

**THE PREVALENCE OF NOISE- INDUCED TINNITUS AMONG WORKERS IN SYRIA,
AND ITS RELATED FACTORS**

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Article Received on 13/06/2020

Article Revised on 23/07/2020

Article Accepted on 03/08/2020

ABSTRACT

Objectives: This cross- sectional study aimed to investigate the prevalence of noise-induced tinnitus and its relationship with other related factors. **Methods:** The study group was composed of 111 workers exposed to noise. Each ear was treated as a separate sample giving a sample size of 222. Workers were evaluated by filling in a form, clinical examination and undergoing a pure-tone audiometry. Noise levels in work place were also measured. **Results:** 28.8% of our sample complained of tinnitus, while 22.5% complained of hearing loss. Of those with tinnitus, only 21% complained of an associated hearing loss. Mean thresholds were higher in workers with tinnitus, and the highest difference between the mean thresholds was on the frequencies 4000 Hz and 6000 Hz. Mean age of workers with tinnitus was 31.1 years old, compared with 39.8 years old for those without. Other factors, showed no significant differences. **Conclusion:** The prevalence of tinnitus among workers exposed to noise was higher than that of hearing loss. Workers with noise induced tinnitus have higher thresholds on audiograms, especially on the 4000Hz and 6000Hz, which are also the frequencies on which noise- induced hearing loss begins, hence demonstrating a relationship between the two. The tinnitus complaint may be a prodromal symptom to hearing loss. Tinnitus was also found to be higher in younger ages. Finally, no correlation was found between tinnitus and noise levels, and between tinnitus and lifetime cumulative exposure to noise.

KEYWORDS: Noise-induced tinnitus, noise-induced hearing loss.**INTRODUCTION**

Tinnitus is defined as the perception of a sound, similar to ringing or hissing, in the absence of external physical stimuli.^[1] It may be either temporary or chronic.^[2] Tinnitus has been known to be “one of the most challenging symptoms in otology”^[3] (Sataloff & Sataloff, 1987, p. 397) and occurs in 15% of the population.^[4]

Mechanisms of the pathophysiology of tinnitus has not yet been fully understood, which therefore explains the lack of a gold standard of treatment. Nevertheless, scientist have agreed that generation of these sound stimuli occurs in the brainstem as a response to the decreased auditory input from the cochlear nerve fibers, which in turn causes either decrease or increase in spontaneous neuronal activity (SNA) in auditory-related brain regions. This occurs when cochlear nerve fibers are damaged.^[5,6]

Until now, the most known cause of this damage is environmental noise exposure, of which occupational is the most common.^[7]

The exposure to high sound levels can induce metabolic and mechanical changes in the organ of Corti, resulting

in temporary or permanent hearing threshold shifts¹. However, noise induced hearing loss (NIHL) is not recognized at the beginning of the injury^[8], but noise induced tinnitus is a common complaint even with patients with normal audiograms.^[4] Studies show that loss of synapses and nerve fibers in the cochlea may still be occurring despite the absence of any change in the audiometric thresholds after exposure to noise.^[5]

Tinnitus can become a strain on the patient's daily life, especially in chronic cases, as it may lead to impaired concentration, anxiety, sleep disturbances, and difficulties in communication. These comorbidities of emotional distress signify the presence of maladaptive functional connections between the central auditory pathway and the limbic system.^[9]

Several studies in different countries have been conducted in to study the prevalence of noise-induced tinnitus (NIT). Results of these studies showed that temporary noise induced tinnitus was more prevalent than chronic, as the percentage of temporary tinnitus ranges between 15% and 75% for teenaged group, and between 58% and 70% for young adults, while the chronic ranges between 3% and 9% for teenagers and between 5% and 10% for young adults.^[1]

A study conducted in Flanders Flemish young adults that were frequently exposed to leisure noise reported temporary tinnitus in by 73.5% and chronic tinnitus by 6.6% of the patients.^[1]

The aim of our study is to access the prevalence of occupational noise-induced tinnitus among workers in the capital city of Syria, Damascus. We then evaluated the relationship between tinnitus and other factors that included age, noise levels, total years of exposure to noise, and audiogram results. The study was conducted in two different industries, on workers exposed to noise levels of 85 dB and above.

METHODS

A cross-sectional study was conducted on three factories in Damascus and its suburbs. The workers were picked out from a workplace with high noise levels in a random manner.

Inclusion & exclusion criteria

The inclusion criteria required workers to be between 10 to 60 years old, working 6 days per week, and working around 8 hours a day.

All workers aged above 60 years old or with an active infection, a wax plug, otosclerosis, vestibular vertigo, or any other disease that may cause cochlear damage, such as Meniere's disease etc., were excluded from the sample.

Sample size

Sample size was calculated using an application on the internet all Sample Size Calculator, with a 95% confidence interval.

The study sample 111 workers that matched the inclusion and exclusion criteria mentioned above. Each ear was treated as a separate sample as each was tested for hearing thresholds separately. Thus, the sample size becomes 222 ears.

Data collection

Data was collected using a form that was filled in by the researcher. The form covered socio-demographic information including age, and gender, work-related information like working hours and job duration, ear complaints related to the study, as well as the measured noise level in the workers section.

Noise levels were measured by a “” Digital sound level meter”” of the brand “Hold peak” HP882a. The measurement was repeated three times and the mean value was taken.

Ears were examined by an otoscope, and Tuning forks tests were then performed. Each worker was then placed in an audiometric test room to take a Pure-tone audiometry using (Interacoustics Diagnostic Audiometer AD229 b) with Peltor H7A supra-aural earphones. The audiometer was calibrated prior to the study.

RESULTS

Table 1: The age distribution of the 222 workers.

Age (years old)	Frequency	Percentage
10-20	20	9.0 %
21-30	38	17.1%
31-40	86	38.7%
41-50	52	23.4%
51-60	26	11.7%
Total	222	

Table 2: The prevalence of tinnitus and hearing loss among the 222 samples.

	Tinnitus	Hearing Loss
Total	222	222
N	64.0	50.0
%	28.8%	22.5%

Table 3: Workers complaining of both tinnitus and hearing loss and those only of tinnitus.

	Tinnitus with hearing loss	Tinnitus without hearing loss
Total	64	64
N	13	51
	20.31 %	79.69%

Table 4: Mean thresholds on all frequencies for workers with tinnitus complaint.

Frequency (Hz)	125	250	500	750	1000	1500	2000	3000	4000	6000	8000
N	64	64	64	64	64	64	64	64	64	64	64
Mean	18.75	21.79	22.57	23.04	25.85	24.68	22.50	29.53	39.21	36.95	26.95

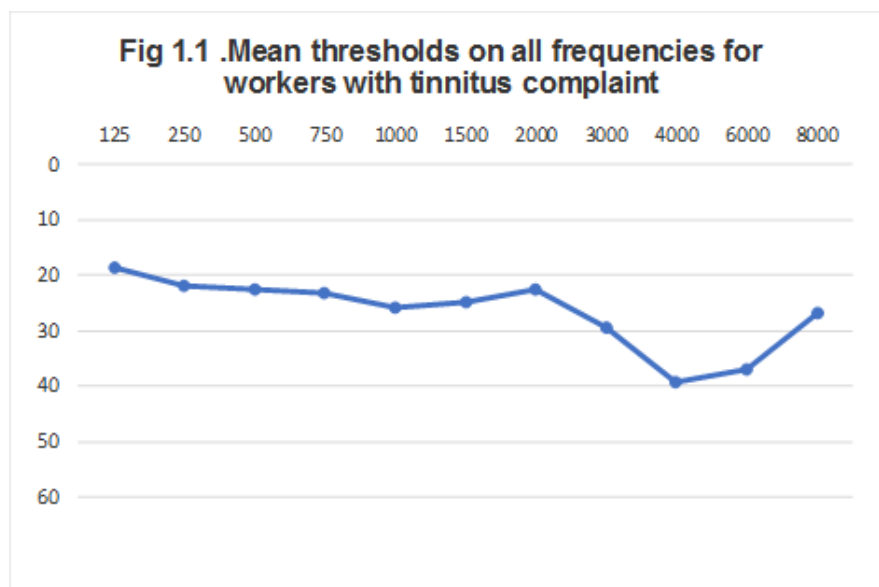


Table 5: Mean thresholds on all frequencies for workers without tinnitus complaint.

Frequency (Hz)	125	250	500	750	1000	1500	2000	3000	4000	6000	8000
N	158	158	158	158	158	158	158	158	158	158	158
Mean	17.62	19.96	19.62	19.84	22.34	21.45	19.90	26.36	32.47	30.19	26.77

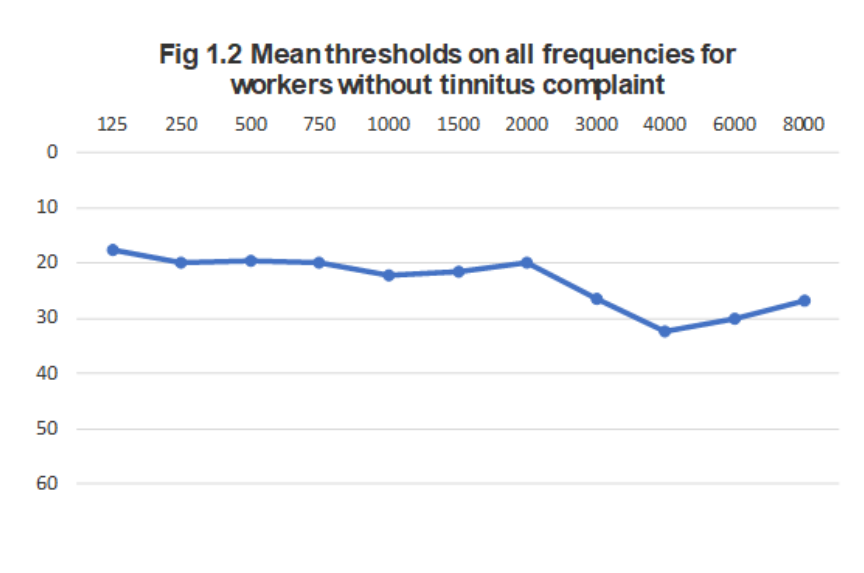


Table 6: Differences of mean thresholds between tinnitus and no-tinnitus groups on all frequencies.

Frequency (Hz)	125	250	500	750	1000	1500	2000	3000	4000	6000	8000
Difference	1.13	1.83	2.95	3.2	3.5	3.23	2.6	3.17	6.74	6.76	0.18

Table 7: Mean age of workers with and without tinnitus complaint.

	Tinnitus	No Tinnitus
Mean (Years old)	31.1	39.8

Table 8: Mean noise exposure level of workers with and without tinnitus complaint.

	Tinnitus	No Tinnitus
Mean (dB)	92,78	91.86

Table 9: Mean total working years and tinnitus complaint.

	Tinnitus	No Tinnitus
Mean (years)	10.84	10.10

DISCUSSION

Throughout the literature, data analysis and epidemiological studies show that exposure to noise is one of the most common causes of tinnitus, estimated at about 20.7% according to Hazell, 28% according to

Axelsson, and 42% according to Palmer.^[10] It is, in fact, one of the first symptoms of hearing loss^[11], which, in turn, is the occupational health problem most prevalent in industrial environments.^[12] Other than occupational noise, Noise-induced permanent tinnitus (NIPT) can also derive from leisure noise or even acoustic trauma.^[13]

In our study, the prevalence of tinnitus among the workers was only 28.8%, which contradicted the results found by other studies in literature, where tinnitus accounted for more than 50% of the sample. Sulkowski^[10], for example, found tinnitus in 70.4% of the sample, and by Williams & Carter^[14] found tinnitus in 63%. Another study conducted among Flemish young adults showed tinnitus in 74.9% of the sample after leisure noise exposure.^[1]

In our sample, the number of workers complaining of tinnitus was higher than those complaining of hearing loss, which is compatible with Degeest and Kepler's study.^[1] Also, only 21% of the sample with positive tinnitus complaint had an associated hearing loss. This matched only one study that found the association in about 11% of the sample only^[15], and differed from the results of other studies where one showed an association in 95.8% of the sample^[13], and another found it in 80%.^[14]

Over the literature, most studies detected a relationship between noise-induced tinnitus and the frequencies at which hearing loss was mostly affected on audiograms of the workers. These frequencies ranged mostly between 4000 Hz to 6000 Hz.^[10,13,16] This suggests that noise-induced tinnitus may be caused by the damage on the cochlea at the same spot affected in noise-induced hearing loss.^[16] Similarly, our audiogram results demonstrate that hearing loss is greater in subjects with tinnitus compared to those without (tables 4 and 5, Figures 1 and 2). Also, the most significant difference in mean thresholds between the two groups, (hence the highest degree of hearing loss difference) was on the frequencies 4000 Hz and 6000 Hz, which is the most common frequency of noise-induced hearing loss (Tables 4,5 and 6).

When relating the hearing loss complaint and the audiometry results, data showed that although only 21% of the workers with tinnitus complained of hearing loss, audiometry results showed deeper hearing loss in samples with tinnitus compared with those without. This agrees with the idea that tinnitus may be one of the first symptoms of hearing loss.^[11]

Another study found no correlation between the pure tone hearing thresholds (by frequency) of those who experienced tinnitus and those who did not.^[14] In these cases of tinnitus with normal audiograms, researchers believe that this could be explained by diffuse damage of up to 30% of the outer hair cells throughout the spiral of the cochlea^[16], which is not yet enough to cause hearing

loss. To add to the topic, Hall and Haynes claim that individuals with tinnitus and normal hearing in the conventional frequency range may have worse hearing thresholds at high frequencies and failures in the otoacoustic emission.^[17]

Regarding the link between NIH and age, some studies found that the occurrence of tinnitus increases with age.^[13,15] In our study, the comparison between tinnitus complaint and the mean age of the workers showed that tinnitus was more prevalent among the younger group, mean age= 31.1 years old, compared with mean age of 39.8 years old for those with no tinnitus complaint (table 7). The mean age 31.1 years old is similar to a study conducted by Williams and Carter^[14], 27.8 years old. Although contradicting to other studies, this may be due to the fact that hearing thresholds are lower in younger patients, and hence the effect of noise damage if more enhanced. Other research found no statistically significant relationship was between the presence of tinnitus and age.^[18,19,20]

When looking at the noise exposure duration, we found no significant relation with the tinnitus complaint, agreeing with Griest and Bishop.^[20] On the other hand, some studies did find a direct correlation between the incidence of tinnitus and increasing cumulative, life-time noise exposure.^[13,21,22,23] Sulkowski saw that tinnitus prevalence was highest in operators with longer exposure duration (> 10 years).^[10]

Just like the noise exposure duration, no link was detected between the measure noise level in the work environment of the worker and having tinnitus. Not much studies in literature investigated this factor. The research that was conducted on Flemish young adults studied the exposure to noise in night clubs and venues, and revealed a significant higher lifetime noise level for nightclubs and music venues for subjects with chronic tinnitus (mean \pm SD 85.8 dBA; \pm 9.93) compared to subjects with temporary tinnitus (mean \pm SD 81.1 dBA; \pm 10.46) and subjects without tinnitus (mean \pm SD 79.8 dBA; \pm 10.09).^[1]

CONCLUSION

This was the first study on noise-induced tinnitus to be done in Syria. It was clear that the prevalence of tinnitus among workers exposed to noise was higher than that of hearing loss, and tinnitus may be a prodromal symptom of hearing loss. Workers with noise induced tinnitus have lower thresholds on audiograms, especially on the frequencies 4000 Hz and 6000 Hz, which are also the frequencies on which noise-induced hearing loss begins, hence demonstrating a relationship between these two. It was also shown that the tinnitus complaint precedes that of hearing loss and, hence, may be a prodromal symptom. Tinnitus was also found to be higher in younger ages. Finally, no correlation was found between tinnitus and noise levels and between tinnitus and life-time cumulative exposure to noise.

Compliance with Ethical Standards

Funding: This study was not funded by any institution.

Conflict of Interest: The authors of this study have no conflict of interest regarding the publication of this study.

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