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by Budi Utomo .

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Hearing screening using distortion product otoacoustic emission(DPOAE) in high-risk employees of an Indonesian hospital

Serafiki Permoni Putri Manyakori¹, Nyilo Purnami^{1*}, Budi Utomo²

¹Otorhinolaryngology, Head and Neck Surgery, Faculty of Medicine, Universitas Airlangga –Dr. Soetomo Hospital Surabaya, East Java, Indonesia

²Public Health – Preventive Medicine, Faculty of Medicine, Universitas Airlangga, Surabaya, East Java, Indonesia

Corresponding author: Nyilo Purnami

Otorhinolaryngology, Head and Neck Surgery, Faculty of Medicine, Universitas Airlangga –Dr. Soetomo Hospital Surabaya, East Java, Indonesia

Campus A, Jl. Mayjen. Prof. Dr. Moestopo 47, Surabaya East Java Indonesia– postal code: 60132 Indonesia

*Email: nyilo@fk.unair.ac.id

Abstract. Noises in hospitals cause noise-induced hearing loss in the employees. The standard diagnostic is audiometry to determine the hearing level. Distortion product otoacoustic emission (DPOAE) is a potential screening tool for cochlear problems. Noise exposure can be found not only in industrial areas but also in hospitals. This study aims to hear conservations to control the risk factors by doing noise measurement using the sound level meter. The design of this study was an analytic observational study with the cross-sectional design where measurements were made of intensity and noise dose in 3 installations, namely medical facilities maintenance (MFM), sanitation, and nutrition. Fifty-six subjects underwent tympanometry to exclude conductive hearing loss, resulting in a total of 48 subjects who fit the inclusion criteria. The correlation between examination results and age, work station, and working duration were analyzed by using the Spearman correlation test ($p < 0.05$). The correlation between noise dose, intensity, and hearing status, however, were analyzed by using Fischer test ($p < 0.05$). The result showed the average noise intensity at MFM was 95.83 dBA, at the nutrition installation was 99.07 dBA, and at the sanitation installation was 105.5 dBA. Meanwhile, the average noise dose at MFM was 674.25%, at nutrition was 1632.5%, and at sanitation was 8977.75%. Abnormal audiometry was 50% and DPOAE refer 77.083%. Thus, it can be argued that there was a significant correlation between the work station and DPOAE ($p = 0.0184$). There was also a correlation between noise intensity and hearing loss, while no significant differences were discovered between DPOAE and audiometry.

Keywords: Hearing screening; distortion product otoacoustic emission; audiometry

1. Introduction

Noise is an unwanted sound that gives negative impacts on human health, and it can trigger noise-induced hearing loss (hereafter, NIHL). Audiogram notch at 4,000 Hz is pathognomonic for NIHL, firstly found by Fowler in 1939 [1]. WHO data reported 16% of adults to suffer from hearing impairment due to noise exposure at work, which number will rise especially in developing countries [2].

Noises source are not only found in industrial areas but also hospitals. A hospital is a health provider for the public that must also provide the health of its employees. There are three installations in General Hospital Dr. Soetomo in Surabaya, Indonesia, with the intensity of > 85 dB, namely medical facilities maintenance (hereafter, MFM), sanitation installation, and nutrition

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installation. According to the Minister of Health of the Republic of Indonesia Regulation No. 48 of 2016 on the Standards of Occupational Safety and Health in the Workplace, noise is considered as the potential physical danger to employees that can cause hearing loss. Thus, efforts to control risk factors, early disease cases, disease management, and health recovery for employees are needed [3].

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Based on the background, therefore, this study aims to hear conservations to control the risk factors by doing noise measurement using a sound level meter. Distortion product otoacoustic emission (hereafter, DPOAE) plays a significant role in NIHL screening, besides being able to interpret the hair cell response in two different frequencies [4]. Permissible noise dose exposure could be analyzed more precisely, especially in noise-exposed employees in more than one source in a certain period [5].

2. Material and methods

This study was an analytic observational study with a cross-sectional design. The subjects were high-risk employees in General Hospital Dr. Soetomo Surabaya, Indonesia, who met the inclusion criteria, such as being exposed to >85 dB noise intensity at the specified three installations, willing to undergo several examinations, and filling out the consent form. Meanwhile, the exclusion criteria covered the presence of any conductive or mix type of hearing loss from audiometry, common cold, allergic rhinitis, nasal polyp, and the history of using ototoxic drugs. Initially, there were 56 subjects; however, only 48 subjects fit the criteria – nine subjects from MFM installation, seven subjects from sanitation installation, and 32 subjects from nutrition installation.

Noise intensity measurement and exposure were carried out by utilizing a sound level meter performed by several students from Physical Engineering Program Study of Sepuluh Nopember Institute of Technology, Surabaya, for two days (April 12 – April 13, 2017). Furthermore, the data was obtained using a sound level meter digital with standing mic in front of the noise source with distance ±120 cm from the ground. The measurement was held for 24 hours with a 4-level equivalent (Leq) in the afternoon and 3 Leqs in the night at several spots. The data was collected for 10 minutes for every Leq with data clipping for every 5 seconds by using Realtime Analyzer software. Thus, in 10 minutes, 120 data could be obtained. Data collected twice in two days for accuracy.

The examination processes included history taking, ENT-KL physical examination, tympanometry examination, audiometry examination, and DPOAE. The results of DPOAE were in the monitor, pass for normal and refer to abnormal hearing function. The statistical analysis of the correlation between the examination results and age, working station, and working duration was completed by using the Spearman correlation test ($p < 0.05$). The analysis of the correlation between noise dose, noise intensity, and hearing level further performed by using the Fisher test ($p < 0.05$).

This study had been conducted from April 1 to April 30, 2017, with the ethical clearance according to the ethical committee of General Hospital Dr. Soetomo Surabaya.

3. Results

From a total of 48 participants, more than half of them were women (58.33%). The educational attainment of most respondents was high school (81.25%), and worked in the nutrition installation (68.75%) by the time this study was carried out. Moreover, the data indicated that the average age of the respondents was 42.43 ± 10.72 in the age range of 22-58 years old, while the average working duration was 19.54 ± 9.56 years in the 1-36 year periods. The average noise intensities showed the numbers of 105.5 dBA at sanitation installation, 95.83 dBA at MFM installation, and 99.07 dBA at nutrition installation. Meanwhile, the average noise doses were 8977.75% at sanitation installation, 674.25% at MFM installation, and 1632.5% at nutrition installation (Table 1).

Table 1. Noise Record from Three Installations

No	Location	Machine	Leq (dB)	Duration (hours)		Dose (%)
			Average	Reference	Real-time	
1.	Workshop	Gerinda	102.04	0.17	2	1 263
		“Bubut”	88.66	3.56	4	116
2.	Incinerator	Incinerator	101.33	0.19	2	1 074
		Driller	112.90	0.01		

3.	Water Pump	inside	103.98	0.10	10	9 877
		outside	103.82	0.11		9 529
4.	Boiler	inside	96.45	0.59	7	1 222
		outside	85.39	7.48		96
5.	Kitchen	stove 1	99.07	0.33	8.5	2 714
		blower 1				
		blower 2				
		washer				

From the anamnesis and physical examinations, it can be noticed that three subjects from nutrition installation suffered from a common cold. From the tympanometry examination, there were five results type B: one subject from the sanitation installation, two subjects from MFM installation, and two subjects from nutrition installation.

Further results indicated that NIHL with a peak in high frequencies of 4,000 Hz and 6,000 Hz was found in 16 subjects: two subjects from sanitation installation (12.5%), five subjects from MFM installation (31.25%) and nine subjects from nutrition installation (56.25%). Audiometry with normal level (<25dB), mild level (26-40dB), and moderate level (41-55 dB) was discovered in six subjects, six subjects, and four subjects, respectively. Normal audiometry was further found in 24 participants: five of sanitation installation (20.83%), one of MFM installation (4.16%), and 18 of nutrition installation (75.01%). Neural sensory audiometry was found in the remaining eight subjects, namely three participants of MFM installation (37.5%) and five of nutrition installation (62.5%).

DPOAE results referred in one/two ears in 37 respondents (77.083%), including 9 respondents from sanitation installation (24.32%), 6 respondents from MFM installation (16.21%), and 22 respondents from nutrition installation (59.47%). Furthermore, at sanitation installation, three subjects referred DPOAE in both ears, three subjects referred in one ear, and one subject passed both ears. At MFM installation, additionally, seven subjects referred DPOAE in both ears, two subjects referred in one ear, and no subject passed. Seventeen participants at nutrition installation, moreover, referred DPOAE in both ears, while five participants referred in one ear, and ten subjects passed.

4. Discussion

In other words, it can be argued that there was a significant correlation between the work station and the DPOAE referred ($p = 0.0184$), in addition to a correlation between noise intensity and hearing level ($p = 0.0242$). Noise exposure allowed is 85dBA in 8 hours straight. Meanwhile, all measurements showed a noise intensity of >85dB, which according to the rule, it was a high potential for causing NIHL. Several methods were found to diagnose NIHL. The standard examination, according to the hearing conservation program, however, was audiometry.

There are many studies agreed that OAE, as a diagnostic tool, is better in assessing how middle ear function to noise exposure besides its usage as a screening tool NIHL [6,7]. Moepeng in 2016 conducted a study about DPOAE applicability as a screening tool for the cochlear problem after noise exposure. The result revealed that DPOAE was sensitive in detected cochlear problems in NIHL. Moreover, DPOAE was found easy to use, cheap, and did not need an examination chamber [8]. Shupak et al., in 2007 carried out a study in naval Israel, which at the beginning of training, they performed audiometry, TEOAE, and DPOAE to obtain the initial data and two more examinations in the following 5 years as the evaluation. The final results disclosed that DPOAE had no significant correlation with pure tone audiometry and that it could not be used as an objective tool to determine hearing level changes in early NIHL [9]. However, in this study, there were some limitations, including no differentiation of the working period and the use of a hearing protector for each employee.

6. Conclusion

In this study, DPOAE was utilized as a screening tool for NIHL since it could also assess the cochlear function. More in-depth studies with a bigger sample size are still needed because there are still many high-intensity noise areas in hospitals. Besides, a regular hearing examination is necessary to support the hearing conservation program for the employees. In conclusion, there was no significant

difference between audiometry results and DPOAE results. DPOAE can also be further used as a screening tool and replace the audiometry.

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9. Conflict of Interest

This study didn't have any conflicts of interest.

10. Funding

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