

Patterns of Hearing Loss Due to Noise Exposure Among Plant Workers at Aluminum Industry in Dubai

Hussein H. Y.^{1, *}, Al Faisal W.¹, Al Marashdah A. M.², El Sawaf E. M.², Wasfy A. S.³

¹Health Affairs Department, Primary Health Care Services Sector, Dubai Health Authority, Dubai, UAE

²Health Centers Department, Primary Health Care Services Sector, Dubai Health Authority, Dubai, UAE

³Research and Statistics Department, Ministry of Health, Dubai, UAE

Abstract

Backgrounds: Noise-induced hearing loss (NIHL) is one of the oldest occupational diseases, and is one of the most important occupational diseases arising from long-term exposure to unauthorized noise levels. *Objectives:* To study the patterns of hearing loss among workers at aluminum industries due to exposure to noise. *Methods:* 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: Plant and Administrative. *Results:* plant workers have significantly about 2.56 times the risk of developing hearing loss compared to administration workers. The prevalence of hearing loss among plant workers was 8.5% while that among administration workers was 3.5%. The risk was higher in each exposure group but attained significance only at the high exposure category (OR = 3.22). The prevalence of hearing loss was 6.0% among the low noise exposure group, 9.0% in the moderately high group and 10.4% in the high exposure group. hearing threshold level among study workers at different frequencies. In both ears, significant higher mean threshold were encountered among plant workers than among administration groups at high levels frequencies (3000 Hz, 4000 Hz and 6000 Hz). *Conclusion:* There was an apparent higher risk of hearing loss associated with longer duration of work, having 10 hours or more overtime per week, as well as having past exposure to noise. Health Education of the workers exposed to noise should be done regularly about: the health effect of noise (auditory and non auditory), the risk factors contributing to noise hazard, how to protect themselves from noise, the purpose of hearing protectors, as well as their responsibilities and their role in the Noise Management Program.

Keywords

Hearing Loss, Noise Exposure, Plant Workers, Aluminum Industry

Received: June 19, 2015 / Accepted: July 8, 2015 / Published online: July 20, 2015

© 2015 The Authors. Published by American Institute of Science. This Open Access article is under the CC BY-NC license.

<http://creativecommons.org/licenses/by-nc/4.0/>

1. Introduction

Noise has both auditory and non-auditory health effects. Although the direct physical consequence of loud noise,

especially over a period of time, is hearing loss and tinnitus (auditory effect), noise at lower levels can have indirect impact on physiological and psychological systems, that is, non-auditory effects. (1) Noise-induced hearing loss (NIHL) is one of the oldest occupational diseases (2) and is one of the

* Corresponding author

E-mail address: hyhussain@dha.gov.ae (Hussein H. Y.)

most important occupational diseases arising from long-term exposure to unauthorized noise levels. (2-7) NIHL is characterized by a gradual reduction in hearing acuity because of continuous exposure to intense levels of sound pressure, causing damage to outer and inner hair cells of the Organ of Corti. (8) NIHL is measured by comparing the threshold of hearing at a specified frequency with a specified standard of normal hearing, and is reported in units of dB hearing loss.

The first effects of exposure to excess noise are typically an increase in the threshold of hearing called temporary auditory threshold shift (TTS). This is defined as a change in hearing thresholds of an average 10 dB or more at 2000, 3000 and 4000 Hz in either ear. The hearing loss corresponds to a permanent increase in the threshold of hearing that may be accompanied by tinnitus. Because hearing impairment is usually gradual, the affected worker will not notice changes in hearing ability until a large threshold shift has occurred. Noise-induced hearing impairment occurs predominantly at higher frequencies (3000–6000 Hz), with the largest effect at 4000 Hz. It is irreversible and increases in severity with continued exposure. (9-11) The consequences of NIHL include: social isolation; impaired communication with co-workers and family; decreased ability to monitor the work environment (warning signals, equipment sounds); increased injuries from impaired communication and isolation; anxiety, irritability, decreased self-esteem; lost productivity; expenses for workers’ compensation and hearing aids. (9, 10, 12).

Primary aluminum production is considered as one of the largest industries in the world today. According to the International Aluminum Institute, this industry directly employs over a million people worldwide and indirectly generates four times as many jobs in downstream and service industries.(13) In all phases of aluminum production, workers are exposed to numerous chemical and physical hazards. Noise is a significant health risk in aluminum smelting and casting operations where it has been identified to exceed 90 dB(A).

2. Objectives

To study the patterns of hearing loss among workers at aluminum industry due to exposure to noise.

3. Methods

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

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) revealed that plant workers have significantly about 2.56 times the risk of developing hearing loss compared to administration workers. The prevalence of hearing loss among plant workers was 8.5% while that among administration workers was 3.5%.

Table 1. Hearing loss by study group.

Study group	Hearing loss				Total	OR	95% CI	
	Yes		No					
	No.	%	No.	%				
Administration	7	3.5	193	96.5	200	1.00		
Plant	17	8.5	183	91.5	200	2.56	1.04	6.32
Total	24	6.0	376	94.0	400			

Table 2. Hearing thresholds of right and left ears of workers by place of work.

Frequency level (Hz)	Administration (200)		Plant (200)		Mann-Whitney Z	P
	Mean	SD	Mean	SD		
Right ear						
500	12.47	10.05	12.5	11.01	0.36	0.145
1000	13.56	13.66	15.28	13.57	1.46	0.716
2000	15.99	13.79	16.99	13.74	2.07	0.281
3000	10.56	11.37	12.16	9.16	2.64	0.008
4000	12.05	9.00	15.73	9.26	4.39	0.000
6000	9.88	8.63	11.38	8.78	2.07	0.039
8000	16.22	11.48	18.26	13.76	1.35	0.178
Left ear						
500	15.38	7.27	15.63	11.15	0.39	0.696
1000	12.41	9.55	12.59	7.99	0.52	0.605
2000	11.13	6.84	12.56	8.49	1.72	0.085
3000	12.51	8.88	16.07	10.22	3.78	0.002
4000	14.22	11.38	18.13	12.75	3.17	0.000
6000	11.31	14.70	13.33	13.56	2.55	0.011
8000	13.28	12.56	14.18	15.34	0.15	0.881

Table (2) shows the hearing threshold level among study workers at different frequencies. In both ears, significant higher mean threshold were encountered among plant

workers than among administration groups at high levels frequencies (3000 Hz, 4000 Hz and 6000 Hz).

As shown in table 3, the risk was higher in each exposure group but attained significance only at the high exposure

category (OR = 3.22). The prevalence of hearing loss was 6.0% among the low noise exposure group, 9.0% in the moderately high group and 10.4% in the high exposure group.

Table 3. Hearing loss by noise exposure group.

Noise exposure	Hearing loss				Total	P	OR	95% CI	
	Yes		No						
	No.	%	No.	%					
Administration	7	3.5	193	96.5	200		1.00		
Low <85 dB	4	6.0	62	94.0	66	0.366	1.75	0.50	6.18
Moderately high 85- <90 dB	6	9.0	61	91.0	67	0.073	2.76	0.89	8.52
High >90 dB	7	10.4	60	89.6	67	0.028	3.22	1.09	9.54
Total	24	6.0	376	94.0	400				

Hearing loss did not show statistically significant difference by demographic characteristics, the only exception is worker's age (table, 4). As age increases the risk of hearing loss also increases from about two times at the age of 40-<50

years to almost three times at age of 50 years or more. Males showed apparently higher risk of hearing loss than females (OR = 2.56). Non-national have about two times the risk of acquiring hearing loss compared to national workers.

Table 4. Hearing loss among study workers by demographic data

Personal data		Hearing loss				OR	95% CI	
		Yes		No				
		No.	%	No.	%			
Age (years)	<40	10	4.3	225	95.7	1.00		
	40-	9	7.2	116	92.8	1.75	0.69	4.42
	50+	5	12.5	35	87.5	3.21	1.04	9.96
Gender	Male	22	6.7	3.5	93.3	2.56		
	Female	2	2.7	71	97.3	1.00	0.59	11.14
Marital status	Unmarried	3	4.1	70	95.9	1.00		
	Married	21	6.4	306	93.6	1.60	0.47	5.52
Educational level	School	8	8.1	91	91.9	1.57		
	University	16	5.3	285	94.7	1.00	0.65	3.78
Nationality	Local	3	3.2	90	96.8	1.00		
	Nonlocal	21	6.8	286	93.2	2.20	0.64	7.56

5. Discussion

Industrial noise is usually considered mainly from the point of view of environmental health and safety, rather than nuisance, as sustained exposure can cause permanent hearing damage. Traditionally, workplace noise has been a hazard linked to heavy industries and associated only with noise induced hearing loss (NIHL). (14) Modern thinking in occupational safety and health identifies noise as hazardous in many places of employment and by a variety of means. Noise can not only cause hearing impairment, but it also acts as a causal factor for many other health problems. Additionally, it can be a causal factor in work accidents, both by masking hazards and warning signals, and by impeding concentration. Noise also acts synergistically with other hazards to increase the risk of harm to workers. (3)

This study aimed to assess the potential auditory and non-auditory health effects due to occupational exposure to noise among workers of Aluminum Industry in Dubai. A sample of

four hundred workers (200 workers from different plants with noise exposure and another 200 from administration departments with no noise exposure) were taken from DUBAL. Level of environmental noise at work site was determined by real time measurement in dB(A) using Sound Level Meter. Noise level exposure was classified into three strata, low noise exposure : <85 dB(A), moderately high noise exposure: 85- <90 dB(A) and high noise exposure: >90 dB(A). It was evinced that plant workers have significantly about 2.56 times the risk of developing hearing loss compared to administration workers with prevalence of 8.5% among plant workers and 3.5% among administration workers.

The association between hearing loss and level of noise exposure was more elucidated; the risk of hearing loss was proved to increase with increasing the level of noise exposure at - work site from low noise exposure level, moderately high to high noise exposure level. Moreover, the occupational character of hearing loss among plant workers in this study was brought out. The results displayed unequivocal high

threshold levels of hearing at high frequency levels (3000, 4000 and 6000 Hz) in both ears among plant workers in comparison with administration workers. In accordance with the definition of NIHL, (9-11,15) this finding can serve reliably the assumption that hearing loss among plant workers can be attributed to noise exposure at work site. Reputing the differences between this study compared to others regarding the criteria used for defining hearing impairment, yet, the prevalence rate of hearing impairment reported in the current study is comparable to those reported by other researchers who found prevalence rate ranging between 8.59 %and 59.7 %. (11,16-19)

6. Conclusion

There was an apparent higher risk of hearing loss associated with longer duration of work, having 10 hours or more overtime per week, as well as having past exposure to noise. Health Education of the workers exposed to noise should be done regularly about: the health effect of noise (auditory and non auditory), the risk factors contributing to noise hazard, how to protect themselves from noise, the purpose of hearing protectors, as well as their responsibilities and their role in the Noise Management Program.

References

- [1] Ana G R, Shendell D G, Brown GE, Sridharl M K. Assessment of Noise and Associated Health Impacts at Selected Secondary Schools in Ibadan, Nigeria. *Journal of Environmental and Public Health*. 2009. (2009): 1-6 [cited 2010 Jan 10]. Available from: <http://www.hindawi.com/journals/jep/2009/739502.html>
- [2] Attarchi M S, Labbafinejad Y, Mohammadi S. Contemporary exposure to cigarette smoke and noise of automobile manufacturing company workers. *J Public Health*. 2010;18(3):245-249
- [3] Babisch W. Guest Editorial: Noise and Health. *Environmental Health Perspectives*. 2005;113 (1): A 14-A15
- [4] Mizoue T, Miyamoto T, Shimizu T. Combined effect of smoking and occupational exposure to noise on hearing loss in steel factory workers. *Occup Environ Med* 2003;60:56-59
- [5] Kock S, Andersen T, Kolstad H A, Kofoed-Nielsen B, Wiesler F, Bonde J P. Surveillance of noise exposure in the Danish workplace: a baseline survey. *Occup Environ Med* 2004;61:838-843
- [6] Palmer K T, Griffin M J, Syddall H E, Davis A, Pannett B, Coggon D. Occupational exposure to noise and the attributable burden of hearing difficulties in Great Britain. *Occup Environ Med*. 2002;59:634-639
- [7] Seixas N S, Goldman B, Sheppard L, Neitzel R, Norton S, Kujawa S G. Prospective noise induced changes to hearing among construction industry apprentices. *Occup Environ Med*. 2005;62:309-317
- [8] Boger M E, Barbosa- Branco A, Ottoni U C. The noise spectrum influence on Noise-Induced Hearing Loss prevalence in workers. *Braz J Otorhinolaryngol*. 2009;75(3):328-334
- [9] Yildirimi I, Kilinc M, Okur E, Tolun F I, Kilic M A, Kurutas E B, Ekerbcer H C. The effects of noise on hearing and oxidative stress in textile workers. *Industrial Health*. 2007; 45:743-749
- [10] Krishnamurti S. Sensorineural Hearing Loss Associated with Occupational Noise Exposure: Effects of Age-Corrections. *Int. J. Environ. Res. Public Health*. 2009; 6:889-899
- [11] Gidikova P, Prakova G, Ruev P, Sandeva G. Hearing impairment among workers occupationally exposed to excessive levels of noise. *Central European Journal of Medicine*.2007;2(3):313-318
- [12] Wallhagen M I, Strawbridge W J, Cohen R D, Kaplan G A. An Increasing Prevalence of Hearing Impairment and Associated Risk Factors over Three Decades of the Alameda County Study. *American Journal of Public Health*. 1997;87(3):440-442
- [13] International Aluminium Institute (IAI). The aluminium industry's sustainable development report. [displayed 9 April 2009, cited 2010 March 4]. Available from: <http://www.world-aluminium.org/cache/fl0000107.pdf>
- [14] Nelson D I, Schwela D. Foreword. In: Goelzer B, Hanson C H, Sehrndt G A editors. Occupational exposure to noise evaluation, prevention and control. Special Report S 64. Dortmund and Berlin: Federal Institute for Occupational Safety and Health; 2001. 19-20
- [15] Al-Otaibi S T. Occupational hearing loss. *Saudi Medical Journal* 2000; 21 (6): 523-530
- [16] Pouryaghoub G, Mehrdad R, Mohammadi S. Interaction of smoking and occupational noise exposure on hearing loss: a cross-sectional study. *BMC Public Health* 2007; 7:137: 1-5
- [17] Chang S, Chang C. Prevalence and Risk Factors of Noise-induced Hearing Loss among Liquefied Petroleum Gas (LPG) Cylinder Infusion Workers in Taiwan. *Industrial Health*. 2009; 47:603-610
- [18] Gomes J, Lloyd O, Norman N. The health of the workers in a rapidly developing country: effects of occupational exposure to noise and heat. *Occupational Medicine*. 2002;52(3):121-128
- [19] Ahmed H O, Dennis J H, Badran O, Ismail M, Ballal S G, Ashoor A, Jerwood D. Occupational Noise Exposure and Hearing Loss of Workers in Two Plants in Eastern Saudi Arabia. *Ann occup Hyg*. 2001;45(5):371-380