J. Environ. Sci. & Natural Resources, **9(2): 155-160, 2016** ISSN 1999-7361

The Impact of Noise Pollution on Workers' Health in Selected Industries of Mirzapur Industrial Area, Tangail, Bangladesh

S. Alam, S. T. Akter, M. S. Sheikh* and I. Bahar

Department of Environmental Science and Resource Management, Mawlana Bhashani Science and Technology University, Santosh, Tangail-1902, Bangladesh
*Corresponding author: sshemulju@gmail.com

Abstract

The unwanted and intolerable sound causes noise. The study was conducted through interviewing of workers and measuring of noise levels on six types of industries. The data were collected on April, May and June, 2013. The data of noise levels were measured at main gate, administration office and working place of the selected industries. The noise level at the working places during day time of the selected industries were 81.50 dB (textile mill), 104.20 dB (cotton mill), 90.50 dB (jute mill), 95.90 dB (spinning mill), 89.25 dB (knit and garments factory) and 83.50 dB (knitting factory), respectively. All the recorded noise level data in working places of the industries exceeded the DoE standard (75 dB at day time and 70 dB at night time) that caused noise pollution. The important contributors of noise pollution were machineries and overcrowding of the workers in the industry. Most of the common impacts of noise pollution were headache, heart diseases and hearing problem. To resolve the noise problem in industry it was suggested to eliminate the noise sources substituting noisy machineries and so on.

Key words: Health Impact, Industrial Area, Noise and Noise Pollution

Introduction

Pollution is man-made or man aided alteration of chemical, physical or biological quality of the environment to the extent that is detrimental to that environment or beyond acceptable limits. Noise is nothing but an unacceptable level of sound that hampers mental and physical peace, and may induce severe damage to the health. It damages our hearing capacity and causes other health hazard such as stress, hypertension, increased blood pressure, heart disease and headache. It can also interfere with communication at work, which could lead to accident. The normal range of hearing for a healthy young person is from approximately 20 Hz (Hertz) to 20,000 Hz (20 kHz). Our ears are more sensitive to the middle frequencies, which range from 500 Hz to 4000 Hz - the speech frequencies. (Hertz is a measure of the pitch or frequency of sound, sometimes referred to as cycles per second). The World Health Organization has drawn up guidelines to promote a community noise management plants and to reduce the effects of noise exposure on health (WHO, 2010). Noise means unpleasant sound that gives a disturbing and annoying effect to the listener. It can block, distort, change or interfere with the meaning of a message in both human and electronic communication. Noise also affects children, new born baby and even the embryo. Exposure to high level of noise causes severe stress on the auditory and nervous system (Ahmed, 1998). However, because of their complexity and variability, and the interaction of noise with other environmental factors, the adverse health effects of noise do not lend themselves to a straight forward analysis (Gabor *et al*., 2003). Noise is a risk factor in sleep disturbance (Gabor *et al*, 2003; Monsen and Edell-Gustafsson, 2005; Xie *et al.,* 2009). It has also an impact on cardiovascular dysfunction, speech interference and mental health distortion, including hearing impairment and balance disorder (Satterfield, 2001; Ising and Kruppa, 2004). Gorai, Mirzapur industrial area is a noisy area. The people of this area do not possess so much knowledge about the impact of noise pollution. To study the impact of noise on workers' health in selected industries of the study area the objectives were: to identify the major sources of noise pollution at the study area and to determine the workers health condition due to noise at the study area.

Materials and Methods

Study Area

The study was conducted at Gorai union under Mirzapur upazila of Tangail district. Mirzapur upazila with an area of 373.89 km^2 is bounded by Shakhipur and Bashail upazillas on the north, Kaliakor and Dhamrai upazillas on the south, Kaliakor upazilla on the east, Delduar and Nagarpur upazillas on the west. The area of Gorai union is 30.6 km^2 and it is located at 24º02′N and 90º17′E. Main rivers are Bangshai and Elangjani and the upazilla has Salban (*Shorea robusta).* More than one hundred industries are located in this area. It is estimated that, more than fifty thousand employees are employed here. The majority number of the industries is located near the Dhaka-Tangail highway.

Measurement of Noise Level

Noise is characterized by its sound level, its frequency spectrum and its variation over time. It is a function of the magnitude of the pressure fluctuation about the ambient barometric air pressure. Sound intensity (also called sound power density) is the average rate of sound energy transmitted through a unit area perpendicular to the direction of sound propagation, typically measured in Pico watts (10^{-12}) per $meter^2$. The human ear can detect sound intensity as weak as 1 Pico watt and tolerate intensities as high as 10^{12} Pico watts. The decibel (dB) is used to describe sound level. The sound intensity expressed in decibels, is

Sound intensity = $10\log_{10} (I/I_0)$

where,

I = Sound intensity

I_0 = 1 Pico watt/m^2, a standard reference intensity representing approximately the weakest audible sound.

Since no instrument is available for directly measure the power level of a source, sound pressure is employed as a measure in this regard. Sound pressure is usually proportional to the square root of sound power. Because of dealing with large range of numbers, a logarithmic measure called decibel (dB) is used to describe sound level. The sound level in decibel is defined as follows,
Sound level (dB) = 10 l0g $_{10}$ (p/ p_o) ^{2} = 20 l0g $_{10}$ (p/ p_o)
where,
P = Root-mean-square sound pressure (Newton per meter^2),
P_0 = Standard reference pressure corresponding to the weakest audible sound (20 micro newton per meter^2) for practical purpose, the dB scale ranges from zero, the threshold of hearing, to about 140 dB, and the onset of pain. For every 10 dB increase in sound level, the apparent loudness of sound doubles.

Sound Level Meter
A sound level meter is an instrument which has a microphone amplifier and weighting networks and an indicating meter which gives a reading in dB relative to 2×10^{-5} N m^{-2}. The microphone responds directly to the pressure variation in the sound field and its output is amplified to give a reading of sound pressure level directly on the meter. The weighting networks superimpose a frequency response on the amplified similar to that of the human ear (Kudesia, 2000). In this study, noise levels have been measured by a sound level meter (Multi-Function Environmental Meter, Model:ST-8820, Made in China) which consists of a microphone that converts the pattern of sound pressure fluctuations into a similar pattern of electric voltage, amplifiers and a voltage meter that is normally calibrated to read in decibel.

Field and Population Selection for Sampling
Gorai industrial area has a potentiality as it is closed to Dhaka and Gazipur industrial area. The road communication is comparatively and for data collection the experienced workers of different ages especially different position were selected who could provide the real and sufficient information about the noise level and impacts of noise pollution of the relative area. For the purpose of determining the level of noise the following points had been selected: gate of the industry, administration office of the industry and working place of the industry. The conducted industries for study were- i. South East Textile Mills Ltd., ii. Naheed Cotton Mills Ltd., iii. M.H. Jute Mills Ltd., iv. Uttara Spinning Mills Ltd., v. Comfit Composite Knit Ltd. and vi. Newtex Knit Fashions Ltd. The data were collected from the respondents. The samples for the noise level were taken from the different selected points of the industries (gates, administration office and working place) with the sound level meter during working hour.

Data collection

Primary Data Collection
Data were collected through in depth interview from the workers by the questions and interviews from the questionnaire. There were different types of questions such as ranking, open-ended, closed-ended. Closed ended questions are most in number. In the aspects of noise the data were collected by using the noise level meter and questionnaire survey among different workers. A questionnaire was prepared to incorporate all the aspects required for the information. During questionnaire preparation survey samples were divided into five groups i.e. workers, mid-level officers, top level officers, Department of Environment in Tangail, and Doctors. During the study workers of various levels of different industries were considered as survey population to find out the effects of noise pollution. Sampling was taken in such a way that the randomness was strictly maintained for better output. All of the information required for the study was collected with meticulous care.

Secondary Data Collection
Secondary data were collected from the Department of Environment, Bangladesh; noise pollution related journals; books; literatures; reports and thesis papers and website.

Data Processing, Analysis and Interpretation
The collected data were tabulated. The open-ended questions were converted into the groups. The qualitative data were converted into quantitative form. Computer program such as MS word and MS excel were used to process, analyze and interpret the data. Because of the logarithmic nature of the dB, the average value of collected sound pressure level measurement in the normal fashion, instead of the following equation has been used.

$$\mathrm{Lp} = 20\log 1/\mathrm{N}\sum_{j=1}^{N} 10^{(\mathrm{Lj}/20)}$$

where,
Lp= Average sound pressure level, dB re: 20µpa
N= Number of measurements
Lj= The jth sound pressure level, dB re: 20µpa and
j= 1,2,3……N

Results and Discussion

There are hundreds of industries are located in the Gorai industrial area. Among them dyeing industries, knitting industries, spinning industries, textile industries are mentionable. The A-weighted, measured in decibel (dB), is the generally accepted scale for measuring sound level in industries.

Demographic Characteristics
A total of 18 respondents got interviewed in order to get their personal background. The respondents were being picked by selecting their works or job level. A total of 18 workers completed the questionnaire 12 of them were male and 6 of them were female. Most of the female workers worked at the production areas. The respondents of female worker were with the range of age between 25 to 35 years. Based on the survey, 20% of the workers are aged between 21 to 30 years. At least 40% of workers are aged between 51 to 60 years. This shows that workers in this section are composed of over 40 years old. Elderly are more vulnerable to the senses of hearing loss compared to the younger workers.

According to Passchier and Vermeer (1993), workers exposed to high levels of industrial noise for 5 to 30 years get increased blood pressure and significant increases in risk for hypertension, compared to workers in control areas. Based on the survey conducted, about 47% of the workers have been working for at least less than 10 years, 20% of the workers have been working for 11 to 20 years, 20% of workers have been working for 21 to 30 years and 13% of the workers have been working for more than 30 years. Therefore, those who worked for nearly 40 years are more vulnerable to loss sense of hearing.

Acceptable Noise Level (dB)

In order to account for the ear's response to different levels of noise, weighing filters are used while measuring the sound level. The A-weighted sound level is devised to represent a person's subjective response to the variation of sound more accurately. The A weighted sound level, measured in decibel (dB), is the generally accepted scale for measuring sound level in transportation. The standard noise level limits regarding to Bangladesh are as follows:

Table 1. Noise level standards in Bangladesh in various areas during day and night time

Sl. No.	Category of areas	Sound levels (dB)	
		Day time	Night time
01	Silent Zone	45	35
02	Residential area	50	40
03	Mixed area (mainly residential area, and also simultaneously used for commercial and industrial purposes)	60	50
04	Commercial area	70	60
05	Industrial area	75	70

(Source : Department of Environment, 2004 Bangladesh)

Sources of Noise in the Industry

There are various sources of noise in the industry, which has various negative impacts on the workers health. The main sources of industrial noise pollution are the machineries source and overcrowding of the workers in every industry. Another major source of noise pollution is the vehicle. Because most of the industries are situated near to the highway. Every vehicle uses hydraulic horn. Every industry has a generator room which produces high level of noise.

Table 2. Sources of noise according to the type of industry

Sl. No.	Type of industry	Major sources of noise
01.	Textile	Finishing machines
02.	Cotton	Auto machines, blowroom, preparatory machines, ring fan and finishing machines
03.	Jute's thread	Spreader machines
04.	Spinning	Rolling machines and finishing machines
05.	Knit	Sewing machines and knitting machines

Other important sources of noise pollution in every industry are as follows: i) Fans and blowers, ii) Electric motors and transformers, iii) Pumps and plumbing systems, iv) Air compressors, v) Gears and bearings, and vi) Air vents and gas jets etc.

Noise Level of the Industries

Most of the industries noise level are high. Machineries sources of noise are the common source of noise pollution in the industries. Noise levels of different selected industries in various points during day time are recorded and presented in the table 3. It is noticed that, the noise level of the most industries gate was normal because most of the industries' gate were located at a moderate distance from the basic part of industries. The noise level of administrative office of all industries was normal because all the administrative offices' wall were made of glassware protector from noise and most of the administrative offices were situated at a distant place from the machinery instrument. The noise level of all the industries exceeded permissible level and exist in dangerous limit against the standard level of ILO (International Labor Organization) because of the machineries sound.

Table 3. Noise level (dB) of the selected industry

Name of the industry	Noise level (dB) and comments						
	Gate No	Comments	Administration office	Comments	Working place	Average noise level	Comments
South East Textile Mills Ltd.	75	Normal	65.5	Normal	81.5	74	Moderately dangerous
Naheed Cotton Mills Ltd.	70	Normal	74.5	Normal	104.2	82.9	Very dangerous
M.H. Jute Mills Ltd.	91.1	Dangerous	60	Normal	90.5	80.5	Dangerous
Uttara Spinning Mills Ltd.	70	Normal	66.7	Normal	95.9	77.5	Dangerous
Comfit Composite Knit Ltd.	78.5	Moderate dangerous	55.6	Normal	89.25	74.45	Moderately dangerous
Newtex Knit Fashions Ltd.	72	Normal	60.5	Normal	83.5	72	Moderately dangerous

The noise level was recorded at gates, administrative buildings and working places of all the industries at day time where, the highest noise level (104.2 dB) was observed in working places of Naheed Cotton Mills Ltd. and the lowest noise level (81.5 dB) was observed in working places of South East Textile Mills Ltd. both of them exceeded the standard value of noise level (75 dB, Department of Environment, Bangladesh) for industrial area at day time. Most of the industries' gates were exist very close to the highway. Therefore, recorded noise level of the gates higher than the administrative buildings but lower than working places except Naheed Cotton Mills Ltd. because it was very close to the working place. The highest average noise level was recorded 82.9 dB in cotton industry and the lowest average noise level was recorded 72 dB in textile industry.

The noise level of gates in different industries is shown in the Table 3. Here the noise level of M.H. Jute Mills Ltd and Comfit Composite Knit Ltd exceed the limit for industry (compare to standard of DoE). The noise level of the rest of the four industries: South East Textile Mills Ltd, Naheed Cotton Mills Ltd, Uttara Spinning Mills Ltd and Newtex Knit Fashions Ltd exist in allowable level for the industry (75 dB, According to DoE, Bangladesh).

The Table 3 revealed that textile industry exposes the lowest level of noise and cotton industry exposed the highest level of noise comparing to the other industries. The noise level of working places of all the industries was higher than the standard level (75 dB during day by, DoE, Bangladesh).

The average noise level of the industries is noticed that the average noise level of Naheed Cotton Mills Ltd. M.H. Jute Mills Ltd and Uttara Spinning Mills Ltd industries exceed the standard level for industry and exceed limit (compare to standard of DoE). Three industries: South East Textile Mills Ltd. Comfit Composite Knit Ltd. and Newtex Knit Fashions Ltd. exist in standrd level but almost closed to the highest limit of standard for the industry (75 dB, According to DoE).

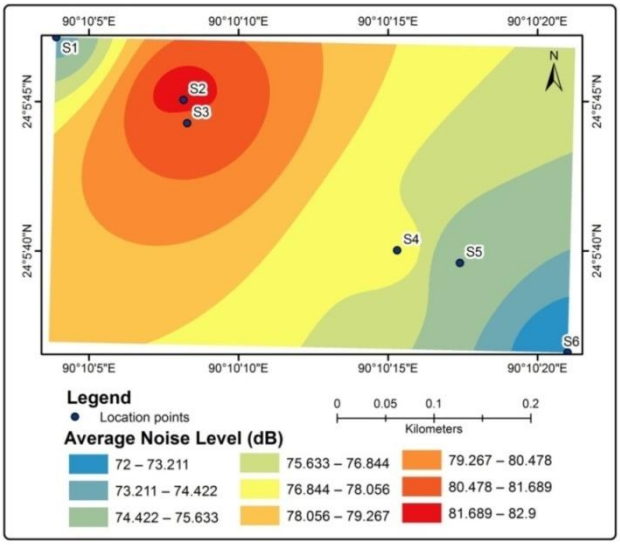

Fig. 1. Spatial distribution of average noise level of different industries at the study area

The noise level of working place of the selected industries varried from 81.5 dB to 104.2 dB. According to the standard level of DoE (75 dB during day), it can be said that, the noise level of working place of all the industries exceeded the permissible limit of noise level (Fig. 1). The highest level of noise was recorded in the Naheed cotton mills Ltd. and the lowest level of noise was recorded in the South east textile mills Ltd.

Naheed Cotton Mills Ltd. exposed the highest average noise level (104.2 dB) that exceeded the standard level of noise (75 dB, during day by DoE) and Newtex knit fashions Ltd. had exposed the lowest limit of average noise level (dB) that was within the standard level of noise. The level of noise depends on the machineries which were specially placed in production site of the industry. The average noise level of Naheed cotton mills Ltd., M.H. Jute mills ltd. and Uttara spinning mills Ltd. exceeded the standard level of noise (75 dB, during day by DoE). Other three industries were within standard level of noise. The noise levels of administrative office and industry's gate were not the same but a little difference. There was a great variation

of noise level in the working places among such industries. So, the average noise level (dB) was mostly depended on the level of noise in the working place of the respective industry.

Effects of Noise Pollution on Workers Health

Survey on Workers

18 respondents were selected for survey purpose during the study from the lower class, middle class and top level working position of the industry. Among them 12 respondents were male and 6 respondents were female. Most of the interviewers were male because it was easier to get responses from the men than the women and the male workers are more interested than female workers to discuss about the matter.

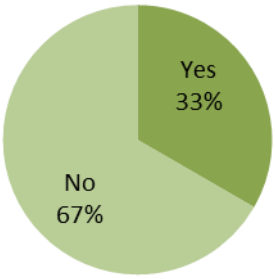

Fig. 2. Percent of respondents about the knowledge of noise pollution (%) in study area

The fig. 2 represents the percentage of workers who know or do not know about the noise pollution. From fig. only 33% of the workers know about the noise pollution and 67% of the workers do not know about the noise pollution. Most of workers do not know about the noise pollution, because most of the workers are not educated or conscious.

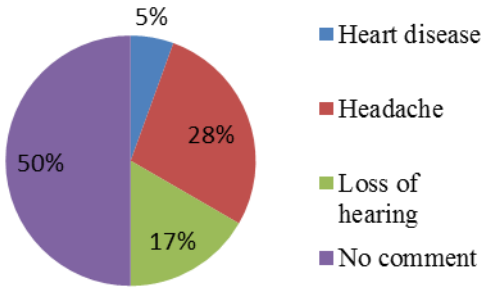

Fig. 3. Types of problem faced for noise pollution (%) in study area

On answering the question, about the types of problem they face 5% of workers say that they are suffering from heart disease, 28% of workers had headache, 17% of workers had hearing loss, and 50% had no comments. From the study it can be said that, the main effect of noise pollution on worker is headache. Another main problem is hearing loss.

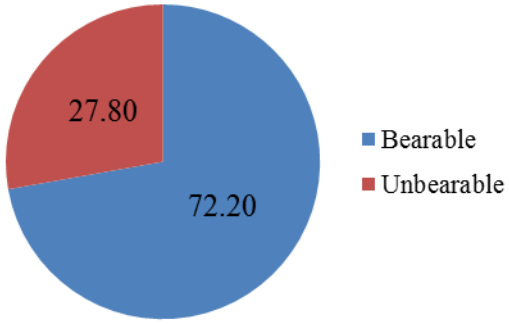

Fig. 4. Comments of respondents depending on the thinking of tolerable and intolerable noise level in study area

Actually most of the workers do not aware about the impacts of noise pollution because most of the workers are not conscious about it. Their level of education were below HSC /SSC/JSC/ PSC. Another reason is the adjustment with the high noise level in the industry. As a result they think the noise level is bearable. The workers which have a short or long working experience in the industry, they think the noise level of working place is unbearable.

Survey on Doctors

Six doctors were selected during the study for survey purpose. Two of them were ENT specialist and surgeon, two of them were medical officer and other two were medicine specialist. All of them said that noise affected patients had come to their chambers in every month but their number was very poor. They identified the main three negative effects of noise pollution. These were sleeplessness, headache and hearing problem. The doctors suggested using hearing protector, earmuffs, earplugs and helmet to reduce the health impacts of noise pollution.

Table 4. The noise level and their impacts on human according to the doctors

Noise level	Description
0 to 20 dB	Normal
20 to 45 dB	Mild hearing loss
40 to 67 dB	Moderate harmful
70 to 100 dB	Serious hearing loss
More than 100 dB	Acute health hazard

Conclusion and Recommendation

The result of the study shows that the workers of all industries are victim to high levels of noise. The older workers were more vulnerable to high level of noise. The minimum sound level 83.5 dB and the maximum sound level 104.2 dB were observed in the working place of the industry. According to Factories and Machineries (Noise Exposure) Regulation 1989, the results are still relevant and the noise exposures to the workers are not exceeding the prescribed level. Noise pollution is a neglected issue in Bangladesh but it is a severe health hazard for the physical and mental health of the urban people, particularly of the children. It is imperative for the decision makers, leaders, planners, engineers and concerned authority to keep the noise level within the acceptable limits. Design and fabrication of silencing devices and their use in various machines would become an effective measure for noise reduction in the industry. Implementing one or more of the following hierarchy of control measures can manage excessive noise levels: i) substituting noisy machinery with quieter machinery which are more efficient and goes with cost and benefit to control noise pollution, ii) engineering controls by treating the noise at the source or in its transmission path, iii) providing hearing protectors, iv) poor maintenance of tools leads to increased noise levels. So maintenance of the equipment and any noise reduction devices regularly should be ensured v) Absorber should be used to reduce the noise level of the source, vi) appropriate design of compressed-air lines and ventilation ducts.

References

Ahmed, K. 1998. A Study on Noise Pollution in Dhaka City, Department of Environment, Bangladesh, pp. 81-84.

DoE. 2004. Noise Control Rules, 2004, Dhaka: Department of Environment, GOB.

Gabor, J. Y.; Cooper, A. B.; Crombach, S. A.; Lee, B.; Kadikar, N.; Bettger, H. E. and Hanly, P. J. 2003. Contribution of the intensive care unit environment to sleep disruption in mechanically ventilated patients and healthy subjects. *American Journal Respiratory Critical Care Medicine*, 167: 708-715.

Ising, H. and Kruppa, B. 2004. Health Effects caused by noise: Evidence in the Literature from the past 25 years. Noise Health, 22: 5-13.

Kudesia, V. P. 2000. Pollution (Everywhere) (2nd Ed.). Pragati Prakashan, Meerut. pp. 153-154.

Monsen, M. G. and Edell-Gustufsson, U. M. 2005. Noise and sleep disturbance factors before and after implementation of a behavioral modification programme. *Intensive Critical Care Nursing*. 21: 208-19.

Passchier-Vermeer, W. 1993. Noise and healthy. Hague: Health Council of the Netherland.

Satterfield, K. 2001. Balance disorders and patients with NIHL in on ear. Academy of Otolaryngology Head and Neck Surgery, 703: 1-3

World Health Organization (WHO). 2001. Occupational and community noise. Fact sheet, pp. 258

World Health Organization (WHO). 2010. WHO Guidelines for Community Noise. Retrieved from http:// whqlibdoc.who.int/hq/2010.

Xie, H.; Kang, J. and Mills, G. H. 2009. Clinical review: The impact of noise on patients sleep and the effectiveness of noise reduction strategies in intensive care units. *Critical Care*, 13(2): 208-215.