

Research Article

# Epidemiology of Occupational Noise Exposure Level in the Industries of Bhutan

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## I N F O

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## A B S T R A C T

**Introduction:** Noise hearing loss has been long recognized as an occupational disease which is preventable. The health effect of noise exposure depends on the level of noise and the duration of exposure. Thus, understanding noise levels and determining workers' exposure to different noise levels at workplace is paramount in determining preventable programs at workplace. However, in Bhutan, there is limited or no information or studies on the prevalence of noise exposure level in the industries.

**Methods:** The objective of this article is to ascertain the level of occupational noise exposure in the 26 manufacturing industries in two state of Bhutan and determine the high-risk industry and occupation. Sectors with high risk of noise exposure were selected for the study and similarly, the departments with high noise pollution within the establishment were considered for sampling. The level of noise was measured using NIOSH SLM apps on iOS devices and structured forms were used.

**Results:** 34.6% of industries have occupation noise level between 85 to 90dB(A) and 38.5% have above 91dB(A). By occupation, 43.5% of workers are exposed to occupational noise level more than 90dB(A). Among various occupations, carpenters and operators are found to be vulnerable to hearing loss.

**Conclusion:** Since more than one third of the enterprises have occupational noise level exceeding 90 dB(A), the workers in these workplaces have a higher risk of hearing loss. The situation could be further aggravated due to not using ear protection and not having hearing conservation programs in these workplaces.

**Keywords:** Occupational Noise Exposure Level, Noise Induced Hearing Loss, High Risk of NIHL

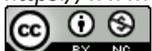
## Introduction

Excessive exposure to noise hazards have an adverse health effect including social and physiological problems.<sup>14</sup> Noise

hearing loss has long been recognized as an occupational disease which is one of the major preventable occupational problem.<sup>9</sup> Globally, about 22 million workers (17%) are

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estimated to be exposed to hazardous noise each year and about 10 million workers are exposed to solvent that can damage hearing.<sup>15</sup> In the United States, about 11% of the working population have hearing problems and one out of four were found to be caused by work-related exposures such as noise and ototoxic chemicals.<sup>15</sup> On an average, about 62 per 100,000 workers suffer from Noise Induced Hearing Loss (NIHL) in UK accounting to 75% of all occupational diseases claim.<sup>6</sup> Similarly, in Korea an average of 258 workers claim compensation for NIHL annually.<sup>8</sup>

The common source of noise in industries are mainly from the machineries, tools and manufacturing processes. According to HSE, most of the food and drink manufacturing industries have processes that emit high level of noise exceeding 80dB(A).<sup>5</sup> Masterson EA et al. found that among the occupations in United States, workers working in mining, construction, wood processing manufacturing, real estate and rental leasing were at higher risk of hearing loss.<sup>11</sup> Similarly, the literature reviews had shown that Asian workers in manufacturing, agriculture, fishing and mining industries were at higher risk of getting NIHL.<sup>4,17</sup> In India, industries such as mining, construction, printing, sawmills, crushers were found to be at a high risk.<sup>13</sup>

NIHL is a major disability caused by extreme and long-term exposure to noise.<sup>9,17,20</sup> Exposure to extreme and prolonged noise damages cochlear hair cells causing a loss of sensitivity to sounds leading to a permanent threshold shift.<sup>16,19</sup> Noise that is 85dB or stronger particularly if exposed for longer duration can result in permanent hearing damages or irreversible sensorineural hearing loss.<sup>10,17,19</sup> Sriopas A et al. found that noise exposure levels of 86-90dB(A) increases the risk of hearing loss significantly in either ear whereas exposure above 90dB(A) increase the prevalence of hearing loss in both ears significantly.<sup>17</sup> Further, the risk of hearing loss increased with the increase in the exposure to higher level of noise intensity such as from 85dB(A) to 90dB(A).<sup>17</sup> Studies have also found that workers exposed to even 85dB(A) for 5 years can cause permanent threshold shift.<sup>17</sup> However, it was found that risk of occupational hearing loss (OHL) significantly reduced with the use of hearing protection devices.<sup>7</sup>

NIOSH had recommended exposure limit for noise at 85dB(A) for 8 hours a day whereas OSHA had set the limit at 90dB(A) for 8 hours a day.<sup>17,19</sup> However, according to OSHA if the noise level at the workplace reached at 85dB(A) the workplaces are required to implement hearing conservation program (HCP).<sup>17,19</sup> Bhutan Occupational Health, Safety, and Welfare Regulation 2012 on noise exposure too limits daily exposure at 90dB(A) for 8 hours. However, the legislation is silent on the requirement of initiating hearing conservation program at the workplaces.<sup>18</sup>

In Bhutan, there are no information on surveillance of noise

exposure level at workplace nor comprehensive data on epidemiology of hearing deafness and impairment or any other occupational related illness. In 2017, the Ministry of Health estimated about 2188 (0.28%) of the population (779,666) has hearing impairment but does not differentiate between general hearing impairment and NIHL.<sup>12</sup> Low percentage of hearing impairment many not necessary means that Bhutan has low risk in NIHL.

The objective of this study is to assess the noise level in the industries of Bhutan to ascertain the level of noise that workers are exposed to in those industries, determine the high-risk industry for NIHL and recommend some protractive measures to minimize the hazards associated with high noise level.

## Methods

### Selection of Sectors

The study was conducted in the manufacturing industry comprising of nine different sectors which includes 26 workplaces such as cement, wood, ferroalloy, fruit and brewery processing, dolomite, cardboard, and iron and steel and polymer. Standard forms were used to collect information on the types of occupations and establishment.

### Noise Measurement

Snapshot sampling was conducted and the Occupational noise levels were measured using NIOSH Sound Level Meter (SLM) app in iOS devices (iOS version 12.1 on iPhone 6) using built in microphone which met the requirements of IEC61672/ANSI S1.4 sound level meter standards.<sup>1</sup> Data recorded were of the instantaneous sound on the A-weighted Equivalent sound level (LAeq). The measurement was taken by strategically positioning the device at the work station, with an effort to keep it as close as possible to their hearing zone.

## Results

The overall level of occupational noise exposure in manufacturing industry was recorded at an average of 88.6dB(A) with the maximum of 102.5dB(A) and Minimum of 76.8dB(A). This study found that each workplace employs about 24 workers on an average with maximum of 72 and minimum of 5 workers. 43.5% of workers are exposed to noise level more than 91dBA for 8hours a day.

## Discussion

This study has found that most of the industries have higher occupational noise level. 34.6% of workplace have noise level more than 85dB(A) but less than 90dB(A) and 38.5% more than 91dB(A) in the industries like the cement, ferroalloy, wood and furniture, polymer, and iron and steel (Table 1). Thus, 38.5% of workplaces exceeds the Bhutan's noise permissible level of 90dB(A) for 8 hours.

**Table I. Occupational noise exposure level by industry and occupation for 8 hours per day**

S. No.	Particular	Total		84.9 dB(A)		85-90 dB(A)		91 dB(A)	
		No.	%	No.	%	No.	%	No.	%
<b>1.</b>	<b>Industry</b>	<b>26</b>	<b>100</b>	<b>7</b>	<b>26.9</b>	<b>9</b>	<b>34.6</b>	<b>10</b>	<b>38.5</b>
1.1	Cardboard	1	3.8	0	0.0	1	100.0	0	0.0
1.2	Cement	5	19.2	2	40.0	0	0.0	3	60.0
1.3	Ceramic	1	3.8	1	100.0	0	0.0	0	0.0
1.4	Dolomite	2	7.7	1	50.0	1	50.0	0	0.0
1.5	Ferroalloy	7	26.9	2	28.6	4	57.1	1	14.3
1.6	Fruits and Dairy product	2	7.7	1	50.0	1	50.0	0	0.0
1.7	Wood and Furniture	2	7.7	0	0.0	1	50.0	1	50.0
1.8	Polymer	3	11.5	0	0.0	1	33.3	2	66.7
1.9	Iron and Steel	3	11.5	0	0.0	0	0.0	3	100.0
<b>2.</b>	<b>Occupation (workers)</b>	<b>620</b>	<b>100</b>	<b>151</b>	<b>24.4</b>	<b>199</b>	<b>32.1</b>	<b>270</b>	<b>43.5</b>
2.1	Carpenters	37	6.0	0	0.0	0	0.0	37	100.0
2.2	Operator	283	45.6	0	0.0	50	17.7	233	82.3
2.3	Packer and loader	115	18.5	85.00	73.9	30	26.1	0	0.0
2.4	Production	15	2.4	15.00	100.0	0	0.0	0	0.0
2.5	Tapper and Packer	170	27.4	51.00	30.0	107	62.9	12	7.1

Furthermore, the study found that 43.5% of workers are exposed to noise level more than 91dB(A) 8 hours per day. Among the occupations, carpenters and operators are exposed to higher noise level as compared to other occupations. Consistent with the studies that have found existence of a poor safety culture, particularly on the usage of personal protective equipment in the Bhutan's workplaces, this study also observed that majority of workers firstly, did not use hearing protections at all times.<sup>2</sup> <sup>3</sup> Secondly, it was found that one time use ear plugs are often used again and again. Thirdly, none of the industries have established hearing conservation programs. Therefore, workers are not only susceptible to NIHL but are also prone to ear infections due to reuse of earplugs.

### Conclusion

This study has found the prevalence of higher occupational noise level in almost all manufacturing industries. More than one third of the enterprises have occupational noise level exceeding 90 dB(A) and 43.6% of the workers are significantly at a higher risk of hearing loss.

### Recommendation

This study is limited to only prevalence of occupational noise exposure level and does not capture the NIHL. Thus, it is recommended that a study with the objective of assessing NIHL of workers should be conducted to establish the relationship with occupational noise exposure level.

This study encourages conducting similar studies to validate the findings. Further, there is a need to review Bhutan's safety and health regulation particularly on hearing conservation programs and fit test of the PPE. At the enterprise level it is highly recommended to conduct periodically monitoring of noise exposure level and audiometry test for those workers who are highly vulnerable to NIHL and ensure use of hearing protection.

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**Conflict of Interest:** None

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