

Investigation of Noise Induced Hearing Loss at Shipyard Company, Surabaya

Investigasi Gangguan Pendengaran akibat Bising di Perusahaan Galangan Kapal, Surabaya

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ABSTRACT

Introduction: Noise is a health risk that cannot be avoided in production process. Noise has the potential to cause hearing loss for workers. The bad news, noise damage due to noise is permanent. Audiometric screening at shipyard company employees found 81.2% experienced Sensory-Neural Hearing Loss. 61.5% of employees experience deafness in both ears. The research objective was to find the cause of deafness at shipyard company. **Methods:** A Quantitative research with cross sectional approach in 64 subjects who worked in the ship repair production unit. The sample is chosen with a simple random technique according to inclusion and exclusion criteria. Assessment was carried out using questionnaires, measurement, and direct observations. **Result:** The bad habit of wearing ear protectors on employees as a cause of deafness ($p < .001$, Coef .517**). Sound level measurement shows the activity of chipping, welding, cutting and outfitting with noise intensity more than the recommended threshold (85 dBA for 8 hour per day). Noisy sources were found such as blowers, compressors, grinders, cutting machines, ringlet machines, hammer blows on plates and generators. **Conclusion:** Hearing loss in shipyard company employees is a work-related disease caused by the poor culture of wearing ear protectors. The habits does not wear earplug/earmuff tools because its not comfortable in the ear when the appliance is used, the tools too small so its easily lost, forgotten to carry, and tool are not available.

Keywords: hearing loss, noise, occupational diseases, sensorineural

ABSTRAK

Pendahuluan: Bising merupakan risiko kesehatan yang tidak dapat dihindari dalam proses produksi. Bising berpotensi menimbulkan gangguan pendengaran bagi pekerja. Kabar buruknya, kerusakan pendengaran akibat bising bersifat menetap. Skrining audiometri pada karyawan galangan kapal ditemukan 81,2% mengalami tuli sensorineural. Sebanyak 61,5% karyawan mengalami tuli pada kedua telinga. Tujuan penelitian adalah menganalisis penyebab ketulian pada karyawan galangan kapal. **Metode:** penelitian kuantitatif dengan pendekatan cross sectional pada 64 subjek yang bekerja di unit produksi bengkel kapal. Sampel dipilih dengan teknik acak sederhana sesuai kriteria inklusi dan eksklusi. Penilaian dilakukan menggunakan kuesioner, pengukuran, dan pengamatan langsung. **Hasil:** ditemukan kebiasaan pemakaian pelindung telinga yang buruk sebagai penyebab ketulian pada subjek penelitian ($p < ,001$, Coef ,517**). Pengukuran tingkat suara menunjukkan aktivitas pemecahan kerak besi, pengelasan, pemotongan dan pengerjaan perlengkapan dengan intensitas bising lebih dari nilai ambang batas (85 dBA selama 8 jam perhari). Sumber bising ditemukan berupa blower, kompresor, gerinda, mesin potong, mesin ringlet, pukulan palu pada plat besi dan generator. **Kesimpulan:** Ketulian pada karyawan galangan kapal adalah penyakit terkait pekerjaan yang disebabkan oleh buruknya budaya memakai alat pelindung telinga. Kebiasaan tidak memakai alat earplug/earmuff karena rasa tidak nyaman di dalam telinga saat alat digunakan, alat terlalu kecil sehingga mudah hilang, kelupaan membawa, dan alat yang tidak tersedia.

Kata kunci: bising, gangguan pendengaran, penyakit akibat kerja, sensorineural

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INTRODUCTION

According to Law number 13, 2003 regarding employment, a worker's health and safety in the workplace is the responsibility of their employer (Rumagit, 2014). Noise hazard is an unavoidable condition in a work environment. Tana indicated that production sectors that depends on machines will have noise hazard. Noise hazard is a health risk factor, especially for hearing disorders (Tana *et al.*, 2002).

World Health Organization stated that the prevalence of deafness in Indonesia is 4.2% (WHO, 2007). Countries in the world have determined that Noise Induced Hearing Loss (NIHL) as the most prevalent chronic occupational disease. According to Salawati, 16% of hearing loss suffered by adults are caused by noise hazard in the workplace (Salawati, 2013). NIHL needs special handling and attention, as no effective therapy has been found so far. Therefore the focus needs to be on health and safety monitoring to prevent NIHL cases.

A shipyard company that engages in ship repairs has many source of noise hazard. An audiometric screening done in 2018 found that 81.2% of employees suffered Sensory Neural Hearing Loss (SNHL). This screening was done on 64 random sample. This finding was much higher than findings by WHO and the highest reported prevalence of hearing loss on traffic police officers in Kathmandu, Nepal that was reported by Shrestha to be as high as 66.4% (Shrestha *et al.*, 2011).

Referring to provisions of the 2007 National Institute for Occupational Safety and Health, Indonesia set the threshold value for noise hazard in the workplace at 85 dBA. If this threshold value is continuously exceeded for a long period of time, then the noise may cause NIHL. According to Alwi (2017) and Rambe (2013), other influential factors include daily exposure period, length of work, work unit, age, gender, comorbidity, smoking habit, headset use, ear protectors use habit, mental condition, ototoxic drugs, and noise hazards condition around place of residence.

This research aim to asses SNHL risk factors on shipyard production workers in Surabaya, and analyze incidents of SNHL as an occupational disease. The results of this research may provide reference to recommend prevention for similar occupational disease.

METHODS

This research applies ethical principals, and had obtained ethical clearance from the UKWMS faculty of medicine ethics committee, number: 0756/WM12/Q/2018. This research is an observational research with cross-sectional approach. The research population were 254 employees. 64 people were chosen as sample using simple random sampling technique.

Inclusion criteria: willingness to participate as subject (inform consent), not in medically dangerous health condition. Exclusion criteria: subjects that has hearing disorder due to ear anatomical abnormalities, corpus alienum, head injury, and history of trauma on hearing organs.

The independent variables were age, gender, comorbidity, mental status, smoking habit, ototoxic drugs use, length of work, work unit, ear protectors use habit, headsets use habit, and noise intensity obtained from primary data using questionnaire, or noise measurement form. The dependent variable was prevalence of SNHL in the sample from the result of audiometric examination by an ENT specialist. Statistical analysis used Spearman Rank Correlation test, with 0.05 significance level and $\alpha = 5\%$.

RESULT

Prevalence of SNHL

The results of examination using audiometer found that 81.2% or 52 subjects was diagnosed with clinical SNHL. Out of those with clinical SNHL, 61.5% (32 people) had disorder on both ears, while 38.5% (20 people) had disorder on only one ear. The degree of SNHL severity is shown in Fig.1 below.

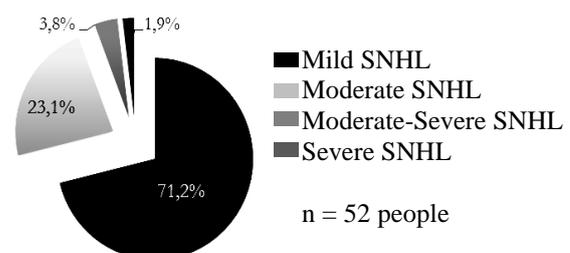


Figure 1. SNHL Degree of Severity

As shown in Fig.1, 1 employee had severe sensory-neural hearing loss (1.9%), 2 people with moderate-severe hearing loss (3.8%), and 12 people with moderate hearing loss (23.1%). The highest proportion, 37 people (71.2%) had mild sensory-neural hearing loss.

Subject Characteristics

All subjects in this research were male. The majority, 53 of them, were middle aged 45-50 years old (age group below retirement age for employee). Only 4 people were below 45 years old. Examined further, 52 people (81.5%) have been working for more than 20 years, and 11 people (17.2%) have worked for 15-20 years, and only 1 has worked for 9 years. Spearman rank correlation test showed $p=0.920$, suggesting that the length of work was not correlated with incidence of SNHL.

Research subjects were not placed in a permanent work unit since they started employment. This is due to the type of work, that is professional labor, so that it was not possible to move them to units that are not within their expertise. Description of the work units of research subjects is shown in Fig.2.

As shown in Fig.2 above, the research subjects were evenly distributed among all the work units that were taken as sample for this research. The number of workers in each

units conform with the requirement of labor for each units. Mann-Whitney U test showed $p=0.532$, which suggest that there were no correlation between the subjects' work units with SNHL in this research.

On the other hand, data regarding work stress found that 46.9% of subjects had stress burden while working. Out of those, the highest proportion, 31.2% attribute their stress to feelings that the company does not pay attention to their health, specifically increased neglect toward worker's health and safety during work, as well as limitations on health services provided in polyclinics post compulsory enrollment in national health insurance. Followed by 17.1% that attribute stress to heavy workload burden, while the rest attribute stress to family issues, problems with coworkers or superiors. Mann Whitney U test showed no significant correlation ($p=0.511$) between mental condition and hearing disorder on subjects in this research.

Description of daily risk factors for the subjects are shown in Table 1. As noted in Table 1, most subjects in this research smoke cigarette (53.1%), while only small proportion of subjects have hobbies related to noise such as listening to music using headset (14.1%). No subjects had any history of ototoxic drug use for the last 5 years. Only 1 subject (1.6%) had alcohol consumption habit.

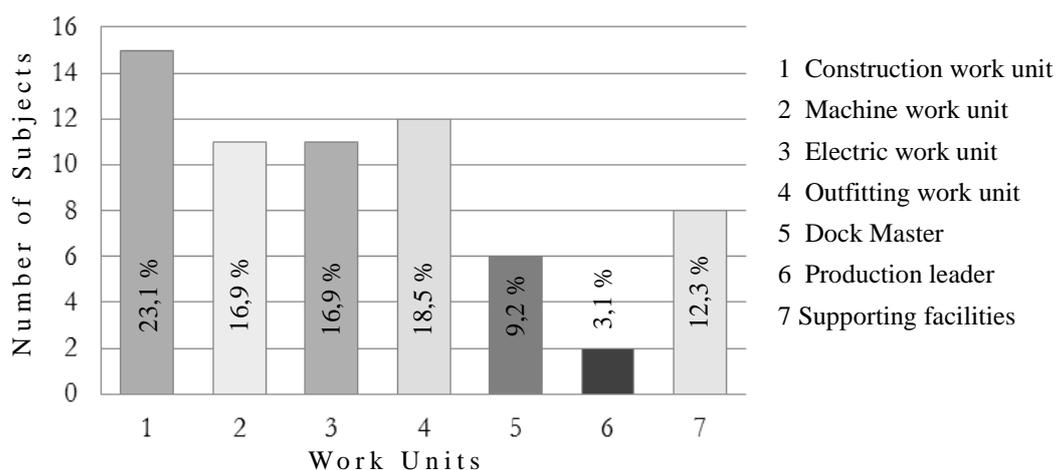


Figure 2. Research Subject Work Units Distribution at Shipyard Company, 2018

Table 1. SNHL Risk Factors Distribution at Shipyard Company, 2018

Variable	Frequency (n)	Percentage (%)	Analysis test (sig ; coef corr)	
Ototoxic drug use history			-	-
no	64	100,0		
yes	0	0,0		
Smoking habit			0.092	0.212
no	30	46,9		
yes	34	53,1		
Alcohol consumption habit			0.928	0.011
no	63	98,4		
yes	1	1,6		
Headset wearing habit			0.067	0.231
no	55	85,9		
yes	9	14,1		
Ear protector wearing habit (<i>ear plug/ear muff</i>)			0.001	0.517**
Never	29	45,3		
Occasionally	21	32,8		
Always	14	21,9		

The main finding that needs to be recognized from table 1 is that 78.1% of subjects never or only sparingly wear ear protectors while working. Reasons given by the subjects regarding the bad ear protector wearing practice were discomfort in the ears while wearing the protectors, the protectors were too small so that they were easily lost, unavailability of the protectors, and forgetting to bring the protectors when entering work areas with high noise hazard.

Statistical analysis found that only ear protectors wearing habit was strongly correlated with incidence of SNHL on the subjects of this research. Other variables, history of ototoxic drug use, smoking habit, alcohol consumption habit, and headset use were not correlated with incidence of SNHL in this research.

Measurement of Noise Intensity

Field meta-survey was done to measure noise intensity using sound level on several noise locations. In total, there were 17 points of noise measurement locations where employees work daily, which include: shipyard, machine workshop, dock, ship access way, hold construction workshop, electric workshop, outfitting workshop, compressor room, and area around generator room.

Based on the measurement results, there were 12 location points with noise

intensity above the recommended threshold value. Description of each noise source and noise measurement is shown in more detail in the following table 2.

As shown in Table 2, almost all (12 out of 17 measured locations) ship production unit locations have noise level above the recommended threshold value as recommended by ministerial decree from the minister of labour number 15, 1999 regarding threshold values of physical factors in the workplace. Two locations were found to even have noise intensity above 100 dBA, where humans are recommended to be exposed to such noise intensity for less than 15 minutes. The two locations were area surrounding the hull where chipping (removing rust by pouding the ship's metal plate) activity was performed, and ship access way area I that had noise from an old and leaking compressor machine.

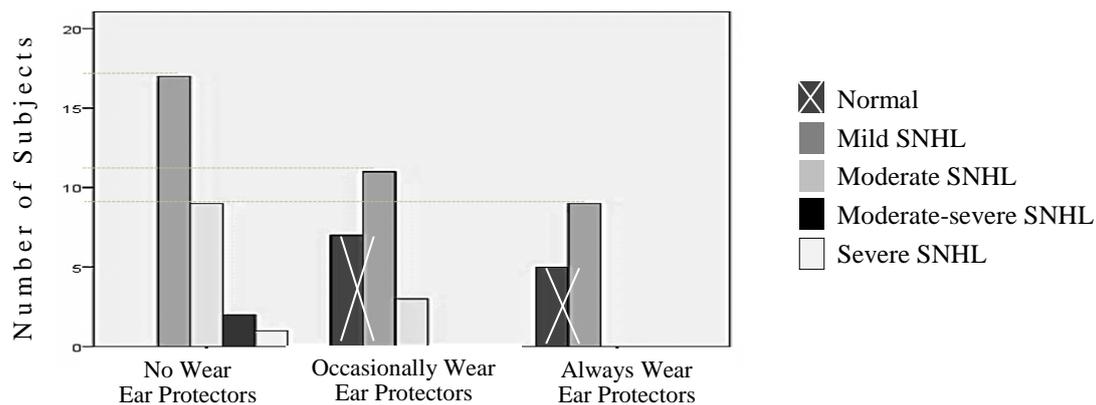
Almost all duration of work exposure toward the noise sources are 8 hours daily, due to the shipyard company policy of operating hours: 08.00-12.00 and 13.00-17.00.

Correlation between Ear Protectors Wearing Habit and Incidence of Sensory-neural Hearing Loss

As shown in table 1, it was found that only ear protector wearing habit was significantly correlated with SNHL incidence in subjects of this research, with $p < 0.001$ and correlation coefficient + 0.517.

Table 2. Noise Sources and Measured Noise Intensity at Shipyard Company, 2018

Noise locations	Average sound level (dBA)	Noise source	Exposure time (hours in a day)
Shipyard	93,4	Blower machine	8
Main deck	89,5	Chipping activities	8
Ship hull	101,9	Chipping activities	8
Ship hull	86,0	Cutting – welding activities	8
Ship access way V	99,8	Air compressor machine	8
Ship access way V	97,4	Compressor machine	8
Ship access way I	109,7	Air compressor machine	8
HC workshop	79,8	Bending – welding activities	8
HC workshop	88,1	Blower machine	8
HC workshop	76,5	Cutting – welding activities	8
Compressor room	81,4	Compressor machine	8
Electric workshop	75,9	Welding dan blower machines	8
Outfitting workshop	88,2	Ringlet machines	4
Outfitting workshop	74,9	Welding activities	8
Outfitting workshop	88,2	Iron sheets cutting activities	4
Outfitting workshop	97,9	Grinder machine	8
Generator room	95,0	Generator	8

**Figure 3.** Correlation Between Ear Protectors Wearing Habit and SNHL Severity at Shipyard Company, 2018

More detailed description of the correlation between ear protectors wearing habit and SNHL in subjects is shown in the following figure 3. As shown in Fig. 3, the first important issue was that there were no subjects in the normal hearing category among those that never wear ear protectors. On the contrary, cases of moderate-severe and severe SNHL were only found on subjects that never wear ear protectors.

The number of mild SNHL cases increased with increased disobedience toward ear protectors wearing practice, 9 cases (24.3%) among subjects that always wear ear protectors, 11 cases (29.7%) among subjects that occasionally wear ear protectors, and 17

cases (45.9%) among subjects that never wear ear protectors. The same pattern was observed with moderate SNHL cases.

DISCUSSION

Discussion was directed toward the research aim, analysis of SNHL cases as an occupational disease. Reference that was used was the seven steps of diagnosis determination for occupational disease according to Indonesian Ministry of Health ministerial regulation Number 56, 2016 regarding occupational disease. The phases for the aforementioned reference were explained as follows.

Step 1: The establishment of clinical diagnosis was found based on audiometric examination. It was found that 81.2% of subjects were diagnosed with SNHL. The prevalence of cases found was different from the results of research by Syah (2016) that was conducted in similar location, that is a shipyard. That study found that the prevalence of hearing disorders was 21.6% from a sample of 37 people. The weakness of the study by Syah was that the sample was only taken from the machine workshop. Results from a research by Jumali on ferry machine operator found that the prevalence of SNHL was only 34.85% (Jumali *et al.*, 2013). From literature research and experiences as corporate health and safety doctor, the prevalence of SNHL cases found in this study was very high.

Step 2: Determining noise exposure in the workplace using sound level meter on 17 location in the shipyard production unit. It was found that 12 locations had noise intensity above the threshold value recommended by the minister of labor regulation Number 51, 1999 regarding threshold values for physical factors in the workplace (Ministry of Manpower, 1999). Work activities which measured noise level were above the threshold value were: chipping, welding, cutting, and outfitting. Other noise sources include blower machines, compressor, grinder machines, cutting machines, ringlet machine, hammer blows on metals, and generator.

Step 3: Correlation between noise and hearing disorder has been recognized in the medical field (Kunto, 2008). According to Rimantho and Cahyadi (2015), the determination of occupational NIHL diagnosis must proof that there is a noise hazard as a cause. Subjects in this research were workers who work in the shipyard production unit and were directly exposed to occupational noise, where 23.1% of subjects work in the construction unit, 16.9% in machines unit, 16.9% in electricians, 18.5% in outfitting, 9.2% on docks, 3.1% as production leaders, and 12.3% on supporting facilities.

Step 4: Sufficiency of noise exposure was measured from the subject's work duration and the measured noise intensity. As shown in table 2, there were 3 locations with noise intensity of 86-88 dBA, with exposure of 8 hours/day, 2 locations with 88.2 dBA noise intensity with noise exposure of 4 hours/day, 5 locations with noise intensity 91-97 dBA with 8 hours/day

exposure, and 2 locations with noise intensity ≥ 100 dBA with exposure 8 hours/day. These values were above the recommend threshold, which are ≤ 4 hours for noise intensity 86-88 dBA, 30 minutes to 2 hours for noise intensity 91-97 dBA, and ≤ 15 minutes for noise intensity above 100 dBA.

Step 5: Determination of individual risk factors using statistical tests. Variables work unit, work duration, mental status, smoking habit, and alcohol consumption habit found no significant correlation with significance level > 0.005 . Only ear protectors wearing habit was significantly correlated with SNHL on the research subjects. This finding was in line with research by Christi *et al.*, (2017) that suggested that age and work unit were not risk factors for NIHL. Similarly, works by Dewi (2012) and Umyati (2015) also found that the use of ear protectors were correlated with NIHL on workers.

Step 6: Other factors outside of the workplace that was of interest for this research was hobbies related to noise such as headsets use habits for listening to music. Statistical analysis found no correlation between headsets use and SNHL incidence on research subjects. Therefore other factors outside the workplace can be eliminated.

Step 7: Based on the six previous steps, the incidence of SNHL among the research subjects were purely caused by occupational noise exposure. NIHL diagnosis can be established in this case.

CONCLUSION

Sensory-neural hearing loss that occurred on shipyard workers was an occupational disease caused by bad culture of ear protectors wearing habit. The habit of not wearing ear protectors was attributed to discomfort in the ears while wearing the protectors, protectors that were too small and become easily lost, forgetting to bring the protectors, and unavailability of protectors.

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