wrote the original draft. BH supervised the study, wrote the review, and edited the text. All authors were involved in conceptualization, methodology, software, validation, resources, data curation, review writing, and editing. All authors have made substantial contributions to the final manuscript for publication.

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References

- World Health Organization. Addressing The Rising Prevalence of Hearing Loss. Geneva: World Health Organization; 2018.
- Olusanya BO, Davis AC, Hoffman HJ. Hearing loss: Rising prevalence and impact. *Bull World Health Organ.* 2019; 97 (10): 646-646A. DOI: 10.2471/BLT.19.224683
- Haile LM, Kamenov K, Briant PS, et al. Hearing loss prevalence and years lived with disability, 1990-2019: Findings from the Global Burden of Disease Study 2019. *The Lancet.* 2021; 397 (10278): 996–1009. DOI: 10.1016/S0140-6736(21)00516-X
- Anggraeni R, Carosone-Link P, Djelantik B, et al. Otitis media related hearing loss in Indonesian school children. *Int J Pediatr Otorhinol.* 2019; 125: 44–50. DOI: 10.1016/j.ijporl.2019.06.019
- Chen KH, Su SB, Chen KT. An overview of occupational noise-induced hearing loss among workers: Epidemiology, pathogenesis, and preventive measures. *Environ Health Prev Med.* 2020; 25: 65. DOI: 10.1186/s12199-020-00906-0
- Marisdayana R, Suhartono S, Nurjazuli N. Hubungan Intensitas Paparan Bising Dan Masa Kerja Dengan Gangguan Pendengaran Pada Karyawan PT. X. *J Kesehat Lingkung Indonesia.* 2016; 15 (1): 22-27. DOI: 10.14710/jkli.15.1.22-27
- Occupational Health and Safety Administration. Occupational Noise Exposure: Hearing Conservation Program. Washington, DC: United States Department of Labor; 2008.
- Noweir M, Zytoon M. Occupational exposure to noise and hearing thresholds among civilian aircraft maintenance workers. *Int J Ind Ergon.* 2013; 43 (6): 495-502. DOI: 10.1016/j.ergon.2013.04.001
- Menteri Tenaga Kerja dan Transmigrasi Republik Indonesia. Peraturan Menaker Nomor PER.13/MEN/X/2011 tentang Nilai Ambang Batas Faktor Fisika Dan Faktor Kimia Di Tempat Kerja. Jakarta: Kementerian Tenaga Kerja dan Transmigrasi Republik Indonesia; 2011.
- Mitaran P. Tingkat Kebisingan dan Gangguan Pendengaran pada Pekerja di Pelabuhan Udara El Tari Kupang 2016 [Thesis]. Depok: Universitas Indonesia; 2017, 89 p.
- Melese M, Adugna DG, Mulat B, Adera A. Hearing loss and its associated factors among metal workshop workers at Gondar city, Northwest Ethiopia. *Front Public Health.* 2022; 10. DOI: 10.3389/fpubh.2022.919239
- Rasasoran DR, Atil A, Jeffree MS, et al. Hearing loss and associated factors among noise-exposed workers in palm oil mills. *Risk Manag Healthc Policy.* 2021; 14: 3653–3658. DOI: 10.2147/RMHP.S319858
- Achmadi, UF. Upaya Kesehatan Kerja Sektor Informal di Indonesia. Jakarta: Kementerian Kesehatan Republik Indonesia; 2013.
- Wattamwar K, Qian ZJ, Otter J, et al. Increases in the Rate of Age-Related Hearing Loss in the Older Old. *JAMA Otolaryngol–Head Neck Surg.* 2017; 143 (1): 41–45. DOI: 10.1001/jamaoto.2016.2661
- Menteri Ketenagakerjaan Republik Indonesia. Peraturan Menteri Ketenagakerjaan Nomor 29 Tahun 2015 tentang Cara Pendaftaran Kepesertaan, Pembayaran, dan Penghentian Manfaat Jaminan Pensiun. Jakarta: Kementerian Ketenagakerjaan Republik Indonesia; 2015.
- Davies EMM, Van der Heijden BIJM, Flynn M. Job satisfaction, retirement attitude and intended retirement age: A conditional process analysis across workers' level of household income. *Front Psychol.* 2017; 8. DOI: 10.3389/fpsyg.2017.00891
- Zaw AK, Myat AM, Thandar M, et al. Assessment of Noise Exposure and Hearing Loss Among Workers in Textile Mill (Thamine), Myanmar: A Cross-Sectional Study. *Safety Health Work.* 2020; 11 (2): 199–206. DOI: 10.1016/j.shaw.2020.04.002
- Occupational Health and Safety Administration. Occupational Noise Exposure: Overview. Washington, DC: United States Department of Labor; 2008.
- Rinawati S, Utari S, Sumardiyono. Perbedaan Gangguan Pendengaran Pekerja Terpapar Bising Industri Di Surakarta Antara Pekerja Memakai Alat Pelindung Telinga Dan Pekerja Tidak Memakai Alat Pelindung Telinga. Purwokerto: Universitas Muhammadiyah Purwokerto; 2015.
- Puspitasari I. Studi Aplikasi Alat Pelindung Diri sebagai Faktor Risiko Gangguan Pendengaran Karyawan Unit Produksi PT. Semen Tonasa [Thesis]. Makassar: Hasanuddin University; 2014.
- Tambunan STB. Kebisingan di Tempat Kerja (Occupational Noise). 1st ed. Yogyakarta: Andi Offset; 2005.
- Kamal AA, Junaini SN, Hashim AH, et al. The enhancement of OSH training with an augmented reality-based App. *Int J Onl Eng.* 2021; 17 (13): 120-134. DOI: 10.3991/ijoe.v17i13.24517
- Hatzigiannakoglou PD, Okalidou A. Development of an auditory rehabilitation tool for children with cochlear implants through a mobile-based VR and AR serious game. *Int J Onl Eng.* 2019; 15 (02): 81-90. DOI: 10.3991/ijoe.v15i02.9709
- Forouharmajd F, Nazaryan K, Fuente A, et al. The Efficiency of Hearing Protective Devices against Occupational Low Frequency Noise in Comparison to the New Subjective Suggested Method. *Int J Prev Med.* 2022; 13: 143. DOI: 10.4103/ijpvm.IJPVM_700_20

25. Sulistiadi W, Nurhidayah S, Asyary A. Evaluating the Management Information System of Integrated Medical Emergency Care in Batang

Regency, Indonesia. *Int. J. Onl. Eng.* 2020; 16 (07): 75-85.
DOI: 10.3991/ijoe.v16i08.14725