Short Communication
Association Between Occupational Noise Exposure and Depression

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ABSTRACT

Noise-induced hearing loss (NIHL) is a common occupational disorder. Previous studies have investigated the role of hearing deprivation in mood disorders, especially depression. The aim of this study was to elucidate the relationship between NIHL and depression in employees of an iron ore plant. This was a cross-sectional study on 409 employees with at least one year of job experience. In order to assess the association between noise exposure and NIHL with depression, and based on the results of audiometry, employees were categorized into three groups: without noise exposure, with noise exposure and without hearing loss, and with noise exposure and hearing loss. The Beck depression inventory II (BDI-II) was used to assess the degree of depression. Demographic data and the BDI-II scores were compared among the three groups. The Mean±SD age of the participants was 34.43±7.8 years. The BDI-II score was significantly higher in employees with noise exposure (with and without hearing loss) than in employees without noise exposure (P<0.001). Categorical analysis of the BDI-II score showed a significantly higher prevalence of normal patients in patients among those without noise exposure compared to the two other groups (P<0.05). The results of this study showed that depression was more prevalent in employees with exposure to noise in their workplace, regardless of suffering from NIHL, than in employees without noise exposure.

Keywords: Noise, Noise-induced hearing loss (NIHL), Occupational exposure, Mood disorder

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Introduction

Noise, as an environmental and occupational exposure, is a factor that can significantly affect humans' physiologic balance through mechanisms such as free oxygen radical production and can impact both physical and mental health [1]. It is defined as the most frequent physical hazard in many industries, and millions of workers are exposed to noise levels higher than the permissible exposure limit (PEL) [2]. Environmental exposure to noise, such as exposure to traffic noise, has been noted as a source of hearing loss [3].

Several studies have been conducted on the effects of noise on human physical and mental health, and almost all have shown a positive relationship between exposure to noise and some disorders [1, 4]. Exposure to loud noise may deleteriously affect hearing, the cardiovascular system, mental health, and performance [5].

The most frequent health effect of noise is on the hearing system, which can lead to noise-induced hearing loss (NIHL) [5]. NIHL is probably associated with other problems, such as hypertension, certain mental disorders, and decreased quality of life. Lie et al. found a higher frequency of mental disorders and lower job performance in noise-exposed workers [6]. Zeydabadi et al. showed that noise exposure affects some human cognitive functions, such as attention and memory [7]. Another study showed that workers suffering from NIHL have lower performance in some cognitive domains [8].

Presbycusis and NIHL affect quality of life and may lead to disturbance in social behaviour, making patients prone to depression and anxiety [2]. The relationship between hearing loss and depression is somehow complex, and several factors, such as social separation, communication problems, and physiologic changes, may play a role. Some studies have shown an independent relationship between hearing loss and depression [5, 9, 10]. Deng et al. found a positive relationship between NIHL and depression [2]. A cohort study with 12 years' follow-up found a positive relationship between hearing loss and depression, independent of age, gender, and background diseases [11]. Additionally, some studies indicate that using hearing aids, which improve communication, may decrease the frequency of depression [12].

Due to the importance and high frequency of NIHL and depression, this study was performed to compare the frequency of depression among three groups of workers, considering their exposure to noise and suffering from NIHL.

Methods

This cross-sectional study was conducted on 409 workers of Bafgh iron ore mine, Yazd, Iran. Workers with at least one year of work experience were included in the study. The study was performed from March 2022 to March 2023.

The workers with a history of any kind of hearing loss except for NIHL, such as conductive and mixed hearing loss, presbycusis, and unilateral hearing loss, were excluded. Also, any kind of mental disorder except for depression, such as anxiety, psychotic disorders, and bipolar mood disorders, was excluded from the study. NIHL was defined as a sensory-neural hearing loss characterized by one of the following patterns: 1) Mean hearing threshold at 3000, 4000, and 6000 Hz higher than 15 dB in each ear; or 2. An audiometric notch (a difference of more than 10 dB between the frequency with the notch and the previous and subsequent frequencies) at one of the following frequencies: 3000, 4000, or 6000 Hz [13].

Participants were randomly selected from the workers referred for annual occupational health screening examinations using simple random sampling with a random digits table.

Initially, a questionnaire consisting of demographic information, exposure to noise, and past medical history was completed for each participant. The information about the exact exposure to noise was extracted from the environmental noise monitoring results of the plant, and the equivalent continuous sound level for 8 hours was recorded for each participant. Pure tone audiometry (PTA) was done by an expert audiologist in an acoustic chamber that met the ANSI guideline [14]. A diagnostic audiometer (Madsen AC40, Denmark) was used to record hearing thresholds at the following frequencies: 250, 500, 1000, 2000, 3000, 4000, 6000, and 8000 Hz. A TDH-39 headphone and an oscillator were used for recording air conduction (AC) and bone conduction (BC) thresholds, respectively. BC testing was conducted to rule out conductive hearing loss. The audiometric tests were carried out after at least 16 hours of abstinence from exposure to noise.

The participants were divided into three groups according to exposure to noise and suffering from NIHL: 1) Control group (n=168): Without present or previous exposure to noise and with normal audiometry; 2) Noise group (n=169): With previous or present exposure to noise (higher than 85dBA) without NIHL; and 3) NIHL group (n=72): With exposure to noise (higher than 85 dBA) and with NIHL. Data about previous exposure to noise were extracted from occupational health files.

Then, the Beck depression inventory II (BDI-II) was administered to each participant. This questionnaire consists of 21 questions and is used to evaluate the severity of depression [15]. According to the BDI-II score, the participants in each group were categorized into the following categories: Normal (0-10), mild mood disturbance (11-16), borderline clinical depression (17-20), moderate depression (21-30), severe depression (31-40), and extreme depression (>40).

Data were analysed by SPSS software, version 24. The Kolmogorov-Smirnov, chi-square, and Kruskal-Wallis tests were used for data analysis. Confounding factors, such as other mental disorders and other types of hearing loss were considered as exclusion criteria.

Results

Totally, 409 workers of an iron ore mine with different jobs entered the study. Their Mean±SD age and work experience were 34.43±7.86 years (range: 20-63 years) and 5.09±4.97 years (range: 1-23 years), respectively. The mean BDI score was significantly lower in the control group compared to the other groups. Table 1 compares the mean scores of BDI, age, and work history among the three groups. Mean age and work history were significantly higher in the NIHL group.

Most participants in all three groups were normal according to the BDI-II score. The frequency of depression was 2.4%, 11.7%, and 9.6% in the control, noise, and NIHL groups, respectively, and the frequency of depression was significantly different between the control and noise groups (OR=4.97, 95% CI; 1.74%, 14.23%, P=0.001), and between the control and NIHL groups (OR=4.41, 95% CI; 1.25% ,15.59%, P=0.02). However, there was no difference in the frequency of depression between the noise and NIHL groups (OR=0.81, 95% CI; 0.32%, 1.99%, P=0.82). Table 2 shows the frequency of different severities of depression in the three study groups (control, noise, and NIHL).

Table 1. Mean BDI score, age, and work experience in the control, noise, and NIHL groups

Study Group	Mean±SD		
	BDI Score	Age (y)	Work History (y)
Control	1.4±3.4	33.0±7.0	4.1±4.0
Noise	4.5±6.2	32.0±6.0	4.0±4.0
NIHL	4.8±8.7	41.0±8.0	8.0±5.0
P	<0.001	<0.001	<0.001

Table 2. The frequency of different severities of depression in the three groups according to the BDI score

Severity of Depression	No. (%)		
	Study Groups		
	Control (n=168)	Noise (n=169)	NIHL (n=72)
Normal	164(97.6)	149(88.1)	65(90.2)
Mild mood disturbance	2(1.2)	8(4.7)	2(2.8)
Borderline clinical depression	1(0.6)	1(0.6)	1(1.4)
Moderate depression	0	7(4.1)	3(4.2)
Severe depression	1(0.6)	1(0.6)	1(1.4)
Extreme depression	0	3 (1.8)	0

Discussion

The present study compared the frequency of different severities of depression among the three groups of workers (control, noise, and NIHL groups) and found a significantly higher BDI score in those exposed to noise, regardless of suffering from NIHL or not, compared to workers without exposure to noise. The frequency of depression was significantly higher in those exposed to noise compared to the control group.

NIHL is one of the most frequent occupational disorders, and there is no known treatment for it. It is an irreversible sensory-neural defect, which is caused due to the damage to sensory hair cells in the cochlea. Occupational, environmental (traffic noise, airport noise, etc.), and recreational (using portable music players, hands-free, etc.) noise exposure can cause NIHL.

A systematic review in Iran found a wide range of prevalence for NIHL (12.9% to 60.5%) in different studies [16], indicating a high prevalence for this condition. Another systematic review in China found a prevalence of 30.2% for NIHL among Chinese workers [17]. Studies have shown that NIHL and some of its complications, such as communication problems, stress, and social separation, are probably associated with some mental disorders, especially depression and anxiety [18].

Auditory perception requires both peripheral auditory perception and central auditory processing. Therefore, impairment in auditory processing and speech recognition may affect auditory performance. Previous studies have shown impaired cognitive function in those suffering from hearing loss [19]. A study on textile workers showed that workers suffering from NIHL had a lower working memory than workers without NIHL [8]. Multiple cognitive functions, including executive function, verbal memory, and attention, are impaired in depressed patients [20]. In addition, reduced activity, lack of motivation, worry, and inability to plan can reduce auditory input and central auditory pathway processing [19]. In contrast, untreated hearing loss leads to impairments in communication and social relationships, which have been reported to be associated with cognitive impairment and depression [21].

In terms of neurological function, hearing loss reduces the activity of central auditory systems, which in turn increases cognitive load and disrupts emotional relationships [22]. This perception can be applied to the present study and can be considered a reason for the higher prevalence of mood disorders in the population of employees exposed to noise.

We found a strong association between exposure to noise and suffering from depression, although the wide confidence interval decreases the accuracy of the results. The difference in age between the groups may have also affected the results of the current study. Hsu et al. found an odds ratio of 1.74 for depression in patients suffering from hearing loss [11], which is consistent with the results of the current study; however, we found a positive odds ratio for those exposed to noise, regardless of whether they developed NIHL. Thus, the mechanisms described in some studies regarding the association between hearing loss and depression, such as feelings of frustration and communication problems [23], cannot be applied in this study. Another mechanism proposed is the relationship of certain neurotransmitters (e.g. serotonin and sertraline) with both depression and hearing loss [24].

Some studies have assessed the effect of environmental or occupational noise exposure on mental health. Beutel et al. in a large population-based study in Germany, found an association between strong noise annoyance (especially aircraft noise) and depression and anxiety in the general population [25]. Yoon et al. in a large study in Korea, found a strong association between occupational noise annoyance and depression, similar to the results of the current study [26]. The association between exposure to noise and its related annoyance with mental disorders, such as anxiety and depression, may be due to the stress induced by the exposure to noise and its associated complications.

It should be noted that the findings of this study should be interpreted with consideration of its limitations. Since this study was cross-sectional, it is not possible to clarify the causal relationships between depression and exposure to noise. There were many confounders that could not be controlled in this study, such as economic status and shift work. It is recommended to conduct prospective and longitudinal studies to find a more precise relationship between noise exposure and depression.

Conclusions

The results of this study showed a higher BDI score and a higher frequency of depression (according to the BDI categorization) in the workers exposed to noise and those suffering from NIHL compared to the control group without exposure to high noise.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of Shahid Sadoughi University of Medical Sciences, Yazd, Iran (Code: IR.SSU.MEDICINE.REC.1400.087).

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Authors' contributions

Study design: Mahmood Vakili; Data collection: Reza Saadatmand and Mohammad Hossein Davari; Revising the manuscript and data interpretation: Mahmood Vakili and Amir Houshang Mehrparvar; Conceptualization, preparing the manuscript and final approval: All authors.

Conflict of interest

The authors declared no conflicts of interest.

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