



## The Effects of Noise Intensity and Duration of Exposure on Hearing Threshold of Students in Vocational High School 2 Banda Aceh

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### Abstract

**Background:** Noise-induced hearing loss is caused by loud and continuous of noise exposure for a long time. Vocational high school students are a population at high risk of noise-induced hearing loss. This is due to exposure to noise from machines or practicum tools. The noise intensity from practicum tools or machines often exceeds the permissible threshold.

**Objective:** To determine the effect of intensity and duration of noise exposure on hearing thresholds in students of Vocational high school 2 (SMKN 2) Banda Aceh.

**Method:** This type of research is an observational analytic with a cross sectional design. The research sample was students of class XI and XII in the engineering and automotive department who were willing to participate in the research. The samples were interviewed and subjected to otoscopic and audiometric examinations. Room noise was rated with sound level meter.

**Results:** 121 samples that met the inclusion criteria of this study. The majority of the sample in this study were 16 years old (47.9%), male (100%), were in the engineering department (75.2%), had never used ear protection (93.4%), were exposed to noise for 4-6 days a week (85.1%) and exposed to noise with an intensity of >85dB (75.2%). In this study it was found that noise intensity and duration of exposure to noise had an effect on the increase in hearing threshold ( $p=0.001$ ).

**Conclusion:** There is a relationship between noise intensity and duration of noise exposure to the hearing threshold.

**Keywords:** Hearing threshold; Noise intensity exposure; Noise duration exposure; Noise-induced hearing loss

### 1. Introduction

Hearing loss occurs due to increasing in the hearing threshold from normal limits (0-25 dB) in one ear or both. The human ear is only capable of picking up sound with the intensity measurement is 85 dB and the sound frequency is around 20-20,000 Hz. The highest sound intensity limit is around 140 dB. If someone listens to the sound with that intensity, there will be a feeling of pain in the ear and triggers the hearing loss [1]. Noise-induced hearing loss is a sensorineural hearing loss in the form of a progressive and irreversible decrease in hearing functions due to loud and continuous noise exposure for a long time from the surrounding environment [2].

World Health Organization (WHO) reported that as many as 16% of hearing loss in adults was caused by noise. It was reported in 2000 that as many as 250 million people or 4.2% of the world's population suffered from hearing loss

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as a result of noise [3]. Indonesia is in fourth place of prevalence of hearing loss in Southeast Asia. One of the causes hearing loss in Indonesia is noise in the work environment [4]. The National Commission for Hearing Loss and Deafness stated that one of the high-risk populations for noise-induced hearing loss were Vocational High School students due to machine noise at the training site [5].

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## 2. Material and methods

Research was conducted from July 2022 to December 2022 on students in class XI and XII majoring machinery and automotive at SMKN 2 Banda Aceh who were willing to undergo interviews, physical examination of the ear, and audiometric examination to determine the effect of the intensity and duration of exposure to noise on the hearing threshold. Audiometric examinations were carried out after students were free from exposure to noise for 16 hours and were free from earwax and ear infections. The average value of noise was measured by Sound Level Meter (SLM).

In this study, there were 121 students who met the criteria out of a total of 130 students. The characteristics of students in this report consist of 91 students (75.2%) majoring in engineering and 30 students (24.8%) majoring in automotive. All of them were male with the highest age in the 16 year age group. The practical tools used were a grinding machine with a noise intensity of 92.4-99.5 dB, a lathe with a noise intensity of 89-95.8 dB and a milling machine with a noise intensity of 72.6-75.6 dB.



**Figure 1** Practicum Room

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## 3. Results

Majority student not using ear protection during practicum as many as 113 students (93.4%). A total of 103 students (85.1%) received exposure to noise for 4-6 days per week, the remaining 18 students (14.9%) received exposure to noise per week. A total of 91 students (75.2%) received noise with an intensity of >85 dB, only 30 students (24.8%) received noise <85dB.

This study shows that there is an effect of the intensity of noise exposure on the hearing threshold of students at SMKN 2 Banda Aceh. In students who received noise with an intensity of <85 dB, there were 22 students (73.3%) with hearing thresholds within normal limits and 8 students (26.7%) with mild degrees of sensorineural hearing loss. In students who received noise with an intensity of >85 dB, there were 14 students (15.4%) with normal hearing thresholds, 61 students (67%) with mild degrees of sensorineural deafness, 14 students (15.4%) with moderate degrees of sensorineural deafness and 2 students (2.2%) with severe sensorineural hearing loss.

This study also report that there is an effect of the duration of noise exposure on the hearing threshold of students at SMKN 2 Banda Aceh. In students who exposed to noise with a duration of 1-3 days per week found 14 students (77.8%) with normal hearing thresholds and 4 students (22.2%) with mild degrees of sensorineural hearing loss. Whereas in students who were exposed to noise with a duration of 4-6 days per week, there were 22 students (21.4%) with a normal hearing threshold, 65 students (63.1%) with mild degree of sensorineural deafness, 14 students (13.6%) ) with moderate sensorineural hearing loss and 2 students (2.0%) with severe sensorineural hearing loss.

#### 4. Discussion

All students in this study were male (100%). This is because the automotive and engineering majors are generally in demand by men. Research by Utari et al, in vocational students majoring in automotive, it was found that 99.2% of the research sample were male [6]. Majority student did not use ear protection. Ear protection is an effective tool in reducing the level of noise intensity [7]. Abel et al reported that hearing protection plays a role in reducing sound input from 12 to 40 dB to 5 to 22 dB [8]. Casali et al found that the use of ear protection devices plays a role in this lower Intensity voice as well as also found masked threshold at 85 dB the use of ear protection is significantly reduced compared to not using it [7,9]. Rahmawati et al showed that the use of ear protection was statistically associated with ear disorders [10]. NIOSH (National Institute for Occupational Safety and Health) recommend wearing ear protection for exposure to noise more than 85 dB [11]. Ear protectors play a role in reducing the risk of hearing loss [12].

In this study, it was found that noise intensity is related to the hearing threshold of vocational students. The noise intensity in the machining department when using a grinding machine is 92.4-99.5 dB and the noise intensity when using a lathe is 89-95.8 dB. The noise intensity in the automotive direction is 72.3-81.1 dB. Research by Li et al showed that the risk of hearing loss is found in workers with high intensity noise exposure (> 85 dB) [13]. Jannah et al showed that noise intensity increases the risk by 67 times the probability of hearing loss in this study. It was found that the majority of samples were exposed to noise exceeding the noise threshold value [12]. Occupational Safety and Health Administration (OSHA) states that permissible sound exposure is as follows:

**Table 1** Permissible sound exposure of Occupational Safety and Health Administration (OSHA)

Duration in a day (Hours)	Level of dB
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
½	110
≤ ¼	115

Based on the OSHA Table, the allowed noise intensity is 92-97 dB, that is, with a duration of 6-3 hours per day. Noise that exceeds the permissible noise threshold value can cause noise induced hearing loss (NIHL) [14]. In this study, there was also a relationship between the duration of noise exposure and the hearing threshold, where sensorineural deafness was found to be severe in 2 students majoring in engineering. Research by Lie et al found that there was an increase in the hearing threshold due to high intensity and duration of exposure which was assessed per 10 years [15]. Gopinath et al found that even exposure to noise at work sites of more than 10 years is associated with increased risk factors for hearing loss [16]. Fernandez et al stated that exposure acoustic overuse and aging are associated with the degeneration of auditory nerve fibers (ANF) prior to damage to the outer and inner hair cells. This cochlear synaptopathy can cause an increase in the hearing threshold [17]. If the cochlear synaptopathy reaches from the cochlear basal region, it will cause a permanent increase in the threshold of hearing at high frequencies [18,19]. American Conference of Governmental Industrial Hygienists (ACGIH) stated that the conditions that are permissible for someone to work in a noisy room or work environment with a noise intensity of 85 dB is 8 hours per day or 40 hours per week [20].

Chronic exposure to noise can cause mechanical and metabolic damage to the cochlea, particularly to the cochlear hair cells and through hypoxia induced by noise-induced capillary vasoconstriction [16,21]. This damage can cause sensorineural hearing loss (SNHL), in which SNHL can be caused by noise while working and is called Occupational-noise induced hearing loss. Excessive intensity and duration of exposure to noise can cause damage to the hair cells and

cortical organs. Destruction of the organ of Corti can be caused by two mechanisms: mechanical destruction from brief exposure to extreme intensity noise or metabolic decompensation after prolonged exposure to noise.

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## 5. Conclusion

Noise-induced hearing loss is a sensorineural hearing loss in the form of a progressive and irreversible decrease in hearing functions due to loud and continuous noise exposure for a long time. An overview of noise exposure at SMKN 2 Banda Aceh students was obtained with a noise intensity of >85 dB in the engineering department during practicum. The duration of exposure to noise at SMKN 2 Banda Aceh students get more exposure 4-6 days per week, as much as 85.1% during practicum. In this study, There is an effect of the intensity and duration of noise exposure on the hearing threshold of students at SMKN 2 Banda Aceh, the majority with mild degree of sensorineural deafness which exceeds the noise threshold value of 67.0% and the duration of exposure in a week is 63.1%.

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## Compliance with ethical standards

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### *Disclosure of conflict of interest*

The authors have declared that no competing interests exist in this study.

### *Statement of informed consent*

All authors declare that informed consent was obtained from all individual participants included in the study.

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