OCCUPATIONAL NOISE INDUCED HEARING LOSS: IT'S FREQUENCY & RISK FACTORS

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ABSTRACT

Objective: To determine the frequency and risk factors of occupational noise induced hearing loss.
Study Design: Cross sectional study.
Place and Duration of Study: Dispensary Unit of Jaith Bhuta Sugar Mill near Rahim Yar Khan, Southern Punjab. from Aug 2017 to Jan 2018.
Methodology: This study was conducted using nonprobability consecutive sampling. n=300 workers of both genders aged 18-40 years were assessed. Basic demographic parameters, otoscopic examination and Pure Tone Audiometry were used for data collection. The Data was analyzed by using SPSS version 21.
Results: Study included 215 (71.7%) males and 85 (28.3%) females with male to female ratio of 2.53: 1 and mean age of 28.34 ± 4.61 years. The frequency rate of hearing impairment (HI) was 90 (30%) out of 300 respondents in this study. Out of 70 (100%) of respondents were affected with duration of job of 6-10 years. There was significant association between gender, age, education, duration of noise exposure with occupational noise induced hearing loss with *p*-value <0.001.
Conclusion: There was high frequency of occupational noise induced hearing loss (ONIHL) with significant risk factors being level and duration of exposure to noise (ETN), age, gender, education and hearing protective devices (HPD)'s.

Keywords: Exposure to noise, Frequency, Hearing protective devices, Hearing loss, Occupational noise.

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INTRODUCTION

Occupational noise is common cause of noise induced hearing loss (NIHL) as well as non-auditory effects like frustration, sleep disturbances, hypertension, cardiovascular diseases and cognitive impairment.[1] Though industry is a common place of noise pollution, however even cities in developing countries have unacceptable levels of noise demanding mitigation measures.[2]

The auditory effects of high noise level (HNL) are occupational noise-induced hearing loss (ONIHL) which has been documented as the primary and most direct health effect from exposure to noise (ETN). According to WHO, exposure to Occupational noise is second commonest risk factors at workplace.[3] Historically, certain occupations were recognized to produced hearing impairment (HI) and terms such as 'boilermakers deafness' and 'weavers deafness' were used,[4] however today a number of occupations are implicated to be at risk. These include working in foundries, construction, printing, factories, fire departments, police, troops as well as couriers, musicians, farmers, drivers and so many other.

With delayed identification of hearing loss in developing countries like Pakistan,[5] knowing the local prevalence or frequency, of ONIHL also becomes very important and necessary to plan preventive and mitigation measures. Prevalence of ONIHL ranges from 7-21%,[6] with higher prevalence reported in some studies.[7]

ONIHL occurs due to continuous or intermittent exposure to noise (ETN). It is labelled with Dobie's criteria which include bilateral neurosensory loss with high frequency loss rarely more than 75 dB and low-frequency loss rarely more than 40 dB, which stops with cessation of noise exposure. Also as HL progresses, rate of loss reduces. The loss is more at 300-6000 Hz, notch at 4000-Hz usually persists at advanced stage. Onihl usually results from damage to the inner hair cells in the cochlea resulting mechanical destruction and metabolic decompensation.[8] A number of risk factors have been implicated in causation of ONIHL including noise level, exposure time, area & frequency;

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individual susceptibility including genetic factors and age; vulnerability to environmental factors like chemicals, temperature and smoking; vulnerability to biological factors, comorbidities like diabetes and cardiovascular diseases and hearing protection devices (HPD)s.[9] ONIHL can be seen at intensities as low as 85 dB (8-hour time-weighted average) but increases progressively as sound intensity and exposure time rise with more harm caused by continuous noise exposure.[10]

Current options to deal with ONIHL include preventive measures to control risk factors and protection from noise. Also promising role of medicines including steroids, antioxidants has also recently been highlighted.[8] To prevent and overcome the problem of HL in workers due to exposure to occupational noise, it is essential to recognize the risk factors of ONIHL.

ONIHL is estimated to contribute to about 10% of the burden of adult hearing loss in west.[11] With a high prevalence of ONIHL 6, and nonuse of hearing protection and screening we expect a high frequency of ONIHL. This fact and the fact that literature on this topic is very scarce in our part of the world prompted us to conduct this study to determine the frequency and risk factors of ONIHL.

METHODOLOGY

This Cross-sectional study including a sample size of 300. Sample were recruited, using non probability consecutive sampling from Dispensary Unit at Jaitha Bhuta Sugar Mill near Rahim Yar Khan, Punjab, from August 2017 to January 2018 after obtaining ethics approval from Institutional Research Board vide Reg. no. 1509-M.Phil-HS-002 dated 27th July, 2017. Sample size of n=297 was calculated using sample size formula $N = \frac{z^2_{\alpha/2} * p * (1-p) * DEFF}{d^2}$, taking a prevalence of 27.18,[12] with 5% absolute precision and 95% level of significance. Following informed consent data collection was done by basic demographic sheet and pure tone audiometry after taking history including history and performing physical examination of the ear with otoscopy.

Inclusin criteria: Cases including both genders, aged 18-40 years, who attended dispensary unit of Jaitha Bhuta Sugar Mill and consented for inclusion in study.

Exlcusion criteria: Cases with co-morbidities like diabetes, hypertension, and cases of ototoxicity, conductive hearing loss and hearing loss prior to noise exposure.

Detailed history was obtained by face to face interview using patient history sheet and demographic sheet including history of noise exposure, occupation, hearing difficulties and wearing of HPDs followed by otoscopy and pure tone audiometry done in all cases. Otoscopy helped excluding cases with outer and middle ear pathologies. Noise levels in different sections/ parts of the industry were taken into account as per previous local study,[13] when considering the workers of different occupations working in the mill.

All participants were subjected to pure tone audiometry using pure tone audiometer (Model AD226 Denmark) in sound treated room by a qualified audiologist. Both ears were tested at 0.5, 1, 2, 4, 6 and 8 kHz frequencies. Using ascending method followed by descending to 0.5 kHz, as per the S 3.1-1991 specifications of American National Standards Institute (ANSI).

Data was organized in Microsoft Excel Worksheet followed by coding and statistical analysis in SPSS-21 utilizing descriptive statistics. For age the mean and standard deviation was calculated while frequencies were used for the rest of the variables. The main variable in the study was hearing loss and chi-square test was utilized to determine associations. Results were then compared with national and international literature and deductions made were discussed.

RESULTS

Current study population (n=300) included 215 (71.7%) males and 85 (28.3%) females with male to female ratio of 2.53: 1 and mean age of 28.34 ± 4.61 years. Majority of the population 127 (42.3%) was in the age group of 26-33 years with 120 (40%) in education were at higher secondary school level (Table-I).

The frequency of ONIHL was 90 (30%) (Figure). Out of 90 participants with ONIHL, majority i.e., 72 (80%) had bilateral HL As regards the severity of HL in cases with ONIHL, majority 61 (67.78%) had mild HL, 24 (26.67%) had a moderate HL and only 5 (5.5%) had severe HL (Table-II).

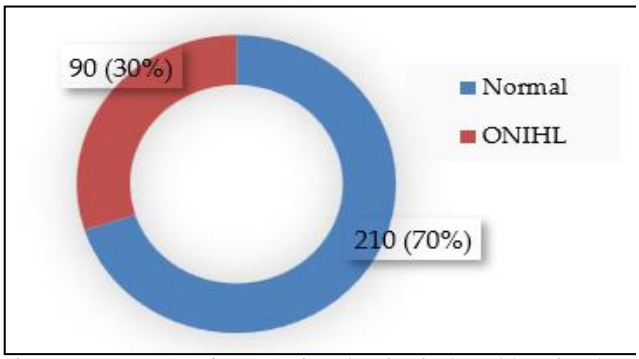

Figure: Frequency of occupational noise induced hearing loss (n=300).

Table-I: Basic demographic variables and association with occupational noise induced hearing loss (n=300).

Variable	Variable Characteristic	Occupational Noise Induced Hearing Loss		
		Absent n (%)	Present n (%)	*p*-value
Gender	Male	210 (70)	5 (1.67)	<0.001
	Female	-	85 (28.33)	
Age (Years)	18-25	78 (26)	-	<0.001
	26-33	127 (42.33)	-	
	34-40	5 (1.67)	90 (30)	
Education	Illiterate	30 (10)	-	<0.001
	SSC level	60 (20)	-	
	HSC level	120 (40)	-	
	Graduate	-	90 (30)	
Nature of Job	Coordinator	12 (4)	6 (2)	0.325
	Electricians	14 (4.67)	10 (3.33)	
	Human resource	22 (7.33)	8 (2.66)	
	Maintenance	32 (10.67)	8 (2.66)	
	Furnace operator	43 (14.33)	17 (5.67)	
	Lift operator	29 (9.67)	13 (4.33)	
	Generator operator	45 (15)	16 (5.33)	
	Boiler maker	13 (4.33)	12 (4)	
Length of Employment	1-5 years	210 (70)	20 (6.67)	<0.001
	6-10 years	-	70 (23.33)	
Duties hours	0-4	-	10 (3.33)	<0.001
	5-8	210	70 (23.33)	
	9-12	-	10 (3.33)	
Noise exposure (hours/day)	0-4	-	20(6.67)	<0.001
	5-8	210 (70)	50 (16.67)	
	9-12	-	20 (6.67)	
HPDs	Not used	145 (48.33)	90 (30)	<0.001
	Used	65 (21.67)	-	

Table-II: Frequency of type of occupational noise induced hearing loss (n=90).

Category		Frequency	Percentage
Unilateral/ Bilateral	Unilateral	18	20
	Bilateral	72	80
	Total	90	100
Severity of Hearing Loss	Mild	61	67.78
	Moderate	24	26.67
	Severe	5	5.55
	Profound	-	-
	Total	90	100

When frequency of degree of Hl was cross tabulated (Table-III) against Nature of job, chi-square revealed a statistically significant difference (p<0.001) with a high frequency in furnace operators,[17] followed by generator operators,[16] and sugar cane operators,[13] with 12 and 15 cases having mild and moderate HL among furnace operators; and 15 and 1 having mild and moderate Hl among generator operators 8, 1 and 4 cases among the 13 sugar cane lift operators had mild, moderate and severe HL.

Table-III: Association of severity of occupational noise induced hearing loss with nature of job (n=90).

Nature of Job	Frequency of degree of occupational noise induced hearing loss			*p*-value
	Mild n (%)	Moderate n (%)	Severe n (%)	
Coordinator	6 (6.67)	-	-	<0.001
Electrician	6 (6.67)	4 (4.44)	-	
Human Resource	7 (7.78)	1 (1.11)	-	
Maintenance	7 (7.78)	1 (1.11)	-	
Furnace Operator	12 (13.34)	5 (5.55)	-	
Sugarcane Lift operator	8 (8.89)	1 (1.11)	4 (4.44)	
Generator Operator	15 (16.67)	1 (1.11)	-	
Boiler Maker	-	11(12.22)	1 (1.11)	

DISCUSSION

Occupational noise induced hearing loss is the primary and most direct health effect from ETN. Industry being common place of noise pollution we conducted this study to determine the prevalence and risk factors of ONIHL with a sample of 215 (71.7%) males and 85 (28.3%) females and mean age of 28.34 ± 4.61 years. The frequency of Occupational noise induced hearing loss (ONIHL) was 90 (30%). Out of 90 participants with ONIHL, majority i.e., 72 (80%) had bilateral hearing loss (HL). As regards the severity in cases with ONIHL, majority 67.78% (61) had mild HL, 24 (26.67%) moderate HL and only 5.5% (5) had severe HL. Similarly a local study involving Aviation personnel reported a prevalence of ONIHL as 32% however in contrast to our study the severity of HL was mild in 40.62%, moderate in 43.75% and severe in 15.62%.[14]

In contrast to our study, Nelson *et al*, in their United States based study in 2005, reported the prevalence range of ONIHL of 7-21% 6 in various regions, however some studies report a higher prevalence including a Nepalese study by Robinson *et al*,[7] with reported prevalence of 31% of carpenters and 44% of sawyers; an Indian study by Ranga *et al,* with a reported prevalence of 39% in industrial workers in textile mills and hard strip rolling mills 15; Nyarubeli *et al*, with a reported significantly higher prevalence of 48% in iron and steel workers compared to 31%, in teachers 16; and Lopes *et al*, with a reported prevalence of 22.36% in drivers.[17] In contrast to our study an even higher prevalence of 58.5% was reported in a Tanzanian study by Abraham *et al*, in textile industry workers,[18] while in another study Musiba *et al,* reported a prevalence of 47% in Tanzanian miners.[19] This difference can explai-

ned partly by the lower prevalence of AHL in developing countries due to lower life expectancy and younger populations, a rising prevalence of ONIHL in some developing countries as a result of expansion of the manufacturing and construction sectors and also because different studies have targeted different occupations.

In our study, the breakdown frequencies were different for different occupations in the same setting of sugar mills. Similarly in a Tanzanian study by Musiba *et al* on mining industry, the age, length of exposure and type of mining resulted in different frequency of minors affected with underground miner being most affected in 71% which was statistically significant,[19] thus indicating that in the same industry different professions/working conditions may result in difference in ONIHL. In review article Metidieri *et al*,[20] noted the prevalence in different industries/occupations being 58.7% in publishing, 51.7% in mechanical, 45.9% in beverage, 42.35% in chemical, 35% in metallurgic, 33.5% in steel, 29.3% in transport, 28% in food and 23.4% in textile industry workers.[20] Another study by Chadambuka *et al,* reported statistically significant difference in development of HL as regards work area in mining industry.[21]

Our study also demonstrated that ONIHL cases increased as working period in the company increased and that employees working for 6-10 years were the most affected ones with all (70) workers affected while only 20 out of 230 who worked for 1-6 years were affected and the difference was significant (p<0.001). This reinforces that hearing consequences also depend on period of noise exposure 16.[22] Also in a Canadian study by Feder *et al*, of the sample population 42% reported ETN for >10 year resulted in HL.[23] Also in a study by Pelegrin *et al*, involving construction workers, those who had ETN of 16.2 ± 11.4 years suffered with Hl significantly more than those exposed for 10.2 ± 7.0 years.[24]

In this study mild SNHL predominated (61, 67.78%), followed by moderate hearing loss (24, 26.67%) and severe Hl was least common (5, 5.55%). In contrast in a local study involving army aviation workers revealed that majority suffered moderate HL (43.75%), followed by mild HL (40.62%) and severe HL in 15.62% only 14 while the severity of HL in Tanzanian miners was poor in 12% and mild in 35%.[19]

Age was also a factor that expressively increased the cases of ONIHL, in the current study with maximum cases (205) in age groups of 18-25 and 26-33 having no case of ONIHL, while the age group 34-40 years was affected with 90 out of 95 cases having ONIHL. This finding was statistically significant (p <0.001). Similarly other studies in which employees were of higher ages were the most affected ones[17,18, 21,23]. In contrast younger age group (20-29 years) was more affected (60%) in a study by Masiba.[19]

In the current study most of the males (210 out of 215, representing 97.67%) had normal hearing, while all the females (85) were having ONIHL and the difference was statistically significant (p<0.001). In contrast a number of studies reported gender association with more males being affected 18, 23, indicating that female population in our study was not taking preventive measures.

The lack of use of HPDs worsens hearing capacity of individuals ETN. Most previous studies proposed that the duration of noise exposure and a bad use of hearing protection devices negatively influenced the audiometric results like in a systematic review by Verbeek *et al,* four studies revealed that the better the use of HPD's, the less is risk of HL,[24] Similarly in our study out of 65 (21.7%) cases who used HPD's did not develop ONIHL, while 90 out of 235 (78.3%) who did not use HPD's developed HL and this difference was statistically significant (p< 0.0001). Also another study reported that workers using ear both muffs and ear plugs were less affected compared to those using one protection (p<0.001) and 94.1% of those who never used hearing protection showed abnormal audiogram findings.[25]

In the current study concludes that Out of 90 respondents, 18 (20%) had a unilateral hearing impairment and 72 (80%) had problems in both ears or had a bilateral hearing impairment. Similarly in another local study by Sheikh *et al*. there was predominance of bilateral HL (62.5%).[14]

In the present study a statistically significant association of ONIHL was noted with education level with all the 90 (30%) affected with ONIHL being graduates with no hearing loss detected in less educated population. In contrast in Khoshakhlagh *et al,* noted that blue collar workers were more likely to suffer Hl compared to white collar.[22]

CONCLUSION

This study concludes that there is high frequency of ONIHL with significant risk factors being level and duration of exposure to noise, age, gender, education and hearing protective devices. Also majority suffer bilateral HL and mild HL being common followed by moderate HL.

Conflict of Interest: None.

Authors' Contribution

MJIP: Data Collection Analysis & Interpretation, NM: Conception of Work & Critical Revision, GS: Manuscript Writing, Iterature Review & responsible for publication.

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