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Prevalence of occupational noise induced hearing loss among industrial workers in Bhutan

Pelden Wangchuk[1], Phuntsho Dendup[2]

[1]*Jigme Dorji Wangchuck National Referral Hospital, Ministry of Health, Thimphu, Bhutan*
[2]*Department of Labour, Ministry of Labour and Human Resources, Thimphu, Bhutan*

ABSTRACT

Introduction: Exposure to any type of noise has a potential risk. Higher the level of noise and longer duration of exposure, more the risk for hearing sensitivity and health as a whole. The objective of the study is to determine the prevalence of Occupational Noise Induced Hearing Loss among the industrial workers in Bhutan and to ascertain high risk establishment and vulnerable occupations. **Methods:** The hearing assessment was conducted among 1638 workers considering different types of industries and occupations to ascertain the prevalence of occupational noise induced hearing loss and vulnerable group among different industries and occupations. Descriptive statistics and binary logistic regression were performed to test the significance of Occupational Noise Induced Hearing Loss among the various independent variables. **Results:** The study found that the prevalence of Occupational Noise Induced Hearing Loss stands at 27.9% among industrial workers in Bhutan. 42.45% of candidates who had Occupational Noise Induced Hearing Loss reported with tinnitus in either or both ears. This study found a significant association between the exposure duration and the severity of Occupational Noise Induced Hearing Loss among the industrial workers. Considering the type of industry, wood based industry, hydro services, cement and polymer were found to have a higher prevalence of Occupational Noise Induced Hearing Loss and similarly, higher prevalence of Occupational Noise Induced Hearing Loss were found among occupations such as blaster, chipper, carpenters, dryer (knife grinder) and crusher operators. **Conclusions:** This study conduces that prevalence of Occupational Noise Induced Hearing Loss among industrial workers is found to be at the higher side and some of the occupations and industries impose higher risk. The study suggests that there is need for intervention such as strict enforcement of the permissible exposure limit, monitor and evaluate hearing conservation programs, and providing advice and recommendation to address such issues by the relevant agencies and industries.

Keywords: Industrial workers; Manufacturing industry; Occupational health and safety; Occupational noise induced hearing loss.

INTRODUCTION

The higher the level of noise and longer the duration of exposure, more the risk for health. Studies have shown that exposure to occupational noise has been known to not only cause Noise Induced Hearing Loss (NIHL), but other diseases such as tinnitus, hypertension and cardiovascular diseases[1-3]. Exposure to high level of noise over a period of time erodes sensory parts of ears causing irreversible condition in hearing mechanisms known as noise induced hearing loss and the condition is usually accompanied by tinnitus. NIHL is irreversible condition if acquired**,** but it is also the preventable occupational disease[4].

Hearing loss can impact one's life in many ways. A ringing in the ear, called tinnitus, commonly occurs after noise exposure, and it often becomes permanent. Some people react to loud noise with anxiety and irritability. An increase in pulse rate and blood pressure, or an increase in stomach acid includes some of the negative impact of noise on health. Studies have also found that noise pollution and occupational noise had been demonstrated to induce asymmetric hearing loss, with the left side being affected more than the right one[5]. Studies have shown that there is some evidence of abnormal auditory functioning in the people reporting tinnitus who have significant social noise exposure compared to those who do not report tinnitus and also to those who have not experienced similar leisure noise. Much larger collaborative studies are needed however, to investigate this important area and make definitive and generalizable statements about the effects of leisure noise, especially on tinnitus[6].

Globally, about 16% to 24% of hearing impairments in adults are due to occupational noise[7]. NIHL were found to be the most prevalent occupational diseases in most of the Asian Countries. Apart from noise emitted from manufacturing and agriculture industries, lack of awareness among the workers and

Corresponding author:
Pelden Wangchuk
peldenwangckuk7@gmail.com

health professionals contributes to higher prevalence of NIHL in Asia[8]. The prevalence rate of ONIHL among the manufacturing industries in India was recorded at 41.5% and higher prevalence among those workers exposed for many years compared to workers exposed for a few years[9]. A study in the automotive industry in China found NIHL of 28.82%[1]. Similarly, NIHL among the wood workers in Nepal was found to be 34.7% of which 31% among the Carpenters and 44% among Sawyers[10]. Although the prevalence of ONIHL is unknown in Bhutan, Annual Health Bulletin 2018 recorded 3029 peoples with hearing impairment. Occupational noise exposure in Bhutan was found more prevalent in manufacturing industries which was recorded at an average of 88.6dB(A) with a maximum of 102.5dB(A) and Minimum of 76.8dB(A). Same study showed that 43.5% of workers being exposed to noise level exceeding 91dBA for 8 hours a day contributes to higher risk of acquiring hearing loss[11]. However, there is limited or no information on the Occupational Noise Induced Hearing Loss in Bhutan.

This study is the first kind of study ever conducted in the occupational health and safety setting of Bhutanese industrial workers. It is expected that this study will benefit the relevant organizations and industries to better understand the situation of occupational hearing impairment in formulating policies and intervention programs. This study aims to determine the prevalence of NIHL among the manufacturing industries in Bhutan and identify the potential risk industries as well the vulnerable occupational groups.

METHODS

Sample design and size

A cross sectional study was conducted among the eight manufacturing industry and one mining industry based on the administrative program initiated under the occupational health and safety program on the health assessment by the Department of Public Health, Ministry of Health in collaboration with the Department of Labour. All the workers employed in these nine establishments were selected for the study which comprised of 1638 workers.

Instrument and methods

History or complaint of other associated symptoms related with noise induced hearing loss such as tinnitus were charted down. The ONIHL was defined by the presence of a notch 10 to15 dB in depth at 4000 or 6000 Hz relative to the best preceding threshold by following Dobies criteria of NIHL.

The industrial workers were also conducted Ear Nose and Throat(ENT) examination by ENT technician to rule out other causes of hearing loss. After ENT assessment the workers were referred to audiologists for hearing tests. Pure Tone Audiometry (PTA) and Otoacoustic Emission test (TEOAE) were performed in a silent room.

Data collection and analysis

Data were collected in standard formats and recorded to excel spreadsheets and analyzed using SSPS version 21. The data were analyzed using descriptive statistics and simple binary logistic regression for inferential statistics to determine the association between independent and dependent variables.

Ethical Approval

Ethical clearance was obtained from the Research Ethical Board of Bhutan, Ministry of Health, Bhutan vide approval letter No. REBH/2019/Approval/002 dated 16th July,2019.

RESULTS

The study was carried out in seven types of industries which are classified from nine participating establishments employing about 1638 workers in various occupations. Among the industries, the cement industry represents a higher number of participants (27.5%) compared to the rest of the industries. Majority of workers participating in the audiometry screening were from the age group of 26 to 35 years (35.1%) followed by 36 to 45 years (28.1%) and 46 to 59 years (23.4%).

Prevalence of ONIHL

This study found that 27.9% of industrial workers have audiometric evidence of occupational noise induced hearing loss. This study also found that about 22.8% of industrial workers has other Hearing Impairment (HI) as shown in Table 1. The study found that the prevalence of ONIHL using Air Conduction (AC) is 504 and Bone conduction (BC) is 457.

Vulnerable or high-risk group

The prevalence of ONIHL and other HI is higher among the older age groups as shown in Table 2. Comparing occupation wise as shown in Table 5, the prevalence of ONIHL among the Dryer (knife grinder) is found to be 100% followed by Chipper (88.9%), Mills operator (76%) and Carpenter (64.3%). Blaster, Crasher operator, Welder and Fabrication, and dispatch at weighbridge has between 50-60% prevalence.

Duration of noise exposure and occupational NIHL

Examining the years of work experience as exposure duration, severity of ONIHL increases with the increase in duration of exposure as shown in Table 3. Severity of ONIHL is relatively seen increasing when exposure duration is more. After 25 years of noise exposure, there seems to be decline in the percentile of ONIHL. This can be because of the audiogram showing loss in all frequencies which do not fall under Dobies criteria of diagnosing NIHL

Table 1. Number and percent of workers having hearing impairment by types of industry

Types of Industry	ONIHL		Other HI		Normal	
	Number	Percent	Number	Percent	Number	Percent
n (1638)	457	27.90	373	22.77	808	49.33
2 Cement (*n*=450)	134	29.78	122	27.11	194	43.11
1 Ceramic (*n*=157)	28	17.83	42	26.75	87	55.41
1 Ferrosilicon (*n*=168)	35	20.83	48	28.57	85	50.60
1 Hydro service (*n*=143)	46	32.17	16	11.19	81	56.64
1 Mining (*n*=251)	52	20.72	47	18.73	152	60.56
2 Polymer (*n*=261)	81	31.03	59	22.61	121	46.36
1 Wood base industry (n=208)	81	38.94	39	18.75	88	42.31

ONIHL (occupational noise induced hearing loss) with 27.90%, other HI (other hearing impairment) with 22.77%. Sample are from total of 9 establishments falling under 7 industry types

Table 2. Number and percent of workers with hearing impairment by age group

Age Group	ONIHL		Normal		Other HI		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
18 – 25	21	10.10	151	72.60	36	17.31	208	12.70
26 – 35	114	19.83	350	60.87	111	19.30	575	35.10
36 to 45	144	31.30	223	48.48	93	20.22	460	28.08
46 to 59	172	44.79	83	21.61	129	33.59	384	23.44
60 +	6	54.55	1	9.09	4	36.36	11	0.67
Total	457	27.90	808	49.33	373	22.77	1638	100.00

Mean (ONIHL) 37.23 ±10.01

Table 3. Degree of ONIHL by number of years in work

Exposure duration (years)	NIHL		Minimal		Mild		Moderate		Moderately Severe		Severe	
	N	%	N	%	N	%	N	%	N	%	N	%
Number (*n*)	457	27.9	173	37.9	190	41.6	72	15.8	13	2.8	9	2.0
0 to 5	78	4.8	42	53.9	26	33.3	10	12.8	0	0.00	0	0.0
6 to 10	83	5.1	37	44.6	28	33.7	12	14.5	4	4.8	2	2.4
11 to 15	97	5.9	41	42.3	37	38.1	15	15.5	1	1.0	3	3.1
16 to 20	82	5.0	30	36.6	39	47.6	10	12.2	1	1.2	2	2.4
21 to 25	39	2.4	6	15.4	25	64.1	6	15.4	2	5.1	0	0.0
26 to 30	49	3.0	13	26.5	21	42.9	8	16.3	5	10.2	2	4.1
31 to 35	24	1.5	4	16.7	12	50.0	8	33.3	0	0.0	0	0.0
36 to 40	5	0.3	0	0.0	2	40.0	3	60.0	0	0.0	0	0.0

Table 4. Association between ONIHL, types of Industry, age groups and exposure duration

Particular	ONIHL		*p*-value*	OR†	95% CI‡	
	Number	Percent			Lower	Upper
Sample size (*n*)	**457**	**27.9**				
Types of Industry						
Ceramic	28	17.83		Ref		
Cement	134	29.78	0.004	2.04	1.25	3.32
Ferro Alloy	35	20.83	0.295	1.37	0.76	2.48
Hydro power	46	32.17	0.018	2.03	1.13	3.63
Mining	52	20.72	0.328	1.32	0.76	2.28
Polymer	81	31.03	0.247	1.4	0.79	2.46
Wood base industry	81	38.94	0.00	2.81	1.64	4.81
Age Group						
18 – 25	21	10.1		Ref		
26 – 35	114	19.83	0.002	2.2	1.34	3.61
36 to 45	144	31.3	0.00	4.06	2.48	6.64
46 to 59	172	44.79	0.00	7.23	4.41	11.84
60 +	6	54.55	0.00	10.69	3	38.04
Exposure duration (years)						
0 to 5	78	15.76	Ref			
6 to 10	83	22.19	0.016	1.53	1.08	2.15
11 to 15	97	34.28	0.00	2.79	1.98	3.94
16 to 20	82	39.05	0.00	3.43	2.37	4.95
21 to 25	39	34.51	0.00	2.82	1.78	4.45
26 to 30	49	43.75	0.00	4.16	2.67	6.49
31 to 35	24	57.14	0.00	7.13	3.69	13.75
36 to 40	5	55.56	0.005	6.68	1.76	25.44

**A p-value less than 0.05 (or ≤ 0.05) is statically significant.*
†Odd ratio measures the association between exposure and risk of acquiring ONIHL. If, OR>1 means greater odds of association between the independent variables and ONIHL, OR=1 means no association and OR< 1 means lower odds of association.
‡95% of confidence interval (CI) where the sample means lies between an upper and lower interval.

Association between ONIHL and dependent variables

This study had found a significant association between ONIHL and Cement, Hydro power, and Wood base industry. Compared to the ceramic industry these industries are more than two times higher risk of ONIHL as shown in Table 4. Similarly, the association between the age groups, duration of exposure and ONIHL were found to be highly significant as shown in Table 4. Among the occupations, significant association was found between ONIHL and loom operators and this occupation is 5 times higher risk of acquiring ONIHL compared to workers working in printing departments.

The study found that the Driver, Security Personnels, Welder/Fabricators/Fitters, Mechanical Engineers, Operators plant/equipment are highly susceptible for ONIHL as shown in Table 5.

Presence of tinnitus with the ONIHL

Prevalence of tinnitus in overall industrial workers stands at 23.2%. Among the total workers with ONIHL, 42.5% reported with different forms of tinnitus in either or both the ears as

Table 5. Association between ONIHL and Occupations

Occupation	Number	Percent	*p*-value	OR	95% CI	
					Lower	Upper
N	457	100.00				
Printing	2	0.44		Ref		
Administration	12	2.63	0.11	0.26	0.05	1.38
Civil engineering	3	0.66	0.60	0.59	0.08	4.22
Driver	30	6.56	0.16	3.25	0.64	16.51
Electrical Engineering	20	4.38	0.93	1.08	0.21	5.50
Food handlers	2	0.44	0.82	1.29	0.14	11.54
Foreman/Supervisor	18	3.94	0.45	1.90	0.37	9.82
Laboratory	3	0.66	0.40	0.43	0.06	3.04
Loom Operator	32	7.00	0.05	5.03	1.04	24.44
Mechanical Engineering	58	12.69	0.22	2.70	0.56	13.12
Mines workers	16	3.50	0.41	2.02	0.38	10.72
Operator plant/equipment/machinery	99	21.66	0.20	2.80	0.59	13.25
Production Process Workers	31	6.78	0.64	0.68	0.14	3.36
Security personal	51	11.16	0.12	3.58	0.73	17.65
Store & Housekeeping	13	2.84	0.80	1.24	0.23	6.58
Tapping /Casting/Chipping	9	1.97	0.39	2.17	0.38	12.53
Weighbridge and Packing	10	2.19	0.38	2.15	0.39	11.74
Welder/Fabrication/Fitter	28	6.13	0.08	4.25	0.83	21.65
Wood work & forestry	20	4.38	0.31	2.38	0.45	12.64

Table 6. Presence of tinnitus in either ear or both among the ONIHL

Presence of ONIHL	Sample size	Presence of tinnitus in either ear or both	
		Number	Percent
N	1638	380	23.20
No	1181	186	15.75
Yes	457	194	42.45

shown in Table 6. Tinnitus was found to increase with increasing ONIHL severity. It signifies strong correlation between frequency and severity of tinnitus episodes and the noise levels to which the workers are exposed. Thus, Tinnitus should be included in hearing conservation programs.

DISCUSSION

This study found that prevalence of ONIHL among the industrial workers at 27.9% which is higher than the global figure (16% to 24%)[5] and nearly half (42.5%) of the industrial workers with ONIHL complained of tinnitus in either or both ears. It's found that more than half (50.7%) of the industrial workers are suffering from hearing impairment either due to ONIHL or other types of hearing impairments. Although the prevalence of NIHL is quite lower compared to the manufacturing industries in India[9], there is not much difference between other Asian countries[8].

Workers in wood base industry, polymer and Hydro power plant services have higher risk of accruing ONIHL compared to other industries. The finding of this study is coherent with the study conducted on epidemiology of occupational noise exposure level in the industries of Bhutan where it was found that

level of noise in wood base and polymer industry are very high[11]. This study found that prevalence of ONIHL is higher among the older age groups. The possibility of having higher ONIHL among the older age group can be correlated to duration of exposure to noise. Similar studies show that duration of exposure to noise is directly proportional to the magnitude of damage to the hearing sensitivity[4]. It was also observed that some of the occupations such as knife grinders (Dryer) in wood based industry, chipper in manufacturing industries is vulnerable for ONIHL. This result correlates to study findings conducted in Nepal where wood workers were found to be 34.7% of which 31% among the Carpenters and 44% among Sawyers.[10]

Significant association exists between the exposure duration, age groups and ONIHL. There is very little medical and surgical management once the condition is acquired but ONIHL is a preventable cause. Proper work and rest regimes can be planned for the high-risk population groups with the aim of conserving hearing.

LIMITATIONS

This study did not investigate the knowledge, attitude and practices of the workers with regard to noise hazards and protection including use of hearing protective devices.
The source of noise that the workers are exposed to and noise exposure level for different occupation and industries were also beyond the scope of this study. The study did not investigate the possibility of ototoxicity in the participating industries.

CONCLUSIONS

The prevalence of ONIHL among the industrial workers is found to be at higher side and some of the occupations and industries impose higher risk.

Thus, the study strongly suggests that there is the need for strong intervention in relevant organizations such as efficient enforcement of noise permissible exposure limits of the workplaces. At industrial level, workers need to be well educated on the ONIHL and hearing conservation programs. Medical professionals can also play a pivotal role in educating workers, managers and relevant stakeholders on noise and adverse health effects. Academicians and researchers can contribute in validating such research and recommend measures to address such issues.

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REFERENCES

1. Chen Y, Zhang M, Qiu W, Sun X, Wang X, Dong Y, et al. Prevalence and determinants of noise induced hearing loss among workers in the automotive industry in China: a pilot study. J Occup Health. 2019;61(5):387-97. [Full Text | DOI]
2. Le TN, Straatman LV, Lea J, Westerberg B. Current insights in noise induced hearing loss: a literature review of the underlying mechanism, pathophysiology, asymmetry, and management options. Journal of Otolaryngology - Head & Neck Surgery. 2017;46(1):41. [Full Text | DOI]
3. Yang Y, Zhang E, Zhang J, Chen S, Yu G, Liu X, et al. Relationship between occupational noise exposure and the risk factors of cardiovascular disease in China: A meta-analysis. Medicine (Baltimore). 2018;97(30):e11720-e. [PubMed | Full Text | DOI]
4. Safety NIFO, Health. Criteria for a recommended standard: Occupational noise exposure. Revised Criteria. 1998.
5. Seydel C, Haupt H, Szczepek AJ, Klapp BF, Mazurek B. Long-term improvement in tinnitus after modified tinnitus retraining therapy enhanced by a variety of psychological approaches. Audiology and Neurotology. 2010;15(2):69-80. [Full Text | DOI]
6. Davis A, Lovell E, Smith P, Ferguson M. The contribution of social noise to tinnitus in young people - a preliminary report. Noise and Health. 1998;1(1):40. [Full Text]
7. Nelson DI, Nelson RY, Concha-Barrientos M, Fingerhut M. The global burden of occupational noise induced hearing loss. American journal of industrial medicine. 2005;48(6):446-58. [Full Text | DOI]
8. Fuente A, Hickson L. Noise induced hearing loss in Asia. International journal of audiology. 2011;50Suppl 1:S3-10. [Full Text | DOI]
9. Rastogi S. Prevalence of Onihl in manufacturing industry. Journal of Otolaryngology-ENT Research. 2016;5. [Full Text]
10. Robinson T, Whittaker J, Acharya A, Singh D, Smith M. Prevalence of noise induced hearing loss among woodworkers in Nepal: a pilot study. Int J Occup Environ Health. 2015;21(1):14-22. [Full Text | DOI]
11. Dendup P, Tenzin S, Penpa. Epidemiology of occupational noise exposure level in the industries of Bhutan. Epidemiology International. 2019;4:6-9. [Full Text]

AUTHORS CONTRIBUTION

Following authors have made substantial contributions to the manuscript as under:

PW: Concept, analysis of data, study design, manuscript drafting and critical reviews

PD: Concept, analysis of data, study design, manuscript drafting and revision

Authors agree to be accountable for all respects of the work in ensuring that questions related to the accuracy and integrity of any part of the work are appropriately investigated and resolved.

CONFLICT OF INTEREST

None

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