ORIGINAL ARTICLE

Hyperacusis Among Adults With Occupational Noise Exposure

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ABSTRACT

Background: Hyperacusis is characterized by increased sensitivity and reduced tolerance to sounds, which most people find acceptable. This research effort addresses this critical gap in understanding the role of occupational noise exposure as one of the contributing factors of hyperacusis. In addition, the study aims to adopt the modified Hyperacusis Questionnaire as a valuable tool for early identification of hyperacusis in an adult population. This study aims to determine the occurrence of hyperacusis in adults who are exposed to occupational noise. **Methodology:** A cross-sectional study was conducted using a convenience sampling technique. A total of 95 workers in Malaysia participated. Data was collected using the modified Khalfa Hyperacusis Questionnaire, which was developed by Khalfa, in 2002. **Results:** Most workers (57.9%) are not well informed regarding the existence of hyperacusis. Hyperacusis was observed in 95.6% of individuals who were exposed to noise in the workplace, while only 4.4% of participants reported having normal sound tolerance. A Mann-Whitney U test showed no significant difference in awareness of hyperacusis between adults with occupational noise exposure and those without occupational noise exposure (p=0.62). **Conclusion:** The findings highlight a considerable gap in workers' awareness regarding hyperacusis. This underscores the need for education and occupational safety regulations to enhance workers' awareness and management of noise in the work environment to create conducive working spaces for them.

INTRODUCTION

Hyperacusis is a rare loudness perception disorder that occurs either unilaterally or bilaterally with an estimated 8% of Swedish individuals having hyperacusis (Andersson et al., 2002; Fredriksson et al., 2022; Paulin et al., 2016). The condition may manifest in individuals with either normal hearing or hearing loss (Fackrell et al., 2017).). Hyperacusis is also defined as hypersensitivity and reduced tolerance to ordinary environmental sounds that would normally be considered as non-intrusive to most people (Fredriksson et al., 2022a). While nearly all cases of hyperacusis are bilateral in nature, the disorder is often associated with significant discomfort triggered by suprathreshold sounds or exceptionally low hearing thresholds. To further expand the concepts of hyperacusis, Tyler et al. (2015) categorized the concepts into four; (1) loudness hyperacusis; (2), pain hyperacusis; (3), fear hyperacusis; and, (4) annoyance hyperacusis.

The impact of hyperacusis on a person can vary from slightly bothersome to incapacitating. Due to avoidance behaviour that results in self-isolation and elevated stress levels, adults with hyperacusis may suffer from sleep disturbances, social anxiety, poor emotional well-being, anxiety, and difficulties concentrating (reference). Nunez (2021) listed a number of potential causes of hyperacusis, including viral infections, autoimmune diseases, head trauma, extreme noise exposure, and emotional stressors like PTSD. Although hyperacusis can have many different diagnoses and aetiologies, numerous studies have found that noise exposure is the most common cause (Fredriksson et al., 2022a). It has been a major concern for people working in noisy workplaces, particularly in industry and manufacturing.

According to Shehabi, Pendergast, Guest, and Plack (2023), exposure to noise at work is linked to a number of auditory symptoms, including tinnitus, hyperacusis, noise-induced hearing loss (NIHL), and temporary threshold shifts, in addition to non-auditory symptoms like high blood pressure, cardiovascular disease, and stress. Taking this matter into consideration, various developed countries have implemented different maximum permissible occupational noise exposure levels (Shehabi et al., 2023; Shaikh, 1999). Locally, the permitted noise exposure limit (PEL) in Malaysia is 85 dB(A) or a daily personal noise dose of 100%, as determined by the Occupational Safety and Health (Noise Exposure) Regulations 2019. Additionally, the maximum sound pressure level should not exceed 115 dB(A), and the peak sound pressure level should remain below 140 dB(C) (Department of Occupational Safety and Health, 2019).

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According to Jahn's (2022) research, hyperacusis affects 8.6% to 15.2% of people, according to population-based data. Tyler et al., (2014), argued that distinct symptom characteristics could separate four categories of hyperacusis: loudness, pain, irritation, and terror (Fredriksson et al., 2022). Aetiology and symptoms are the determinants of its treatment. Since most hyperacusis sufferers report having tinnitus, typical treatments for hyperacusis include cognitive behavioural therapy (CBT), tinnitus retraining therapy (TRT), sound desensitisation, therapies including yoga and acupuncture, and surgery. (Coey, 2020; Nunez, 2021).

Many workers are unaware of the health risks associated with extended exposure to loud noise since the negative consequences of noise pollution take a long time to become apparent. Therefore, to understand and further elaborate on the scenario of hyperacusis in Malaysia, this study aims to study the existence of hyperacusis among adults who are exposed to occupational noise using a Modified Khalfa Hyperacusis Questionnaire, in a large group of randomly selected adult workers. By understanding the intricate interplay between noise exposure at work and hyperacusis, this research also helps to provide valuable insights into the early detection of hyperacusis in order to provide immediate and appropriate treatment for those who may be unaware of their reduced tolerance towards ordinary environmental sounds.

The aim of this study was to study the existence of hyperacusis among adults who are exposed to occupational noise. Specifically, this study aims:

i. To investigate the awareness about the existence of hyperacusis or reduced tolerance toward sound among workers who are at risk of occupational noise exposure.
ii. To investigate the existence of hyperacusis among Malaysian workers who are exposed to occupational noise with Modified HQ scores.
iii. To compare the level of hyperacusis between workers who are exposed and not exposed to occupational noise exposure using Modified HQ scores.

MATERIALS AND METHODS

Study Design

This study adopted a cross-sectional observational study design. Questionnaires were distributed to workers who met the inclusion criteria. This research strategy was chosen due to its ease of administration and cost-effectiveness.

Sampling Technique

The chosen sampling techniques were convenience and purposive sampling. The participants were selected randomly following their willingness and availability to participate in the study by responding to the MHQ form that was sent out as a hard copy and through a Google Form that was sent over a personal messaging app.

Study Population and Sample Size

Ninety-five workers who are at risk of occupational noise exposure, aged 18 to 60 years old were recruited, selected via convenience sampling from a number of Kuantan industrial and non-industrial firms; the sample size was determined to be 76%. Oil and gas processing, electronics manufacturing, polymer synthesis, and chemical manufacture are examples of industrial factories. (International Labour Organization, 2022). However, printing and publishing companies, textile manufacturers, food processing facilities, and assembly plants are examples of non-industrial factories (International Labour Organization, 2022).

The inclusion criteria for the participants were:

1. Currently employed in industries or job roles that involve potential or known occupational noise exposure.
2. Age ranging from 18 to 60 years old.
3. Ability to read and understand English fluently.

The following additional inclusion criteria were made applicable to participants who were chosen for the study's second goal, that is to determine if Malaysian workers who are exposed to noise at work have hyperacusis:

1. Exposed to occupational noise for a minimum duration of 1 year and more
2. Regularly exposed to noise levels exceeding 85 dBA for 8 hours and more.

Location

The questionnaire was distributed using two methods, physical face-to-face administration and as an online survey. For the physical face-to-face administration, the hard-copy questionnaire was distributed to; (1) workers at the Polyplastics facility in Balok, Kuantan; and (2) patients in IIUM Hearing Clinic in Jalan Hospital Building (JHB). For the online survey, the questionnaire was distributed widely through personal communication application using Google Form.

Instrumentation

The study used a Modified Khalfa Hyperacusis

Questionnaire (MHQ) that was developed by Khalfa, Dubal, Veuillet, Perez-Diaz, Jouvent, & Colletin 2022., comprising two parts, participant information and questionnaire items with a 3 point- scoring level ranging from "no" (scoring 0 points), "sometimes" (scoring 2 points), to "yes" (scoring 5 points) (Am Alkharabsheh A-F & Alaqrabawi, 2021). This questionnaire consisted of 20 self-rating items isolated into three dimensions: 1) functional (questions 1–7, total score 0–35), social dimension (questions 8–13, total score 0–30), and emotional dimension (questions 14–20, total score 0–35). respectively. The possible total index score was 100 and the severity of the hyperacusis was determined based on the total score.

Data Collection

The data was gathered over a three-month period. An informed consent form and research information sheet was included in the first page of the form to ensure the participants have a clear understanding of their involvement. Participants were required to read and sign the informed consent form to signify their voluntary agreement to participate in the research. Alongside the consent form, the questionnaire was included in the next page of the form. Clear instructions were provided for participants to accurately complete the questionnaire. The subjects were asked to provide their name, age, and gender for recording purposes and to obtain basic participant information.

Following data collection, all study participants were divided into two groups based on their responses to an extra question on their history of overall job exposure: 1) An experimental group for employees exposed to noise at work, and 2) A control group for employees not exposed to noise at work.

Data Analysis

In this study, IBM SPSS Version 20 was used in the analysis of the quantitative data. By analysing the survey data, quantitative analysis was used to calculate the frequency and percentage. Then, all relevant tables were interpreted in reference to the study's objectives.

RESULTS

A total of 95 completed surveys were collected: 44 males (46.3%) and 51 females (53.7%). The age of participants ranged from 20 to 59 years old. As in Table 1, the majority of the age group participating in the study were young adults, ranging from 20 - 31 years old. Conversely, older adults who are 60 years and above were excluded due to health and comorbidity considerations. Older aged adults are more likely to have age-related health conditions and comorbidities that can influence their experience and reporting of hyperacusis symptoms. Forty-nine participants (51.6%) reported as having the risk of exposed to occupational noise and 46 participants (48.4%) reported of not having any risk being exposed to occupational noise. History of exposure to occupational noise was the independent variable of the study. Occupational noise exposure history was collected by asking participants to report, in free text, every occupation and the working nature they had ever held throughout their working life.

Table 1: The demographic of respondents

Variable	Mean (*SD*)	*n* (%)
Age (years)	1.35 (0.50)	
Young adults		63 (66.3)
Middle-aged adults		31 (32.6)
Old adults		1 (1.1)
Gender	1.46 (1.00)	
Male		44 (46.3)
Female		51 (53.7)
Noise Exposure	1.48 (0.50)	
Yes		49 (51.6)
No		46 (48.4)

Objective 1

Table 2: The awareness about the existence of hyperacusis or reduced tolerance toward sound among adults

Variable	n	Percentage (%)
Awareness of hyperacusis		
Yes	40	42.1
No	55	57.9
Are you familiar with hyperacusis (reduced tolerance towards sound)?		
Yes	11	11.6
No	84	88.4

Based on the data, 42.1% of participants were aware of hyperacusis, and of those, only 11.6% were more knowledgeable about how the decline in sound tolerance may affect their quality of life. On the whole, this result indicates that most of workers in Malaysia are not sufficiently knowledgeable on the existence of hyperacusis or reduced tolerance toward sound.

Objective 2

Table 3 shows the total number of participants and its percentage based on the severity. Severity of hyperacusis was further described by the categorization of total score MHQ into 4 levels; normal (0 to 10), mild (12 to 40), moderate (42 to 60) and severe (>62) (Abdul et al., 2022). Among the 46 participants, a significant percentage (95.7%) demonstrated varied degrees of hyperacusis.

Specifically, 63% of participants had mild hyperacusis, while 19.6% and 13% were categorised as having moderate and severe hyperacusis, respectively. 4.3% of participants did not exhibit hyperacusis, suggesting that prolonged exposure to noise levels at work may be one of the causes contributing to participants' hyperacusis.

Table 3: Occupational Noise Exposure. The existence of hyperacusis among Malaysian adult workers who are exposed to occupational noise with Modified HQ scores (n: 46)

Score	Degree	N (%)
0 - 10	Normal	2 (4.3)
12 - 40	Mild	29 (63.0)
42 - 60	Moderate	9 (19.6)
62 - 100	Severe	6 (13.0)

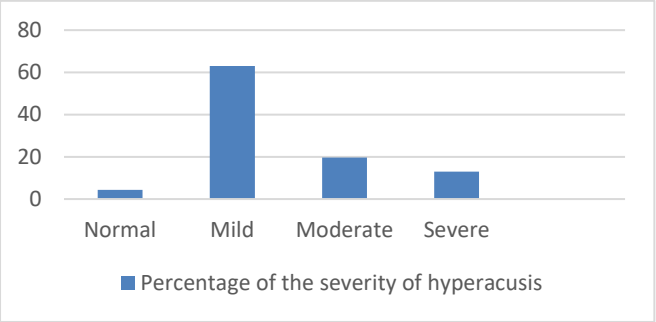

Figure 1: Percentage of the severity of hyperacusis

Figure 1 shows that most of the subjects participating in this study reported having mild hyperacusis indicating that sound tolerance is a common problem seen in occupational noise exposure workers, especially youngsters.

Objective 3

Shapiro-Wilk test revealed that the data was not normally distributed. Therefore, the Mann-Whitney U test (non-parametric) was performed to determine the influence of work history between these 2 groups and the total MHQ scores.

Table 4: Mann-Whitney U Test comparing the level of hyperacusis by calculating the total Modified HQ scores between adults with occupational noise exposure and without occupational noise exposure (n = 95)

	Level of hyperacusis	
	Occupational Noise Exposure	Non-occupational Noise Exposure
N	49	46
Mean	42.55	53.11
Mann-Whitney, U	-1.869	
Sig. difference, *p*	0.62	

Table 4 presents the comparing the level of hyperacusis by calculating the total Modified HQ scores between occupational and non-occupational job exposure. Results showed that Group 1 (occupational noise exposure) with a sample size of 49 and a mean rank of 42.55 and Group 2 (non-occupational noise exposure) with a sample size of 46 and a mean rank of 53.11. The Mann-Whitney value is -1.869 while the *p*-value is 0.62, suggesting that there is no significant difference in total Modified HQ scores between these two groups of workers.

DISCUSSION

Awareness of Hyperacusis

Hyperacusis, an abnormal sensitivity to everyday sound levels that are not uncomfortable to others, remains significantly under-recognized in the workplace. Although there is little awareness among companies and employees, noise exposure is a major contributor to hyperacusis and can have a serious negative influence on people's productivity and quality of life.

As shown in Table 2, the awareness of hyperacusis is still lacking among industry workers, with 42.1% of the participants were unaware of hyperacusis. One primary reason for the low awareness of hyperacusis in industrial environments is its subtle symptoms. Unlike more obvious occupational hazards such as chemical exposure or physical injuries, hyperacusis symptoms can be easily overlooked or incorrectly attributed to other causes. Consequently, affected individuals might suffer in silence, unaware that their discomfort is due to a legitimate medical condition. Furthermore, hyperacusis often coexists with other auditory issues such as tinnitus or hearing loss, further complicating its diagnosis and management. This overlapping symptom can lead to misdiagnosis or inadequate treatment, perpetuating the lack of awareness around hyperacusis.

Another contributing factor is the lack of education and training among employers, occupational health professionals, and workers. Unlike more well-known conditions such as noise-induced hearing loss or tinnitus, hyperacusis is rarely addressed in workplace health programs. Employers may ignore the need for noise control or accommodations, causing ongoing discomfort for affected employees.

Addressing the low awareness of hyperacusis in workplaces requires a multifaceted approach involving education, policy changes, and cultural shifts. Employers should prioritize noise management strategies, conduct regular assessments of noise levels, and provide accommodations for employees with hyperacusis. Training

programs should include information on recognizing, preventing, and supporting hyperacusis to create an inclusive and supportive work environment.

The existence of hyperacusis among Malaysian adult workers who are exposed to occupational noise with Modified HQ scores

The primary finding of this study is the significantly increased risk of hyperacusis among adults working in occupational noise exposure, objectively assessed using the total HQ scores, compared to those with non-occupational exposure. The Modified Hyperacusis Questionnaire is a screening tool that can be used for early identification of hyperacusis in the adult population. The results revealed that more than half of the noise-exposed participants were reported having hyperacusis. Our sample mostly included people who are at risk of developing hyperacusis, such as industrial workers, and most of them were males. Only 4% of the participants had normal sound tolerance/ no hyperacusis. This result revealed that this group's occupation consists of officers and process technicians who answered "no" for both questions of "Do noise levels prevent conversation with co-workers in a normal voice level when at work?" and "Is a raised voice needed to communicate with someone about one meter away?". Therefore, we can conclude that both workers were not directly in contact with the noise at their work that can lead to hyperacusis.

Noise-induced auditory conditions such as hyperacusis typically exhibit a gradual onset rather than sudden occurrence. Occupational noise exposure can initially induce mild hyperacusis, marked by discomfort in response to moderately loud noises, which may not significantly impede daily activities. Continued exposure to high noise levels can cause some individuals to develop moderate to severe hyperacusis, characterized by substantial distress and functional impairment. However, the progression to severe stages is not universal and is contingent upon factors like the intensity and duration of noise exposure, the use of hearing protection, and individual biological susceptibility (Baguley, 2003). Research indicates that prolonged exposure to excessive noise can result in auditory hypersensitivity due to alterations in central auditory processing, notably within the auditory cortex and brainstem. These neurophysiological changes may account for the higher prevalence of mild hyperacusis compared to the fewer cases of severe symptoms (Fredriksson et al., 2021).

Different people react differently to noise, which is why the severity of hyperacusis varies between workers. Whether someone develops mild, moderate, or serious hyperacusis could be based on whether they have any hearing problems and how their brain processes sounds differently. Underlying neurological conditions like migraines or tinnitus have been associated with higher sound sensitivity and may make hyperacusis worse (Tyler et al., 2014). Subsequently, psychological factors such as anxiety and stress can also exacerbate hyperacusis symptoms given that strong emotional responses lead to higher sensitivity towards sound (Aazh et al., 2018). As a result, while most workers exposed to occupational noise develop only mild hyperacusis, a smaller proportion progresses to moderate or severe cases due to these individual differences in auditory susceptibility.

Level of hyperacusis between adults with occupational noise exposure and without occupational noise exposure using Modified HQ scores

The assumption that one's working environment, especially in noisy environments, directly influences the development and severity of hyperacusis is not strongly supported by research and clinical observations. This study also revealed that there is no significant difference in the existence of hyperacusis between those with and without occupational noise exposure with among the workers.

Several factors contribute to the absence of a clear association between occupation and hyperacusis, including individual susceptibility, non-occupational noise exposure, and occupational safety measures. The variability in individual susceptibility to hyperacusis means that not all individuals working in noisy environments develop hyperacusis. One possibility is that chronic exposure to noise leads to a form of auditory adaptation, effectively lessening workers' sensitivity to loud sounds. This desensitization, rather than sensitization, could account for the unexpected results. Furthermore, a "healthy worker effect" may be at play. Individuals with heightened noise sensitivity might self-select out of noisy occupational environments. This potential selection bias could skew the composition of the exposed group toward those more resilient to hyperacusis.

Secondly, it is also important to acknowledge that the non-exposed group may encounter other stressors, both auditory and psychological, that could contribute to hyperacusis. Factors such as sudden loud noises, high-pressure work environments, or mental fatigue, though distinct from sustained occupational noise exposure, could influence their reported hyperacusis scores. Further research is needed to disentangle these complex interactions and gain a clearer understanding of the relationship between noise exposure and hyperacusis.

Thirdly, hearing loss within the exposed group could contribute to lower hyperacusis scores. While seemingly

contradict, hearing loss often a consequence of prolonged noise exposure which can lessen the sensitivity to lower intensity sounds, potentially masking hyperacusis symptoms (Fredriksson et al., 2021; Sheppard et al., 2020). Therefore, while they may still experience hyperacusis, its perceived intensity decreased due to the underlying hearing loss (Baguley, 2003; Plack et al., 2014). However, the relationship between hearing loss and hyperacusis is complex and yet to be fully understood (Baguley, 2003). While they may co-occur, one does not necessarily cause the other. Further research incorporating audiometric testing and psychosocial assessments is needed in order to gain more input on the relationship between noise exposure and hyperacusis existence.

CONCLUSION

In conclusion, while there is a general awareness among workers regarding hyperacusis, there is a clear need for more targeted efforts to enhance this understanding and promote consistent noise reduction practices at work environment. This underscores the need for education and occupational safety regulations to enhance workers' awareness and management of noise in the work environment to create conducive working spaces for them.

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THE IMPLICATION OF THE STUDY

The research can be the basis for public health campaigns and educational initiatives aimed at raising awareness of employers who are routinely exposed to loud environments to implement better hearing protection practices. This study also may stimulate further research in the field, encouraging the exploration of and a deeper understanding of hyperacusis. Besides, this study is believed to become a turning point to initiate training and workshops for employees in Malaysia to enhance knowledge regarding risk of hyperacusis.

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