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# The correlation of smoking and noise induced hearing loss on workers at a palm oil factory X in Medan-Indonesia



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## ABSTRACT

**Introduction:** Noise exposure could result in damage to the organ of Corti and decrease the blood flow of the cochlea, thus resulting in cochlear hypoxia, whereas cigarettes are reported as an ototoxic to the cochlea and as a trigger of cochlear ischemia. Based on that theory, smoking habits and exposure to noise, either alone or together, could cause hearing loss

**Objective:** To determine the correlation between smoking and Noise Induced Hearing Loss (NIHL)

**Method:** Analytic with a cross-sectional study

**Result:** Of the 122 workers, the proportion of NIHL was 89.3%, with mild deafness (68.8%) as the most common proportion. We found that there was a significant correlation between types of smokers and severity of hearing loss ( $p = 0.000$ ). Workers who smoke are likely to experience NIHL 1.224 times more likely than non-smokers ( $PR = 1.224, p = 0.002, CI 95\% = 1,077 - 1,392$ ).

**Conclusion:** There is significant correlation between smoking and noise induced hearing loss

## ABSTRAK

**Latar belakang:** Paparan bising mengakibatkan kerusakan pada organ korti dan dapat menurunkan aliran darah koklea yang mengakibatkan hipoksia koklea, sedangkan rokok dilaporkan berperan sebagai ototoksik langsung dan sebagai pemicu iskemia koklea. Berdasarkan teori tersebut, kebiasaan merokok dan paparan bising secara sendiri ataupun secara bersama-sama dapat menyebabkan gangguan pendengaran

**Tujuan:** Mengetahui hubungan merokok terhadap kejadian Gangguan Pendengaran Akibat Bising (GPAB)

**Metode:** Penelitian analitik dengan pendekatan potong lintang

**Hasil:** Dari 122 pekerja, proporsi GPAB adalah 89.3%. Tuli ringan (68.8%) paling banyak ditemukan. Didapatkan adanya hubungan yang signifikan antara tipe perokok dengan derajat beratnya GPAB ( $p = 0.000$ ). Kemungkinan pekerja yg merokok untuk mengalami GPAB 1.224 kali lebih besar dibandingkan dengan pekerja yang tidak merokok ( $PR = 1.224, p = 0.002, CI 95\% = 1.077 - 1.392$ ).

**Kesimpulan:** Terdapat hubungan yang signifikan antara kebiasaan merokok dengan kejadian GPAB

**Kata kunci:** Merokok, gangguan pendengaran, gangguan pendengaran akibat bising, bising lingkungan kerja

**Keywords :** Cigarette smoking, hearing loss, noise induced hearing loss, occupational noise exposure

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## INTRODUCTION

Noise Induced Hearing Loss (NIHL) is often found in industrial workers in both developed and developing countries, especially industrialized countries that have not implemented a good hearing protection system. Indonesia as a developing country is in an effort to improve the development of many industrial equipment and machines that can enhance industrial efficiency. As a result, workplace noise exposure rose as an occupational hazard to industrial workers.<sup>1</sup>

The noisy work environment is considered as a major occupational health problem in many countries. Based on data from the World Health Organization (WHO), about 16% of the world's population suffers deafness caused by workplace noise exposure.<sup>2,3</sup>

Nowadays, smoking habit has become an important issue. For some people, cigarettes smoking has shifted from habit to daily necessity. Indonesia's National Report on Basic Health Research or *Riset Kesehatan Dasar* (RISKESDAS) 2013 stated that the average proportion of smokers in Indonesia was 29.3%. By type of work, farmers, fishermen and factory laborer holds the largest proportion of active smokers each day (44.5%).<sup>4</sup>

A study of white mice that were exposed to cigarette smoke showed that it could alter cochlear histological integrity. Cochlear damage in cigarette exposed group was greater than control group, with Relative Risk (RR) of 3.5.<sup>5</sup>

The combined effect of smoking habit and noise exposure is an accumulative effect. Exposure

to noise, besides causing damage to the organ of Corti (sensory receptor the inner ear), also causing the decrease in cochlear blood flow, which results in cochlear hypoxia. Smoking is reported to have a direct ototoxic impact (by the effect of nicotine) and to be a trigger of cochlear ischemia through several mechanisms, such as producing carboxy hemoglobin, inducing vasospasm, increasing blood viscosity and aggravating arteriosclerosis as well as endothelial dysfunction. Based on aforementioned theory, it is presumed that smoking habit and noise exposure could deteriorate cochlear function.<sup>6,7,8</sup>

In 2003, a study of 4624 steel workers in Japan claims that the combined effect of smoking and noise exposure in work environments was likely to be additive to NIHL.<sup>9</sup> Similar study was conducted in 2010 on a wagon manufacturing company's employees in Iran, showed NIHL incidence as much as 26.9% in the smokers group and 6.2% in the non-smokers group. The study also stated that possibility of NIHL occurring in the smokers group is 5.6 times greater than the non-smokers group, noting that both groups were exposed to noise.<sup>10</sup>

## METHOD

This research was a cross-sectional study with an analytical approach. The data collection was conducted at Palm Oil Factory X from June 2016 to April 2017. Each worker in the company was included in the study population. The study sample were those of the population members who were examined by the researchers and met the inclusion criteria. The inclusion criteria are: male workers aged 18-40 years worked in the company for at least five years, exposed to noise greater than or equal to 85 dB for minimum of 8 hours per day, denoted normal results on routine ENT examination and history taking, willing to be included in the study and signed the informed consent form.

The total number of samples was 122 workers (sixty-one workers in each smoker and non-smokers group). Auditory function was examined using pure-tone audiometer at the frequency of 125-8000 Hz for air conduction and 250-4000 Hz for bone conduction. The degree of hearing loss is determined by measuring the average hearing threshold value within speech frequency (500 Hz, 1000 Hz, 2000 Hz and 4000 Hz).

The data was processed SPSS 21 and analyzed using the chi-square test to determine the

correlation between dependent and independent variables. Data that did not fit chi-square qualification were then analyzed using Fisher Exact test or Kolmogorov Smirnov test. This research has been approved by the Research Ethics Committee of the Faculty of Medicine, Universitas Sumatera Utara.

## RESULTS

Average noise intensity of instruments used in 8 stations of Palm Oil Factory X is 88.9 dB (SD  $\pm$  4.89). It was found that 109 of workers (89.3%) had a hearing disturbance and 13 workers (10.7%) had a normal hearing function (Table 1). Pure-tone audiometry test revealed 84 workers (68.8%) had mild hearing loss, and 25 workers (20.5%) had a moderate hearing loss (Table 2). According to ISO (International Organization of Standardization) degree of hearing loss : (1) Normal : threshold between 0-25 dB (2) Mild hearing loss : increased threshold between 26-40 (3) Moderate hearing loss: increased threshold between 41-55 dB (4) Severe hearing loss : increased threshold between 56-70 dB (5) Profound Hearing loss : increased threshold between 71-90 dB.

A significant relationship was demonstrated between the types of smokers and the degree of hearing loss ( $p = 0.000$ ), and similarly between smoking behavior and hearing loss ( $p = 0.001$ ), as displayed in Table 3 and Table 4, respectively. The prevalence ratio is 1.224 (95% CI, 1,077-1,392), which means that of those who were exposed to noise, smokers are 1.224 times more likely to experience hearing loss compared to the non-smokers (Table 4).

**Table 1** Proportion of Hearing Loss in Workers

Hearing loss	Total	Percentage(%)
Positive	109	89,3
Negative	13	10,7
Total	122	100

**Table 2** Distribution of Hearing Loss by Severity

Hearing loss severity	Total	Percentage (%)
Normal	13	10.7
Mild Hearing Loss	84	68.8
Moderate Hearing Loss	25	20.5
Total	122	100

**Table 3** Relationship of Smoking Intensity with Degree of Hearing Loss

		Degree of Hearing Loss						<i>p</i> *
		Normal		Mild		Moderate		
		n	%	n	%	n	%	
Smoking Intensity	Light	1	100	30	83.3	1	4.2	0.000
	Moderate	0	0	4	11.1	8	33.3	
	Heavy	0	0	2	5.6	15	62.5	
	Total	1	100	36	100	24	100	

\* Kolmogorov Smirnov test

**Table 4** Relationship of Smoking Behavior with NIHL

		Hearing Loss				<i>p</i> *
		Negative		Positive		
		n	%	n	%	
Smoking Behavior	Smokers	1	7.7	60	55	0.001
	Non-Smokers	12	92.3	49	45	
	Total	13	100	109	100	

\* Fischer's Exact test  
Prevalence Ratio = 1.224

## DISCUSSION

Noise is the most dangerous thing in the workplace. Around 30 billion workers in America are exposed to noise in their workplaces, and an estimated number of 600 billion workers worldwide are exposed to occupational noise. The threshold value allowed by the National Institute for Occupational Safety and Health (NIOSH) and Indonesian Ministry Manpower is 85 dB for 8 hours. Continuous exposure beyond the given limit raises the potential to develop NIHL. Although NIHL is permanent, irreversible and frequently occurring, NIHL is preventable. This research found that the average of noise intensity produced by instruments used in Palm Oil Factory X is 88.9 dB (SD ± 4.89). Knowing that the exposure exceeds the limit allowed, the company advised all employees exposed to noise to use the ear protective device. However, none of the employees used the ear protection device due to difficulty in communicating with each other while using it, which was acknowledged in the interview.<sup>11,12</sup>

This study found that workers who had hearing loss are as much as 89.3%, leaving only 10.7% of workers with normal hearing function. The mild hearing loss was found to be the most common hearing loss (68.8%) and followed by a moderate hearing loss (20.5%). The similar result reported by Silitonga et al., in 2014 in their study, which declared workers exposed to noise at work with intensity over 85 dB are more likely to experience

hearing loss (the study found 53.6% of workers suffered from hearing loss).<sup>13</sup> The different verdict was found by Dib et al. in their study in 2008. Of all workers that were exposed to noise, 50% of them experienced hearing loss, which means the proportion of workers with hearing loss is just as much as those who have a normal hearing function.<sup>3</sup> Furthermore, the study by Juwana et al. in 2013 stated that hearing loss incidence (44.44%) in workers exposed to noise over 85 dB is slightly less compared to those without hearing loss (55.56%).<sup>14</sup> The difference in the findings of hearing loss incidence is likely to be influenced by the failure to use Ear Protective Device during exposure of noise that will ultimately affect workers' hearing function.<sup>11,12</sup>

Some factors that might affect the occurrence of NIHL are the frequency of noise exposure, duration of daily exposure, individual sensitivity, age, systemic diseases possessed, smoking habits and other contributing factors. Smoking habit and noise exposure are believed to be important factors that increase the likelihood of developing hearing loss. In general, tobacco is consumed by about 1.3 billion of the world's population. This study aims to examine the association of smoking habits with NIHL in workers exposed to noise in the work environment, given that smoking is the most common habit in all social level, including factory workers.<sup>11,12</sup>

Fischer's Exact test was used to determine the relationship between smoking behavior and hearing loss, with obtained *p* value = 0.002 (considered significant if *p* < 0.05), which means a significant relationship was found between smoking behavior with hearing loss. Prevalence Ratio (PR) was 1.224 (95% CI, 1.077 – 1.392), implying that compared to non-smokers, smokers have a probability of 1.224 times greater to experience hearing loss. This finding is in line with the study of Tao et al. in 2013 that assorted workers who smoke are 1.94 times more likely to have hearing loss than those who do not smoke.<sup>8</sup> The results are also consistent with the research by Mizoue, Miyamoto & Shimizu, who found that of workers who equally exposed to noisy work environments, workers who smoke are 1.8 times more likely to experience hearing loss compared with workers who do not smoke.<sup>9</sup> From studies mentioned above, we could infer that the workers who smoke tend to develop hearing loss when compared to workers who do not smoke, while equally exposed to noise. Differences found in values obtained in the studies may be brought about by variations in auditory hearing criteria adopted in each study.<sup>8,9</sup>

Analysis using Kolmogorov Smirnov test acquired *p* = 0.000 which suggests a significant relationship between smoking intensity and degree of

hearing loss. Smoking intensity is categorized by the number of cigarettes consumed in a day as follows: light smokers consume less than ten cigarettes per day, moderate smokers consume 11-20 cigarettes per day, heavy smokers consume 21-30 cigarettes per day, and very heavy smokers consume more than 30 cigarettes per day. The previous finding is consistent with Mohammadi et al. in 2010, stating a significant relationship was found between the number of cigarettes consumed and hearing loss.<sup>10</sup> Mizoue, Miyamoto & Shimizu's research in 2003 also pointed that there was a significant relationship between the number of cigarettes consumed with the incidence of hearing loss, along with the supposition of risk of hearing loss increases as the increase in the number of cigarettes consumed.<sup>9</sup> This is likely attributable to the fact that the more cigarettes consumed, the higher the amount and the frequency of the smokers' body exposed to substances that contribute to hearing loss, such as nicotine and carbon monoxide.<sup>8,9</sup>

## CONCLUSION

The proportion of NIHL in workers of Palm Oil Factory X is 89.3% (109 people). The most prevalent degree of hearing loss was a mild hearing loss, with 84 workers (68.8%) had mild hearing loss. There was a significant relationship between smoking habits and the degree of hearing loss, as well as between smoking habit and NIHL in workers who were exposed to noise. It was found that workers who smoke had the chance to experience hearing loss 1.224 times greater when compared with workers who do not smoke.

A routine audiometry check should regularly be performed for workers in noisy environments. Rotating workers periodically from the noisy environment to a quiet environment might be beneficial to reduce the incidence of NIHL if it is possible to be executed. Workers should be obliged to use ear protective device to reduce the incidence of NIHL and the authorities at the factory need to monitor workers compliance in using the ear protective device. Workers can be regularly counseled to increase their awareness about the cumulative impact of smoking and noise exposure to the development of hearing loss.

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