IJCOM 2024 March;3(3):150-4

Analysis between Demographic Factors, Chronic Conditions and Its Association with Increased Hearing Threshold On Factory Workers Exposed to Noise: A Cross Sectional Study in 2022

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Abstract

Background: Exposure to noise in workplace is the leading cause of increased hearing threshold and hearing loss among factory workers. There are other factors other than noise than can cause increased hearing threshold such as age, length of work, history of hypertension, diabetes, dyslipidemia, Body Mass Index and smoking habit. PT K is a company that produce heavy machinery parts for construction where workers are exposed to noise above Threshold Limit Value (TLV).
Methods: A cross-sectional research of 965 employees was conducted after passing the ethical evaluation based on the 2022 medical check-up results. Samples were taken from total secondary data from the company's medical records and data verification was done to eliminate duplication and confirm data validity. Univariate, chi-square for bivariate analyses were performed.
Result: The prevalence of increased hearing threshold among workers is 39.6%. The factors that associated with the prevalence of increased hearing threshold were determined to be older age group (p<0.001), history hypertension (p=0.003), dyslipidemia (p=0.008) and overweight – obese Body Mass Index (p=0.002).
Conclusion: Older age group, length of work, works departments, history of high blood pressure, dyslipidemia and overweight – obese Body Mass Index were significant risk factors associated with increased hearing threshold. The risk of increased hearing threshold is 3.2 times higher in workers above 36 years old. This indicate the importance of preparing better mitigation strategy of noise control and hearing conservation program, particularly in workers older than 36 years old.
Keywords: increased, hearing, threshold, noise, factory, workers

Abstrak

Latar belakang: *Paparan kebisingan di tempat kerja merupakan penyebab utama peningkatan ambang pendengaran dan gangguan pendengaran yang meningkat di antara pekerja pabrik. Ada faktor-faktor lain selain kebisingan yang dapat menyebabkan peningkatan ambang pendengaran, seperti usia, lamanya bekerja, riwayat hipertensi, diabetes, dislipidemia, Indeks Massa Tubuh (IMT), dan kebiasaan merokok. PT K adalah perusahaan yang memproduksi suku cadang mesin berat untuk konstruksi di mana para pekerja terpapar kebisingan di atas Nilai Batas Ambang (TLV).*
Metode: *Penelitian potong lintang dilakukan terhadap 965 karyawan setelah melewati evaluasi etika berdasarkan hasil pemeriksaan medis tahun 2022. Sampel diambil dari data sekunder total dari catatan medis perusahaan dan verifikasi data dilakukan untuk menghilangkan duplikasi dan mengonfirmasi validitas data. Analisis univariat, chi-square untuk analisis bivariat dilakukan.*
Hasil: *Prevalensi peningkatan ambang pendengaran di antara pekerja adalah 39,6%. Faktor-faktor yang berhubungan dengan prevalensi peningkatan ambang pendengaran ditentukan sebagai kelompok usia yang lebih tua (p<0,001), riwayat hipertensi (p=0,003), dislipidemia (p=0,008), dan Indeks Massa Tubuh overweight–obesitas (p=0,002).*
Kesimpulan: *Kelompok usia yang lebih tua, lamanya bekerja, departemen kerja, riwayat tekanan darah tinggi, dislipidemia, dan Indeks Massa Tubuh overweight–obesitas merupakan faktor risiko yang signifikan terkait dengan peningkatan ambang pendengaran. Risiko peningkatan ambang pendengaran 3,2 kali lebih tinggi pada pekerja yang berusia di atas 36 tahun. Hal ini menunjukkan pentingnya menyiapkan strategi mitigasi kebisingan yang lebih baik dan program pelestarian pendengaran, khususnya pada pekerja yang berusia di atas 36 tahu*n.
Kata kunci: *peningkatan, pendengaran, ambang batas, kebisingan, pabrik, pekerja*

Introduction

Noise is an unwanted sound or loud discordant or disagreeable sound or sounds. It can cause health issue such as hearing loss that can be permanent or irreversible.[1] Noise in the workplace is one of the most common cause of hearing loss in adult. About 16% of hearing loss cases were caused by exposure to noise in the workplace.[2,3] Based on the data from Occupational Health and Safety Administration (OSHA), there's around 5 – 10 million American citizens who's at risk for Noise Induced Hearing Loss (NIHL) due to noise exposure which above the Threshold Limit Value (TLV) in the workplace. On 2018, WHO stated that noise in the workplace is the second most common cause of hearing loss in the workplace and contributed up to 22% of health issues in the workplace. Hearing loss usually started as increased hearing threshold that gets worse overtime.[4] Based on several studies, there are several other factor that can cause hearing loss. Those factors were age, length of work, history of hypertension, history of diabetes, history of dyslipidemia, obesity and smoking habit.[5-10] As one of the leading company that produce parts for heavy machinery that used for construction located in Jakarta, PT K is obliged to maintain a safe workplace and maintain the health of workers.

Noise is one of the hazards that can be found in most of the production process in company K.

This research was conducted to describe the prevalence of increased hearing threshold in workers at company K and to analyze its association with several factors that may influence it, as well as to provide input to the company, workers and public on how to manage or prevent increased hearing threshold which may lead to hearing loss in the future. This research emphasizes in analyzing those factors in young workers that usually weren't included in this type of study, which involves factors such as chronic conditions e.g. hypertension, diabetes and dyslipidemia.

Method

This study was cross-sectional design and conducted at company K which located in Jakarta, Indonesia after obtaining permission from the ethical commission department from the medical faculty of University of Indonesia and Cipto Mangunkusumo Hospital. To calculate the sample size using the proportion comparison sample size formula, the number of samples needed was 67 people. Samples were taken from the company's total secondary medical record data based on the Medical Check Up results in 2022. There's a total of 965 workers from 4 different works departments that underwent the medical check-up process in 2022. All of 965 workers medical check-up data were used in this study. Increased hearing threshold was defined as increased threshold in audiometry examination ≥25dbA and/or increased threshold on ≥4000Hz frequency.

This study associated the prevalence of increased hearing threshold with several risk factors such as: age group (below and above 36 years old), length of work, history of hypertension, history of diabetes, history of dyslipidemia, Body Mass Index and smoking habit. Data verification had been carried out to avoid data duplication. Data analysis was performed using the chi square test and continued using logistic regression statistical methods.

Result

The study collected 965 subjects with all variables filled in completely. Most of the workers belong to <36 years age group (55.02%). The average length of work for workers is 14.84 years and the prevalence of increased hearing threshold is 39.6%. Complete data can be seen on the table 1 below.

From the bivariate analysis it was found that the factors associated increased hearing threshold were age group, length of work, works departments, history of hypertension, history of dyslipidemia and Body Mass Index. Based on the analysis, age is the most significant factor that contributes to increased hearing threshold. Workers in the >36 years old age group has 3.2 times higher risk of experiencing increased hearing threshold compared to the <36 years old age group. The result of complete bivariate analysis can be seen on Table 2 below.

Discussion

This study found that the majority of workers were below 36 years old (72.7%), worked for less than 13

Table 1. Characteristics of the subjects (n=965)

Variable	n	%
Age (median, min-max)	40 (19 – 55)	
> 36 years old	434	44.98
< 36 years old	531	55.02
Length of work (median, min-max)	17 (1 – 34)	
>13 years	452	46.84
<13 years	513	53.16
Increased Hearing Threshold		
Yes	382	39.6
No	583	60.4
Department		
Quality assurance	63	6.5
Remanufacturing	245	25.4
Construction & Hydraulic Remanufacturing	433	44.9
Foundry	224	23.2
History of Hypertension		
Yes	88	9.12
No	877	90.88
History of Diabetes		
Yes	99	10.26
No	866	89.74
History of Dyslipidemia		
Yes	437	45.28
No	528	54.72
Body Mass Index		
Overweight – Obese	458	47.46
Underweight – Normoweight	507	52.54
Smoking Habit		
Yes	633	65.6
No	332	34.4

years (71%), worked for Construction & Hydraulic Remanufacturing department (44.9%), didn't have increased hearing threshold (60.4%), without history of hypertension (90.88%), neither diabetes (89.74%) nor dyslipidemia (54.72%). Most of them were also under the BMI category of underweight – normoweight (52.54%) and smokers (65.6%).

Based on the analysis, it was determined that age has a strong association with increased hearing threshold among workers. In this case, workers who's older than 36 years old has 3.2 times greater risk of increased hearing threshold. Length of work also is one of the factors that has a very strong association with increased hearing threshold. Workers who worked for more than 13 years in this company has 2.5-fold higher risk of increased hearing threshold. These data are slightly different with numerous studies and literatures which stated that age older than 40 years old and length of work more than 10 years were risk factors for increased hearing threshold in workers exposed to noise above TLV which shown in studies from Semarang and Samarinda that involved workers from power plant and rubber processing factory.[11,12] As workers get older, degenerative process will affect the hearing and if they got exposed to noise above the TLV in the workplace for more than 10 years, the accumulation of it will increase the likelihood of increased hearing threshold.

From the result of the analysis, it was found that the works departments also affect the chance of workers of having increased hearing threshold. Workers from

Table 2. Factors associated with increased hearing threshold

Risk factors		Increased hearing threshold				Total	p-value	OR (CI 95%)
		Yes		No				
		n	%	n	%			
Age group	>36 years old	237	54.6	197	45.4	434	<0.001	3.203 (2.448 – 4.189)
	<36 years old	145	27.3	386	72.7	531		
Length of work	> 13 years	233	51.5	219	48.5	452	<0.001	2.599 (1.994 – 3.389)
	< 13 years	149	29	364	71	220		
Works Departments	Construction & Hydraulic Remanufacturing	192	44.3	241	55.7	431	0.009	2.156 (1.198 – 3.880)
	Foundry	83	37.1	141	62.9	224		1.593 (0.858 – 2.958)
	Remanufacturing	90	36.7	155	63.3	245		1.571 (0.850 – 2.903)
	Quality Assurance	17	27	46	73	63		Reff
Hypertension	Yes	48	54.5	40	45.5	88	0.003	1.951 (1.255 – 3.033)
	No	334	38.1	543	61.9	877		
Diabetes	Yes	44	44.4	55	55.6	99	0.297	1.250 (0.822 – 1.901)
	No	338	39.0	528	61.0	866		
Dyslipidemia	Yes	193	44.2	244	55.8	437	0.008	1.419 (1.095 – 1.839)
	No	189	35.8	339	64.2	528		
Body Mass Index	Overweight – Obese	205	44.8	253	55.2	458	0.002	1.511 (1.166 – 1.958)
	Underweight – Normoweight	177	34.9	330	65.1	507		
Smoking habit	Yes	142	42.8	190	57.2	332	0.143	1.224 (0.934 – 1.604)
	No	240	37.9	393	62.1	633		

Construction and Hydraulic Remanufacturing with 119.6 dBA noise exposure has 2.1 times higher risk of having increased hearing threshold compared to workers from Quality Assurance with 91 dBA noise exposure. On the contrary, workers from Foundry department with 126.4 dBA noise exposure has 1.5 times higher risk compared to the Quality Assurance department. In this company, Foundry department has the highest noise exposure level compared to the other department. Therefore, it is more likely that the workers have more awareness regarding the noise hazard in the workplace and more likely to comply with the safety protocol related to the hearing conservation program such as better compliance in wearing Personal Protective Equipment which resulted in smaller proportion of workers from Foundry department that had increased hearing loss compared to the Construction and Hydraulic Remanufacturing department.

The analysis also revealed a significant association between history of hypertension, dyslipidemia and overweight – obese BMI with increased hearing threshold. Though there's only small empirical evidence that supported direct relationship between hypertension, dyslipidemia and overweight – obese BMI with increased hearing threshold, previous studies had shown similar results regarding those risk factors.[5,8,9,13,14] The degeneration in the cochlear blood vessels is the mechanism that associated with the risk factors mentioned above.

Conclusion

Overall in 2022, the prevalence of increased hearing threshold in factory workers was high at 39.6%. The factors associated with the prevalence of increased hearing threshold were determined to be age group above 36 years old, works department, length of work more than 13 years, history of hypertension, dyslipidemia and overweight – obese Body Mass Index.

Above 36 years old age group was the most significant risk factor associated with increased hearing threshold.

These data indicate the importance of improving the strategy and implementation of hearing conservation program and risk factor management particularly for factory workers who's exposed to noise above TLV on a daily basis. Several recommendations for companies are (1) to follow up workers that has increased hearing threshold to get further examination by ENT specialist if needed, especially workers who's older than 36 years old, have worked for more than 13 years, have history of hypertension, dyslipidemia and overweight – obese Body Mass Index; (2) Create a special task force for wellness program in order to closely monitor the condition of workers with risk factors and ensure that those risk factors are well managed; (3) Review the implementation of hearing conservation program especially in the Construction & Hydraulic Remanufacturing. Several recommendations for workers are (1) avoid using earphone with loud volume for extended period; (2) always comply with the work protocol and hearing conservation program provided by the company for each workplace.

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