

Hearing threshold levels among clothes convection industry workers in Klaten, Central Java, Indonesia

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ABSTRACT

Introduction: Noise-induced hearing loss is a condition that develops gradually and often goes unnoticed due to the absence of observable symptoms. Noise-induced hearing loss is usually detected after effects on hearing ability, difficulty understanding speech, and communication disorders. This study aims to determine the prevalence of hearing threshold decline in workers in the clothes convection industry in Klaten, Central Java, Indonesia.

Methods: A cross-sectional study, with 21 respondents, was conducted from April to June 2023. Data were collected through interviews, measurement of noise levels in the workplace, otoscopic and audiometric examinations, and research questionnaires.

Results: Most study respondents were female (85.7%) and workers who had worked for 11-20 years (66.7%). The main results showed that the prevalence of decreasing hearing threshold among workers in this study was 33.3%.

Conclusion: The prevalence of hearing threshold decline was correlated with length of work and use of ear protection equipment.

Keywords: Audiometry, Hearing Loss, Noise induce, Occupational diseases, Prevalence

Introduction

Occupational hearing loss (OHL) is a condition that arises when individuals are subjected to high levels of noise (85 dB or above) or ototoxic substances, including organic solvents (such as styrene and trichloroethylene), heavy metals (like mercury and lead), and asphyxiates (such as carbon monoxide and hydrogen cyanide), within their work environment.¹ Noise-induced hearing loss (NIHL) is a condition that progresses gradually over time and frequently remains unnoticed due to the absence of observable symptoms.² The condition has the potential to restrict an individual's auditory capacity to

perceive high-frequency sounds, comprehend spoken language, and impede interpersonal communication.³ NIHL is the second most prevalent workplace ailment in the United States.⁴ Much of the sound energy that is carried by air is reflected rather than absorbed when it reaches the fluids in the cochlea, and the reduction in sound energy is offset by the middle ear.⁵ A particular class of specialised sensory cells known as cochlear hair cells is capable of both detecting low-frequency sounds and withstanding high-frequency noises, there are only about 16,000–17,000 of these cells in each human, and if they are

damaged, there is no way to repair them.⁶ The transmission of vibrations from the middle ear to the inner ear induces motion, which in turn stimulates the upper regions of the hair cells, then this stimulation leads to chemical alterations that give rise to the generation of nerve impulses.⁵ The transmission of nerve impulses occurs along the auditory nerve, ultimately reaching the brain, where they undergo interpretation as auditory stimuli.⁶

Excessive noise poses a significant risk to the auditory organ known as the cochlea, located within the inner ear.⁷ Prolonged exposure to deafening sounds might result in auditory impairment.⁶ Prolonged exposure to high levels of noise has the potential to cause harm to the cells and membranes within the cochlea, potentially leading to the destruction of hair cells.⁶ The deleterious consequences of hearing loss may persist even after cessation of exposure to excessive noise.⁸ Hearing loss may occur once a significant proportion, ranging from 30% to 50% of hair cells have been damaged or killed.⁹ The detection of this phenomenon can be accomplished by the use of an audiogram.¹⁰ Once atypical hearing loss is identified, it is probable that the condition will endure indefinitely.¹¹ Due to the swift progression of industrialisation, individuals are facing an escalating susceptibility to NIHL.¹¹ According to the World Health Organization (WHO), it has been estimated that approximately 10% of the worldwide population is subjected to the detrimental effects of noise pollution.¹² Among this affected group, approximately 5.3% are reported to develop NIHL.¹³

According to the Occupational Safety and Health Administration (OSHA), the existence of occupational noise exposure at or above 85 dB(A) has been identified as the threshold that necessitates the development of a hearing conservation program for workers.¹⁴ Research has indicated that to mitigate the occurrence of sensorineural hearing loss, an occupational condition commonly observed among industrial employees, it is imperative to employ personal

sound level meters to record noise levels throughout an 8-hour workday, while also considering the duration of commute to and from the workplace.¹⁵ A moderate correlation was seen among the values obtained from a traditional noise measurement apparatus, a personal dosimeter, and a smart device equipped with a noise measurement application.¹⁶

The primary objective of this study was to determine the hearing threshold levels of individuals employed in the garments convection business in Klaten, Central Java, Indonesia. Additionally, the study sought to investigate the potential relationship between the decrease in hearing threshold and the duration of employment among workers in clothes factories.

Methods

A cross-sectional study was conducted to determine the prevalence of hearing threshold decline in the clothing convention industry workers in Klaten, Central Java, Indonesia, from April to June 2023.

The sample was calculated using the simple random sampling method for cross sectional $n_1 = n_2 = \left(\frac{Z_{\alpha} \sqrt{2PQ} + Z_{\beta} \sqrt{P_1 Q_1 + P_2 Q_2}}{P_1 - P_2} \right)^2$. The minimum estimated number of respondents for this study was as many as 21 people. The audiometric data of 21 individuals employed in areas with noise levels over 85 dB(A), referred to as high noise zones, were obtained from examination records. This sample consisted of participants whose audiometric data for frequencies of 0.5, 1, 2, 3, 4, 6, and 8 kHz. Demographic data, the commencement of employment, and the utilization of protective gear were obtained by interview methods. The statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS 25.0). Qualitative variables were analyzed using frequency and percentage values. The chi-square test was utilized to compare ratios, with a significance level of 0.05 being used to determine statistical significance.

The data collection process consisted of three primary stages: the measuring of workplace noise

levels, otoscopic and audiometric examinations, and the administration of a questionnaire. Sound level measurements were conducted to assess the levels of noise in each respective part of the workplace. The purpose of conducting the otoscopic evaluation was to detect any abnormalities in the outer or middle ear and to verify that there were no obstructions caused by cerumen that could affect the results of the audiometric assessment. The questionnaire that was administered assessed various aspects,

including demographic information, the commencement of employment, and the utilization of protective equipment.

Results

Eight respondents were from the sewing production site and thirteen were from the cutting production site. Respondents characters were at productive age (31-60 years old), female dominant than male (85.7%), and the wearing ear protection device only almost half (47.6%). (Table 1).

Table 1: Characteristics of respondents

Characteristics	Frequency (%)	
Age (years)	31-40	3 (14.3)
	41-50	9 (42.9)
	51-60	9 (42.9)
Gender	Female	18 (85.7)
	Male	3 (14.3)
Noise level (dB)	≤85	8 (38.1)
	>85	13 (61.9)
Ear protection	Yes	10 (47.6)
	No	11 (52.4)

Table 2: The working duration of respondents

Duration of exposure (years)	Frequency (%)
≤5	1 (4.8)
6-10	2 (9.5)
11-20	14 (66.7)
>20	4 (19)
Total	21 (100)

Table 3: The prevalence of decreasing hearing threshold risk factors

	Decreasing hearing threshold	
	None	Mild
Age (years)		
≤40	3	0
41-50	6	3
51-60	5	4
Gender		
Male	1	3
Female	13	4
Noise level (dB)		
≤85	6	2
>85	8	5
Hearing protection device		
Yes	9	1
No	5	6

Almost all respondents have been working in this home industry for a long duration, more than five years, correlated with hearing loss prevalence (Table 2). It is similar to a study by Chen, 2023 that among military pilots, both age and total flight time were risk factors for noise-induced hearing loss.¹⁷ The findings of a study conducted on individuals employed in the steel industry revealed a substantial correlation between age, experience, and hearing impairment across all

degrees of severity.¹⁸

This study showed that the hearing loss percentage was higher in males (75%) than females (24%), in louder noise, and who were not wearing ear protection devices (Table 3).

The relation of the duration of work and hearing threshold using Chi-square test correlation showed a significant result; the more prolonged noise exposure has a tendency of prevalence hearing threshold decreasing with $p=0.016$ (Table 4).

Table 4: The relation of duration of work and decreasing hearing threshold

Duration of noise exposure (years)	Hearing decrease		Total	p-value
	None	Mild		
≤5	1	0	1	0.016
6-10	2	0	2	
11-20	11	3	14	
>20	0	4	4	

Discussion

The results of this study suggest that there is a statistically significant association between hearing status and exposure duration ($p=0.016$). These findings align with a previous study conducted among Steelworkers in Thailand, which also found that the number of years of exposure did not significantly contribute to the degree of hearing loss. The other study demonstrated that age and smoking habits are also risk factors for hearing loss.¹⁹

Numerous research have demonstrated that noise exposure not only affects hearing functions, but also gives rise to feelings of aggravation, disrupts sleep patterns, hampers work or academic performance, and elevates the likelihood of developing hypertension and cardiovascular ailments.²⁰ Implementing noise reduction and mitigation measures is most important for safeguarding public health.

In this study, noise observation with a sound level meter at the home industry showed >85 dB in the sewing production site and ≤ 85 dB in the cutting production site. The working duration of this industry was 9 hours per day (from 8 am to 5 pm).

It is imperative to monitor noise exposure levels in all work contexts for potential injury. Occupational noise is a highly widespread occupational hazard in contemporary society, with the recognition of its health impacts originating from occupational environments. The rise of modern manufacturing has led to an increased awareness of occupational noise exposure and its correlation with occupational harm. There is a well-established consensus that exposure to occupational noise has the potential to have negative health impacts, both auditory and non-auditory.²⁰ Hearing loss is a widely seen sensory impairment on a global scale, with noise-induced hearing loss (NIHL) emerging as a significant public health concern. NIHL is a type of sensorineural hearing loss that occurs gradually over time as a result of exposure to excessive noise.²¹

Traditional sound level meters are widely recognized as a reliable tool for objectively evaluating noise levels. Nevertheless, the acquisition of sound level meters can be a financial burden, particularly for small enterprises, and necessitate ongoing maintenance and calibration.

These characteristics have the potential to restrict the practicality of monitoring noise exposure, thereby creating an obstacle for employers in completing risk assessments related to this matter. There was a multitude of alternative options exhibiting notable disparities in the efficacy of iPhone applications developed by Apple in precisely forecasting environmental decibel levels. Nevertheless, when employing the appropriate application, an iPhone can serve as a somewhat dependable tool for gauging levels of noise exposure in situations when a sound level meter that has been calibrated by an expert is not easily accessible.²²

In general, the clothing convection sector in Indonesia predominantly consists of single-family or small-scale enterprises, which consequently exempts them from adhering to the restrictions and legislation pertaining to noise imposed by the Occupational Safety and Health Administration (OSHA), as applicable to other industries. The clothing manufacturing industries within the home industry face heightened vulnerability due to extended working hours that exceed the standard 8-hour shift, hence increasing the likelihood of auditory impairment. According to the guidelines established by the Occupational Safety and Health Administration (OSHA), individuals must adhere to widely acknowledged and accepted methods while implementing hearing conservation programs. Nevertheless, some nations have implemented audiometric surveillance programs inside their industries by engaging outsourced service companies that offer mobile van services.⁴

The issue of workplace noise is predominantly approached from the standpoint of environmental health and safety, rather than being regarded solely as a nuisance. The presence of excessive noise in the workplace is considered a potential occupational hazard commonly associated with heavy industries, like the steel industry, mine industry, airforce industry, tyre manufacture, ceramic sanitary industry, transportation traffic or train, farm or fishing, home industry such as laundry, and coffee grinder.^{17,18}

Under the prevailing regulations, the employer must assess and quantify the levels of noise to which employees are subjected, with specific emphasis on the intensity, nature, and duration of the noise. The assessment of noise risk plays a crucial role in safeguarding the well-being and safety of workers from potential health hazards arising from exposure to excessive noise levels. The noise risk assessment aims to identify the individuals who are potentially exposed to the harm caused by excessive noise levels. The system assesses its noise exposure level to ensure that it does not over the maximum noise exposure limit. When the degree of worker exposure is beyond the recommended threshold, the presence of excessive noise poses a significant hazard to both safety and health. This is primarily because elevated noise levels have been scientifically linked to the occurrence of irreversible hearing loss. Moreover, there is a positive correlation between the level of stress induced by prolonged exposure to excessive noise levels and the occurrence of workplace accidents.²³

In a previous study conducted in Nepal,²⁴ there were only about 53.5% of respondents used one or more personal protective equipment when working in a hazardous environment. Another study also showed that only about 31% of workers used personal protective equipment at work. This is due to the low awareness and implementation of the use of personal protective equipment at work.²⁵ The implementation of occupational health and safety management is necessary to oversee the work process and safeguard the well-being of employees. The prevention of hearing loss resulting from exposure to loud noise in the workplace can be achieved through the consistent and correct utilization of hearing protection devices while working in noisy environments. The implementation of a comprehensive hearing conservation program is necessary in order to mitigate the potential hazards associated with occupational hearing loss, safeguard and maintain auditory health, and equip workers with pertinent information and protective measures.²⁶ The limitation of this study is that the number of samples still needs to be more significant to be

able to make broader generalizations of the research results, so the number of research samples will increase in the future.

Conclusions

The results of this study showed that the

prevalence of hearing threshold reduction among convection home industry workers in Klaten, Central Java, Indonesia, was 33%. It was also found that the decline in hearing thresholds was correlated with the length of the working period and the use of ear protection equipment.

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