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Occupational History and Intensity of Exposure to Noise as a Risk Factor for Hearing Loss Among Plant Workers in Aluminum Industry in Dubai

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Abstract

Background: Exposure to intense noise damages the human hearing process, while Noise-induced hearing loss NIHL is the most important adverse health effect and is well documented. *Objective:* To study the effect of risky occupational history and exposure to noise intensity on hearing loss among plan workers at aluminum industry. *Methodology:* A cross sectional study was conducted in Dubai Aluminum Company Limited (DUBAL) which owns and operates one of the world's largest aluminum smelters. The study sample was collected from workers in DUBAL Company. All workers in DUBAL were targeted in the study. The sample size was calculated by using computer program EPI-Info version "6.04". Sample size was 400 workers with 100% response rate. Stratified random sampling technique was used. Two groups were selected according to noise level exposure. *Results:* Though the risk difference associated with each variable is not statistically significant, yet there is an apparent higher risk of hearing loss associated with longer duration of work (OR = 3.60 for 15 years or more in work), having 10 hours or more overtime per week (OR = 1.70), past exposure to noise (OR = 1.44), and history of wearing ear muffs at work (OR = 2.73). stepwise logistic regression revealed only two factors as the most significant predictors of hearing loss namely age of worker and noise level. Each one year increase in age is associated by increasing risk of hearing loss by 6%. Also higher risk of hearing loss was associated by increasing noise level which attained significance at the high level noise where the risk is three times of that working in the administration section. *Conclusion:* Occupational history along with exposure to noise intensity recognized as significant risk factors for hearing loss among plan workers at work environment. Adopting interventional strategies to targeting risky occupational history and managing noise exposure must be adopted as decisive preventive and control tools for risky group workers.

Keywords

Occupational History, Noise Exposure, Aluminum Industry, Hearing Loss

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1. Introduction

Exposure to intense noise damages the human hearing process. While NIHL is the most important adverse health effect and is well documented, other less well-reported reactions include annoyance, hypertension, higher possibility of occupational accidents, stress and poorer performance, interference with communication at work, and mental illness. (1,2) Concerning auditory effects due to work site noise, many researches were conducted in many countries. Several studies in Canada revealed that occupational noise was found to be the most frequent cause of hearing alterations among

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adults with estimates of eight to twelve adults in a thousand in the industrialized western region of that country. (3) Moreover, a study among construction workers in USA showed that there was an adverse effect of occupational noise exposure on hearing levels at 4 and 6 kHz in a population of relatively young adults with about 0.7 dB loss in threshold of hearing level. (4) In addition, a study held in UK revealed that 2% of working aged adults reported severe hearing difficulties, the problem being greatest in middle aged men. (5)

A study by Palmer and Griffin in 2002 mentioned severe deafness among 153,000 male and 26,000 female British workers because of workplace noise. (5) A Taiwanese study showed that the prevalence of NIHL was as high as 56.8%, which was similar to the prevalence among American labors in nuclear weapons facilities (59.7%). (6) A study was conducted in Dubai, revealed that, the mean estimated hearing disability for the foundry workers was 8.59% which was significantly higher compared with that for the workers at the bottling plant (4.63 %). (7) A Nigerian study showed that within 4-8 years of worksite noise exposure, over 90% of the workers had developed temporary or permanent shift in their hearing threshold. By 14 years or over, all the evaluated workers had developed hearing impairment. (8) Moreover, in a study conducted in Turkey, hearing loss in textile workers compared with control was more evident at frequencies of 4 and 6 kHz. (9)

Different occupations had different exposure level to noise which in turn had predictable risk of adverse health effects to noise. (10) In brazil, a prevalence study was carried out based on the audiometric data of workers from 44 plants in nine different industries where it revealed that 45.9% of the workers studied had hearing loss and the prevalence seen of NIHL was 35.7%. The highest prevalence rates were found in the editorial/graph (58.7%), mechanic (51.7%), beverages (45.9%), chemist/petrochemist (42.3%), metallurgic (35.8%), steelworker (33.5%), transportation (29.3%), food (28.0%) and textile (23.4%) industries. (4) There were two types of noise, the impulse noise and steady state noise. Impulse noise occurs most commonly from gunfire and by the banging of metal on metal objects. This type of noise ranges from 100 to 140 dB and can causes direct damage to the organ of Corti and tympanic membrane. (11) Steady state noise is more common in industry than is impulse noise. One example is the noise emitted from a turbine engine. Industries in which there are dangerous noise levels include underground mining, oil drilling, paper, food, textile, rubber, plastic and utility industries. Impulse noise produces a PTS at 4 and 6 kHz after a shorter duration of exposure than continuous noise. Combined exposure to steady, state industrial noise and impulse noise does not increase the risk of NIHL as long as neither exceeds 85 dB.

2. Objective

To study the effect of risky occupational history and exposure to noise intensity on hearing loss among plan workers at aluminum industry.

3. Methodology

A cross sectional study was conducted in Dubai Aluminum Company Limited (DUBAL) which owns and operates one of the world's largest aluminum smelters. The study sample was collected from workers in DUBAL Company. All workers in DUBAL were targeted in the study. Those with a history of ototoxic drug use, diabetes, severe or frequent ear infections, ear trauma, conductive or sensory hearing loss with a known etiology except for noise exposure were excluded. The sample size was calculated by using computer program EPI-Info version “6.04”. Based on the preliminary data given, the minimum expected sample size was 334. Our sample size was 400 workers with 100% response rate. Stratified random sampling technique was used. Two groups were selected according to noise level exposure: The first group (200 workers) in which the employees were classified according to the noise level exposure into three strata: An equal allocation from each stratum was obtained because the strata sizes were approximately similar. Another group was selected from the administrative department where noise level is minimal (200 worker) The simple random sampling was achieved.

4. Results

Table (1) shows the risk of hearing loss by occupational history. Though the risk difference associated with each variable is not statistically significant, yet there is an apparent higher risk of hearing loss associated with longer duration of work (OR = 3.60 for 15 years or more in work), having 10 hours or more overtime per week (OR = 1.70), past exposure to noise (OR = 1.44), and history of wearing ear muffs at work (OR = 2.73).

As shown in table (2), results of stepwise logistic regression revealed only two factors as the most significant predictors of hearing loss namely age of worker and noise level. Each one year increase in age is associated by increasing risk of hearing loss by 6%. Also higher risk of hearing loss was associated by increasing noise level which attained significance at the high level noise where the risk is three times of that working in the administration section.

Table 1. Hearing loss among noise exposed workers according to occupational history.

Occopational data		Hearing loss				P	OR	95% CI	
		Yes		No					
		No.	%	No.	%				
Duration of work (years)	<5	2	5.3	36	94.7		1.00		
	5-	9	7.1	117	92.9	0.686	1.38	0.29	6.70
	15+	6	16.7	30	83.3	0.117	3.60	0.68	19.16
Current Occupation use of protective ear device	Ear plug	8	7.9	93	92.1		1.00		
	Ear muffs	9	9.1	90	90.9	0.767	1.16	0.43	3.15
	None	9	7.4	112	92.6		1.00		
Overtime/week (hours)	≤10	5	9.3	49	90.7	0.683	1.27	0.40	3.98
	>10	3	12.0	22	88.0	0.451	1.70	0.43	6.77
Past exposure to noise	Yes	7	10.4	60	89.6	0.484	1.44	0.52	3.96
	No	10	7.5	123	92.5		1.00		
Past occupation use of protective ear device	Yes	6	9.7	56	90.3	0.690	1.24	0.44	3.51
	No	11	8.0	127	92.0		1.00		
Type of protective ear device used in the past	Ear plug	3	6.8	41	93.2		1.00		
	Ear muffs	3	16.7	15	83.3	0.238	2.73	0.50	15.05

Table 2. Results of stepwize logistic regression analysis of risk factors of hearing loss.

	P	OR	95% CI	
			Lower	Upper
Age (years)	0.019	1.06	1.01	1.11
Noise level Administration				
Low	0.127	2.45	0.78	7.73
Moderately high	0.370	1.79	0.50	6.37
High	0.039	3.20	1.06	9.62

5. Discussion

Studying some other factors likely to affect the development of NIHL among plant workers, projected many important findings. Duration of exposure to noise was one among these studied factors. Though not statistically significant, it was verified that, the risk of hearing loss was nearly fourfold times increased with longer duration of work for 15 years or more compared with workers who had work durations for less than 5 years. Palmer et al., (2002) (5) in their study among working aged people, found that the prevalence of hearing loss increases with duration of occupational exposure to noise, even after allowance for age. A study by Shakhatreh et al., 2000) (12) was carried out in one of the textile factories in Jordan to explore the problem of hearing loss among its workers found that, average hearing loss was highest amongst those who were employed for 25 years or more.

On the other hand, a study done in Brazil by Guerra et al., (2005) (13) to analyze the prevalence of noise-induced hearing loss among metal workers who were potentially exposed to occupational noise (from 83 to 102 dB), showed that the length of exposure to noise in the working environment was not significant. Moreover, it was found that extra exposure to worksite noise during the overtime hours may pose an effect on the development of NIHL. The study results revealed an apparent but not significant higher risk of hearing loss associated with having 10 hours or more overtime per week. Although unlikely and unexpected, it was detected that in contrast to the low noise exposure group, the percentage of workers taking 10 hours or more overtime per week, was significantly higher among the moderately high and high noise exposure groups. In a cross tabulation between response of worker to whisper test and overtime, Ashraf et al., (2009) (14) proved that there was a higher frequency of hearing loss in workers who work overtime than those who don't because of more exposure to noise.

Furthermore, the plant workers with past history of occupational noise exposure manifested apparent higher risk of developing NIHL compared with workers with no similar past history. This finding may raise an assumption of possible cumulative effect of noise exposure on hearing level. (13) Of no possible importance, past exposure to noise being more prevalent among the low noise exposure group. Having this set of evidences, we can conclude that duration of exposure to work site noise expressed either as duration of current employment in years, hours of overtime or even the years of past employment in noisy jobs may have a counterproductive effect on the auditory efficiency of the workers.

Use of ear protective tools is another factor that likely may have an association with the development of hearing loss at work site. Our study brought out that, using ear muffs at work either at current or at past occupations carried apparent higher risk of development of hearing loss. At odds with this finding, same study found that ear muffs were usually used by workers at higher noise levels where ear plugs were preferred by workers at low levels of noise exposure. This observation simply can be explained by the regulations of DUBAL that define ear muffs as safety tool for workers at high noise exposure levels. The efficiency of different ear protectors is a debatable issue and still under lot of researches, though it was reported that under certain conditions, ear plugs provide the most effective protection although the attenuation is higher for earmuffs than for arplugs. (15)

Regarding some personal habits in relation to the development of NIHL, although expressed no association, current smoking and habitual alcohol drinking were found to be higher among plant workers compared with the administration workers. This was in agreement with a study conducted in Abu Dhabi which found that industrial workers had higher proportion of smokers than non-industrial workers. (16) Regarding alcohol drinking, Marchand (2008) (17), found that compared to non-qualified blue-collars, both low-risk and high-risk drinking are associated with qualified blue-collars, semi-qualified white-collars, and middle managers; high-risk drinking is associated with upper managers. How hearing level could be affected by worker's hobbies was also analyzed. Although exposure to non-occupational loud sounds (such as loud music) was not significant among the entire workers but was significantly related with the development of NIHL among plant workers in contrast to administration workers with nearly 13 times the risk.

A study conducted in Japan by Nomura et al., (2005) (18) among Japanese metal workers, revealed that workers with both exposure to occupational and non-occupational noise such as noisy hobbies and listening to loud music, were at higher risk of hearing loss. Also, use of head phones during listening to music was studied. The users among the entire study sample had significant 2.56 times the risk of hearing loss compared with the non-users. Moreover, the risk was apparently higher among users of the plants compared to the administration group. This can be explained by the fact that many portable headphone cassette radios produce peak outputs of more than 100 dBA. Temporary threshold shifts could result from listening levels near the maximum output. Permanent sensorineural loss may result with repeated exposure. (19)

Moreover, individuals who listen to 15 minutes of music at 100 dB using personal music players may be exposed to the same level of loudness as industrial workers exposed to 85 dB in an 8 hour day. (20) A study conducted in Saudi Arabia by Ahmed et al., (2001) (21) to determine the prevalence of hearing loss and other risk factors associated with occupational noise exposure showed that, hearing loss was greater amongst those who used headphones to listen recorded cassettes.

Although highly likely, those persons who practice gun fire shooting as a hobby may be at a higher risk to develop hearing loss; our results featured this hobby as a non-significant contributing factor either among the entire study workers or among the plant workers. At odds with this result, Stewart et al., (2001) (22) and Seixas et al., (2004) (4) reported higher rate of hearing loss among regular gun fire shooters. Regular use of firearms, is a well-known non-occupational risk factor for NIHL.(23) Apart from noise induced hearing loss, many other health problems likely to be associated with exposure to noise at work site were studied as well. First of these health problems, was headache. When plant workers are stratified by level of noise exposure, a significant difference was encountered. Higher percentage of those complaining of headache due to noise was found at the high exposure level than at the moderately high and at low noise exposure level. Headache was proved to be a common non-auditory deleterious health effect among workers exposed to noise at work site by many researchers. (24-26)

On the contrary, stress at work was significantly lower among plant workers than among administration workers. Wieclaw et al., (2006) (27) in their study found consistent association between employment in human service occupations and the risk of affective and stress related disorders. On the contrary, Melchior et al., (2003) (28) found that, job stress is most prevalent among manual workers and office clerks and predicts the occurrence of sickness absence. Annoyance, speech interference and sleep disturbances displayed non-significant relations with the development of NIHL among workers exposed to noise. In a study about noise exposure in oil mills, Kumar, (2008) (29) concluded that as a subjective response, 63% of his study sample expressed that noise was interfering with their conversation during work and subsequently harmed their hearing. Jakovljevic et al., (2006) (30) in a study about sleep disturbance in relation to noise exposure detected that, noise annoyance, subjective noise sensitivity and neuroticism were significantly correlated with difficulties with falling asleep, time needed to fall asleep, poorer sleep quality, tiredness after sleep, and use of sleeping pills.

Some physical findings were also investigated in relation to noise level exposure as well as the development of NIHL. Pulse rate was significantly related to noise level exposure, where it was more rapid among the high noise exposure group than among the moderately high exposure group and

the low exposure group. This finding revealed an agreement with the results of Salameh, (2005) (31) and Powazka et al., (2002) (32) who proved positive correlation between the noise level exposure and pulse rate among workers in their studies. Regarding some other physical findings, it was concluded that plant workers had significantly higher blood pressure level (systolic and diastolic), higher mean total cholesterol level, higher LDL level and apparently higher triglycerides comparing with the workers in administration group. Based on noise level exposure, it was found that, all these parameters revealed just apparent higher levels among the high noise exposure group than among the other two groups. In their study, Zhao et al., (2009) (33) reported that noise exposure is a significant determinant of hypertension prevalence, but third in order of importance behind family history of hypertension and salt use. Our results came in accordance with others who proved an association between noise exposure and hypertension. Salameh (2005) (31) concluded that high levels of noise pollution can affect adversely the blood pressure (systolic and diastolic). Raised blood pressure among workers exposed to noise at work was also reported by other researchers; Stanbury et al., (2008), Haralabidis et al., (2008) Lee et al., (2009) (34-36).

However, Rizk and Sharaf, (2010) (37) in their study to assess the risk of hearing loss among a sample of fermentation plant workers in Egypt exposed to both noise and a mixture of organic solvents have reported no association between blood pressure and exposure to noise. Moreover, Janghorbani et al., (2009) (38) found that blood pressure had no significant independent association with noise-induced hearing. Considering blood cholesterol, Standbury et al., (2008) (34) in their study that assessed the prevalence of self-reported hearing loss and work-related noise-induced hearing loss in Michigan found an association between noise exposure and elevated cholesterol. While Janghorbani et al., (2009)(38) reported no association between noise exposure and raised cholesterol and triglyceride. Also, work site injuries were marked with noise exposure. Where proved to be higher among plant workers exposed to noise compared to administration group, also an apparent higher frequency of work site injuries were reported among the high noise level exposure group in contrast to the low exposure category.

A study was done to assess occupational noise as a risk factor for work-related injuries showed that, "work always exposed to high-level noise" and "work sometimes exposed to high-level noise" were associated with relative high risk for work-related injuries compared with “work with no noise”. Based on these findings, the study concluded that, investing in hearing conservation programs, particularly those for controlling noise emission at its source, is justifiable aiming at both hearing health maintenance and reduction of work-related injuries.(39) Melamed et al., (2004) (40) in their study to explore the possibility that exposure to noise at work might interact with job complexity to affect the incidence of occupational injury among industrial employees, found that the joint exposure to noise and high job complexity is disruptive, resulting in higher distress and occupational injury risk, particularly among women. Explicitly we can brief that exposure to high levels of noise can cause different types of health problems that might be auditory in the form of hearing loss or non auditory effects. Using many sensible approaches, noise exposure at work site could be preventable and controllable hazard. As a sobering step, continuous monitoring of noise level as well as raising the alertness to detect signs of hearing loss or other manifestations in co-workers are sign qua non.

6. Conclusion

Occupational history along with exposure to noise intensity recognized as significant risk factors for hearing loss among plan workers at work environment. Adopting interventional strategies to targeting risky occupational history and managing noise exposure must be adopted as decisive preventive and control tools for risky group workers.

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