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Original Article

Environmental noise induced hearing loss in Nepal

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Abstract

Introduction: Noise pollution in urban cities is a serious problem and steadily increasing over the years. This has direct and indirect affect to the people that can lead to the health hazard. **Objectives:** To find out environmental noise induced health effect on people residing in an urban community and to predict the risk of the environmental noise induced hearing loss ***Material and methods:*** One hundred fifty questionnaires were filled up for the environmental noise pollution survey. For the case control study, 36 exposed and 25 non-exposed residents of Kupondole were included. Based on the place of residence (main road and 20 min. walking distance from the main road), subjects were divided into exposed and non-exposed group concerning environmental noise. Demographic data and information about health problems was obtained by a structured interview. Audiometric test was performed using manual audiometer. Odds ratios (OR) and their 95% confidence intervals (95% CI) for noise induced hearing loss were estimated using logistic regression. Adjustment for occupational noise was done **Results:** The major health effect induced by the environmental noise was observed as lack of concentration followed by irritation, fatigue and headache. The crude OR and 95% CI for the exposed subjects was 4.2 (1.4, 12). After adjustment for occupational noise, the OR (95% CI) was 4.0 (1.2, 13). ***Conclusion:*** This study shows that exposure to noise causes wide range of health effects. For the exposed subjects there was an increased risk of noise induced hearing loss. The risk was significantly increased also after adjusting for occupational noise.

Keywords: Environmental Noise, Noise Induced Hearing Loss (NIHL), Audiometric Test, Noise Pollution Survey, Nepal

In the modern world, development in technology, commerce, communication and education has enhanced the urban growth both in developed and developing countries. With global urbanization, there have occurred many environment problems causing pollution and environmental degradation. Out of many environmental problems, noise has emerged as one of major urban environmental pollution. Environmental noise pollution has not been an entirely new phenomenon, but rather has been a problem that has grown steadily worse with time.

Noise can be defined as any unwanted, distributing or harmful sound that impairs or interferes with hearing, causing stress, hampers concentration and work efficiency or cause accidents.[1]

Noise pollution in urban cities is steadily increasing over the years. Proportion of people exposed to noise is greatly increasing. This has direct and indirect affect to the people that can lead to the health hazard. Some of the major health hazards caused by the noise as suggested by experts are permanent hearing loss, high blood pressure, muscle tension, migraine, headaches, higher cholesterol levels, gastric ulcers, irritability insomnia, increased aggression and psychological disorder.[1]

In Nepal, there were very few researches on noise pollution being carried out. Even such surveys conducted in the past have revealed that noise levels in urban areas are generally much higher than recommended International Standards. The main purpose of this study is to analyse noise induced hearing loss and to develop fundamental database to assist in preparation of guideline for the noise pollution prevention and control in Nepal.

Road traffic noise is a major source of noise in urban areas. It produces disturbance and give an impact to more people than any other forms of noise source.[2]

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Researchers have measured noise level in high traffic, hospitals, campuses and residential areas.[3,4] Khanal *et al.* have recorded traffic noise level in different areas of Kathmandu valley.[5] All those finding shows that during last one and half decades, 70-100 dB(A) range of noise level were typically observed in urban Kathmandu roads. They have also observed the distinct traffic peaks in the morning and evening on urban roads as people travel to and through from work. Khanal *et al*. however, observed little significant variation of noise level in office and non-office hour throughout the day.

Those studies have revealed that vehicle engines, loud and prolong horns, road-tyre friction, gear box and exhaust system are major sources responsible for rising traffic noise and hearing loss is one of the chief complaints of the residents. They have even predicted that the significant factors responsible for increasing noise level were traffic flow rate, the proportion of heavy vehicles and nature of road surface. According to their studies, old vehicle like heavy buses; three wheeler tempos were contributing sources in raising the traffic noise level. Due to lack of vehicle maintenance regulation in Nepal, old vehicles like heavy buses; three -wheeler tempos etc. were freely running in urban cities that were responsible for high traffic noise.

Industrial machines and processes produce industrial noise. The noise may contain predominantly low or high frequencies. They are impulsive or have unpleasant and disruptive temporal sound patterns. The mechanical processes like weaving, blasting, pressing, drilling, cutting, metal chipping and riveting etc. can possess a significant occupational health hazard. The industrial workers are predominantly exposed to industrial noise that can have serious impact on their health.[6]

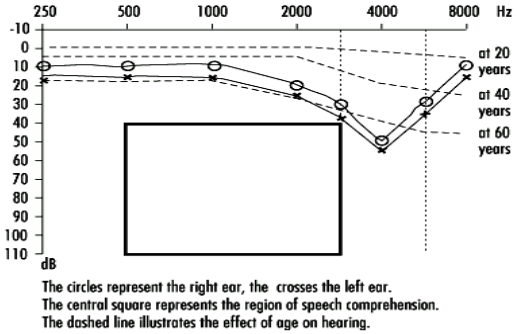
Shrestha and Shrestha[3] and Miyoshi Y[7], have measured the levels of noise produced by various machines and processes in different industries within Kathmandu valley and outside. They have found that noise levels were high in textile industries, metal works, cement industries and flourmills. The highest recorded noise level was 120 dB(A) at Balaju Kapada Udyog.

Noise induced hearing loss is of a sensory neural type involving injury to the inner ear. Hearing loss usually refers to hearing impairment that is causing difficulties or to a hearing threshold level that has deteriorated.[8] Hearing loss can be caused in number of ways due to rupture of eardrum, breaking of the bones in the middle ear etc. Prolong noise exposure to high intensity sound can damage the hair cells of the inner ear leading to permanent hearing loss. It is generally accepted that noise levels below 80 dB(A) do not present a risk to hearing.

An audiometric test is applied in order to determine the auditory sensitivity of the individual who is continuously exposed to high noise level (Figure 1). The audiogram observed in cases of noise induced hearing loss is characterized by an onset of hearing loss at 4000 Hz, visible as a dip in the audiogram. As exposure to excessive noise levels continues, neighbouring frequencies are progressively affected and the dip broadens, encroaching at approximately 3000 Hz. Noise induced hearing loss is usually bilateral and shows a similar pattern in both ears.

Hearing thresholds progressively increase with age, with higher frequencies more affected. Over a period of a lifetime progressive deafness occurs as hair cells die off. This condition is known as *Presbycusis*. Some audiologists have adopted term, as, a *Sociocusis*, eventual hearing loss due to the cumulative effect of noise exposure in every day life. The characteristic 4000 Hz dip observed in noise induced hearings loss is not seen with *Presbycusis* cases.[9]

Figure 1. Audiogram showing bilateral noise-induced hearing loss



Source: ILO Encyclopaedia of Occupational Health and Safety

The objective of the study was to find out environmental noise induced health effect on people residing in an urban community and to predict the risk of the environmental noise induced hearing loss

Methods

A case-control study and an environmental noise pollution survey were designed.

For the environmental noise pollution survey, a questionnaire was set up in both Nepali and English languages. Altogether, 150 questionnaires were taken for the study. The sampling was taken randomly in five cities (Kathmandu, Lalitpur, Bhaktapur, Kirtipur and Janakpur) and the survey was conducted directly through household visits and electronic mailing system.

For the case control study, the study subjects consisted of residents of Kupondole Tole of Kathmandu District, who consented to take part in the study on 22nd April 2003. Confidentiality of all information about the subjects was assured. Tools used for the study were a structured interview and screening audiometric test of all subjects.

Depending on the exposure to environmental noise, two different groups namely exposed and non-exposed group were categorized. Exposed group were those residing or having regular activity near the main road where sound pressure level exceeded 70 dB(A). Non-exposure group were those who lived or used to perform their activity away from noisy areas where sound pressure level did not exceeds 55 dB(A).

The study subjects were interviewed using a structured interview, in a questionnaire format. Information about their education, occupation, present and past medical history, diet pattern, smoking and alcohol habit were obtained.

The manual audiometers were applied for the audiometric test. The screening examination was performed. The site for audiometric testing was selected in most quite area as far as possible excluding all the extrinsic noise factors like traffic, commercial, households noise etc. The audiometric threshold data was recorded on an audiogram form as recommended by ASHA (American Speech Language Hearing Association) in 1974 and as adopted by ANSI (American National Standard Institute) in 1978.

Statistical analysis was done using the statistical program package "Statistical Package for Social Sciences (SPSS)" eleventh version. Odds ratios (OR) and their 95% confidence intervals (95% CI) for noise induced hearing loss were estimated using logistic regression models. Adjustment for occupational noise was done by the use of multivariate logistic regression analyses.

Results

Environmental noise pollution survey

Altogether 150 samples covering different environmental settings were surveyed. During survey, the entire respondents had shown familiarity in relation to noise pollution. Out of total respondents, 30% had shown ignorance on health effect of noise pollution.

Table 1. Respondents' weighted complaints on noise induced health effects.

Noise related complaints of the respondents	Percentage
Hard hearing	24
Fatigue	40
Irritation	40
Headache	35
Speech Disturbance	32
Sleep Disturbance	23
Chest Pain	16
Nausea	17
Dizziness	22
Lack of Concentration (decreased performance)	45

Weighted complaints of the respondents contemplated to different psychological and physical effects induced by the noise are shown in the table 1.

The major health effect induced by the noise pollution was observed as lack of concentration. Irritation, fatigue and headache were also other major

health effects caused by noise pollution. Chest pain and nausea were the least health effects observed according to the respondents.

Case control study

All together 61 samples were included in the study. Among them, 36 subjects were exposed to noise (cases) and 25 subjects were not exposed to noise (controls). There were altogether 46% males and 54% females. Mean age for the cases and controls were 34 and 41 years, respectively. The number of smokers was significantly lower (5%) compared to the number of non-smokers (95%). Variables like sex, diet, education, occupation, medical history, history of smoking and alcohol were not significantly different between the cases and the controls.

Among the controls (Figure 2), the audiometric test revealed noise induced hearing loss in an age group of 36 years and above. No evidences of noise induced hearing loss were observed below 36 years of age. In 13.5% of the total sample surveyed had the noise induced hearing loss. However, the magnitude of the health effect was very less in comparison to that in exposed group. Most of them were found with negligible, mild and moderate noise induced hearing loss. Whereas, among the cases (Figure 3), the number of noise induced hearing loss was about three times higher than that of non-exposed group. The cases were found mostly in the age group of 16-35 years. Among the cases, altogether 39.34 % was found to have noise induced hearing loss. Most of them were having mild, moderate and moderately severe noise induced hearing loss.

Figure 2. Age wise distribution of noise induced hearing loss in non-exposed group

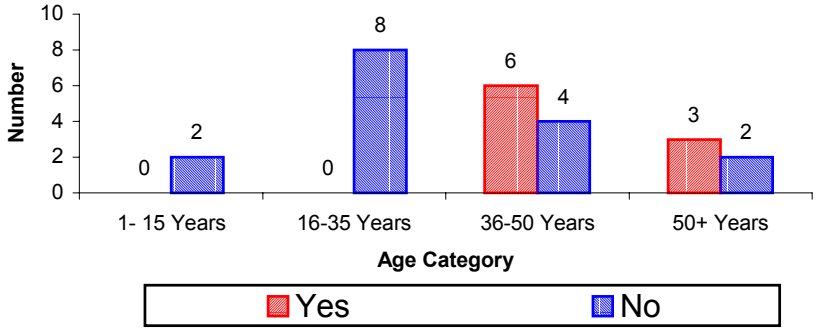
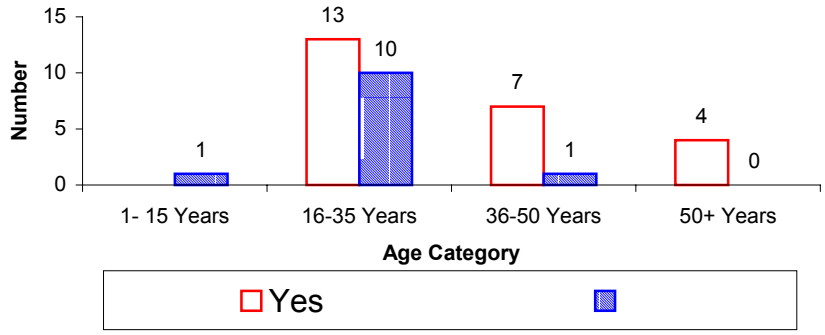


Figure 3. Age wise distribution of noise induced hearing loss in an exposed group



Odds ratios and 95% confidence intervals for noise induced hearing loss are shown in table 2. Variable that could present another cause of noise induced hearing loss viz. occupational noise was adjusted for.

Table 2. Comparison of risk of noise induced hearing loss among exposed and non-exposed

Exposure to noise	Noise induced hearing loss YES	Noise induced hearing loss NO	Crude OR (95% CI)[§]	Crude OR (95% CI) adjusted for occupational noise [§]
Non exposed (Controls)	8	17	Reference	
Exposed (Cases)	24	12	4.2 (1.4, 12)	4.0 (1.2, 13)

[§] Analysed by multivariate logistic regression.

There was a significant excess risk of noise induced hearing loss for the cases exposed to environmental noise. The crude OR (95% CI) for the exposed cases was 4.2 (1.4, 12). After adjustment for occupational noise OR (95% CI) was 4.0 (1.2, 13).

Discussion

In our environmental noise pollution survey, the major noise related health effect according to the respondents was lack of concentration, which has also been correlated in other studies. It has been seen that noise can adversely effect on performance of cognitive tasks such as reading, attention, problem solving and memorization. Although, noise induced arousal may produce better performance in simple tasks in the short term, cognitive performance substantially deteriorates for more complex tasks.[6] It has also been observed that children performance is poor in comprehensive tasks whose school are situated in busy areas of city and suffer from noise pollution.[10]

Previous studies have shown that environmental noise could give rise to psychological and psychosomatic symptoms in the form of headaches, fatigue irritability and annoyance, which is also present in our study.[11,12]

Sleep Disturbance is a major effect of environment noise. Exposure to noise can induce disturbance of sleep in terms of difficulty to fall asleep, alternation of sleep pattern of depth and awakenings.[13,14] After effects of noise-disturbed sleep are reduced perceived sleep quality, increased fatigue, depressed mood or well being and decreased performance.[6] In our survey, only little less than 25% respondents have reported about sleep disturbance, whereas, majority of the respondents have reported about the after effects of noise disturbed sleep.

In the literature search on noise induced health effects, very limited information on noise induced psychosomatic symptoms like chest pain and nausea was found, which were the least health effects observed in our study.

We found a high odds ratio for environmental noise induced hearing loss among the exposed subjects even after adjustment with potential confounder occupational noise. This was found despite the low number of cases in our study. Our 95% confidence interval was wide due to the small sample size.

The study subjects consisted of 36 environmental noise exposed subjects and a reference group of 25 non-exposed cases from Kupondole area of Kathmandu. The decision to include study subjects from Kupondole area was made because, firstly, it was observed as one of the highest noise level during Noise Pollution Monitoring and secondly, as we were going to conduct a case control study, we needed cases and controls from the same community with similar background but with different exposure status. The noise level nearby the main road of Kupondole was above 75 dB (A), whereas, noise level in the inner site (20 minutes walking distance) of Kupondole was below 55 dB (A). At Kupondole, traffic noise dominates the spectrum of environmental noise. Subjects were divided into exposed and non-exposed groups concerning environmental noise. This was a rather rough categorization due to the low number of cases.

None of our study subjects were in the occupations like transports driver, musical groups and procession bands where exposures to high level of noise prevail.

No previous studies on environmental noise induced hearing loss have been done in Nepal. Several studies carried out in developed countries showed an association between environmental noise and noise induced hearing loss. Comparison with such studies is of limited value because of potential difference in environment exposures, between Nepal and developed countries.

A similar study done in Bangkok city, which included four different categories of occupational people, i.e., drivers, street vendors, traffic officers and dwellers revealed that among the occupational population who were living in the urban monitoring

sites, the driver groups were found to have the highest risk of traffic noise induced hearing loss.[15]

Simultaneous exposure to environmental noise and indoor noise, for example noise form music systems at home and discotheques during leisure time is increasingly leading to temporary and permanent hearing loss, with most victims being adolescents and young adults. Particularly harmful is permanent exposure to noise, since the highly sensitive ear is not designed to tolerate it. In discos, concerts in particular, as well as listening to music via headphones, sound levels of 100 dB are regularly reached and exceeded, and levels of 90 dB are already considered to represent a definite risk.[16] The same coincidence could have prevailed in our study as noise induce hearing loss among the exposed group was very high in the age group of 16-35 years. Exposure to high levels of noise and vibration produced by heavy motor bikes could also take place in this age group.

Few exposed subjects in our study were painters and high risk of NIHL among them could be due to concomitant exposure to various organic solvents present in the solvent-based paints. Ototoxicity of organic solvents and the synergistic action of organic solvents and noise have been shown in animals[17,18]. The respective data in humans are scarce and equivocal. A study done to evaluate the effects of occupational exposure to styrene and combined exposures to styrene and noise on hearing has revealed almost a 4-fold (OR 3.9; 95% CI = 2.4 - 6.2) increase in the odds of developing hearing loss related to styrene exposure.[17]

Hearing impairment due to hereditary otosclerosis is one of the causes of hearing loss among children and adolescents, which could not be studied in detail in our study.

A potential limitation of this study is information bias. The main potential source of information bias was reliance on only the place of residence for determining exposure status.

Another drawback of the study was the inclusion of the study subjects that have been exposed to the environmental noise shortly before the study. Such inclusion may create selection bias and noise induced hearing threshold shifts could be considered as noise induced hearing loss.

In our study, though audiometric notch at 4000 Hz were most likely attributable to noise, a diagnosis of NIHL could not be confirmed because the "Noise pollution and health effect in urban areas of Nepal" study did not include an extensive noise exposure history, baseline audiometric testing data, or follow-up audiometric testing data. So, the result of audiometric study was rather suggestive of noise-induced hearing threshold shifts.

This study was confined to a specific area, covering very limited scope of work. Selected monitoring carried out in the cities cannot provide overall database and analyse the overall noise pollution status in a country as a whole.

Conclusion

Noise pollution is emerging as an environmental problem in majority cities of areas in Nepal. This can cause negative impact on public health and welfare. Considering the above aspects, we can conclude that traffic noise dominates the spectrum of environmental noise. Particularly high traffic noise is contributed through excessive sound pressure level above 70 dB(A) and is a contributing factor for major noise induced hearing loss. The people staying in noisy area especially above 70 dB(A) should take precautionary measures in order to avoid noise induced hearing loss.

This study is the first study on environmental noise induced hearing loss in Nepal. Although, this study shows an increased risk of noise induced hearing loss for the environmental noise exposed subjects, the diagnosis of NIHL could not be confirmed because of various limitations of the study. Nevertheless, the finding of highly significant effect of environmental noise on the public health despite of the low number of cases in our study should be considered as alarming findings. The study demonstrates the need for further research on environmental noise in Nepal with larger populations with an extensive noise exposure history, audiologist examinations and baseline & follow-up audiometric testing data.

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References:

1. Miller GT. Living in the Environment. Tenth Edition. United States of America: Wadsworth Publishing Company, 1998
2. Dix HM. Environmental Pollution. The Institute of Environmental Science Series,

Wiley International Edition. John Chichester, New York, Brisbane, Toronto: Wiley and Sons, 1981
3. Shrestha CB, Shrestha GB. A Report: Survey on Noise Level in Kathmandu Valley. Kathmandu: Man and Biosphere, 1985
4. Manandhar MS, Ranjitkar NG, Pradhan PK, Khanal NR. A Report: Survey on Noise Level in Kathmandu Valley. Kathmandu: Man and Biosphere, 1987
5. Khanal GK. A Survey Report: Noise Pollution in Kathmandu Valley. Kathmandu: 1994
6. Berguland B, Lindvall T. Community Noise. Stockholm: Center for Sensory Research, 1995
7. Miyoshi Y. Study Report on Industrial Pollution control. Kathmandu: Industrial Series Center, 1987
8. King PG, Coles RR, Lutman ME, Robinson DW. Assessment of Hearing Disability. Guidelines for Medico legal Practice. London: Whurr Publishers, 1992
9. Mohapatra R. Occupational Health Hazards and Remedies. First Edition. New Delhi: Jaypee Publications, 2002: 276-282
10. Evan GW. Noise as a Public Health Problem. Vol. 4: New Advances in Noise Research – Part II. Stockholm: Swedish Council for Building Research, 1990: 425-453
11. Tarnopolsky A, Hand DJ, Barker SM, Jenkins LM. Noise as a Public Health Problem. ASHA Reports 10, 1980: 588-594
12. Shrestha I. A Dissertation: Health Effect of Vehicular Noise Pollution on Traffic Police Personnel in Kathmandu. St. Xavier's College, Kathmandu: 2001
13. Eberhardt JL. Doctoral Dissertation: The Influence on Sleep of Noise and Vibrations Caused by Road Traffic. University of Lund, 1987
14. Griefahn B. Cardiac responses caused by shots of tanks during sleep. Journal of Sound and Vibration, 1989; 128: 109-119
15. Leong ST, Laortanakul P. Monitoring and assessment of daily exposure of roadside workers to traffic noise levels in an Asian city: a case study of Bangkok streets. Environ Monit Assess. 2003 Jun; 85 (1): 69-85.
16. Eggemann C, Koester M, Zorowka P. Hearing loss due to leisure time noise. Fortschr Med. 2002 Dec; 144 (49): 30-3
17. Sliwinska-Kowalska M, Zamyslowska-Szmytke E, Szymczak W et al. Ototoxic effects of occupational exposure to styrene and co-exposure to styrene and noise. J Occup Environ Med. 2003 Jan; 45(1): 15-24.
18. Davis RR, Murphy WJ, Snawder JE et al. Susceptibility to the ototoxic properties of toluene is species specific. Hear Res. 2002 Apr; 166(1-2): 24-32.