

EFFECTS OF NOISE POLLUTION ON THE HEALTH OF EXPOSED POPULATION AND ITS THRESHOLD LEVELS: A REVIEW

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ABSTRACT

Objectives: This review paper focused on the adverse effects of noise on the health of exposed population.

Material and Methods: Recent publications on the effects of noise pollution are critically reviewed and threshold levels determined by various researchers are presented in this review paper.

Results: This paper shows that noise not only poses serious health risks such as physiological, physical, psychological effects on the exposed population but also imposes various adverse effects on the wellbeing of humans. It also affects the worker's performances who are exposed to high noise levels, depending on the length of time. Questionnaire surveys have revealed that noise is believed to be a cause of many diseases.

Recommendation: It is recommended that noise legislations enacted by the concerned departments should be strictly implemented to save the population from adverse effects of noise.

Key Words: Noise; health effects; threshold levels.

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INTRODUCTION

Noise is a well-known source of pollution in urban environment¹⁻³. "It is defined as an unwanted sound which gets dumped into environment and adversely affects the health of a person and produces ill effects in living and non-living things"⁴. Decibel (dB) is the unit of noise. There are three types of noise; continues, intermittent and impulse. In comparison with other pollution, noise pollution did not create much public concern and its control has been hampered by insufficient knowledge and data^{2,5}, ignorance about the treacherous effects of noise on public and lack of defined criteria².

Noise pollution due to traffic is not only an environmental problem reserved for developed countries but also pronounced in developing countries⁶. In some

cases it is considered more important than any other environmental issues. Dramatically changes in noise level have been observed since mid-twentieth century. Noise levels in urban areas have been increased as a result of rapid population growth and the entry of high percentage of migrants to these areas. Dense transportation systems^{7,8} including air traffic, railways, roads and ubiquitous uses of machineries have characterized the modern urban environment⁶. The significant structural changes including the expansion of roads network, construction of flyovers and incessant growth in the number and density of vehicles, unbalanced urban development, industrialization and unplanned city developments in urban areas are the main sources escalating the noise problem. The major sources of noise pollution which are increasing the level of discomfort in people life are train, airplane and traffic noise, community noise, construction activities⁹, industrial noise and commercial activities¹⁰.

Among the above mentioned sources, the vehicular noise is considered the most affective one because the engines of the vehicles, tires interacting with the road, blasting horn, screaming sirens, sounds of

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Effects of noise pollution on the health of exposed population and its threshold levels: A Review

gearboxes, squealing brakes and cooling fans, exhaust systems, interaction between vehicles and aerodynamic friction are the noise sources produced from vehicles. However, increase in the number of automobiles, vehicle types, its flow and mode of operation, engine type, traffic speed, surface materials, position and dimension of the roads, crossroad signal system, high traffic density and disobeying of traffic rules increase the severity and magnitude of traffic noise¹⁰. Another important factor responsible for the rise in outdoor ambient noise pollution is the close built up of corridors, which as a result creates dense environment¹¹. Few studies also found that outdoor sources of noise also influence personal indoor noise¹². The electrical appliances, blaring television (TV), music systems, generating sets, household equipment, noise from neighborhood, public address system², loud speakers of music sound¹³, ground work (e.g., crane, heavy trucks, hammering), military activities and adoption of new social customs¹ are the other main sources of noise pollution affecting the surrounding population. This paper reviews the latest research

published regarding the effects of noise pollution on the exposed population.

MATERIAL AND METHODS

Recent international publications on noise pollution levels causing damage to the health of the exposed population was compiled and categorized accordingly.

RESULT/DISCUSSION

Health damages and noise levels

Physical/ Physiological effects

Physical effects caused due to noise are hearing defects^{14,15} or paracusis, auditory damage¹⁶, deafness and tinnitus¹⁵. Prolong noise exposure to high intensity sound can cause permanent hearing loss by damaging the hair cells (sensory receptors) of the inner ear¹⁷ and also causes fatigue⁶. Noise pollution causes several physiological effects such as irregularity of heart rhythms⁵, ulcers¹⁴, headache, cardiovascular problems^{5,18-21}, changes in skin temperature, nausea, visual disturbances, vomiting and pains⁵. Persistent noise can

Table 1 Health issues triggered at different noise levels according to recent studies

Health Issues	Noise levels	Reference
Incidence of arterial hypertension and increased risk of myocardial infarction	60 dB at daytime 45 dB at night time	Tonne et al ⁴³
Motility	32 dB	Nayak and Padhye ⁴⁴
EEG (electroencephalogram) awakening, changes in duration of various stages of sleep	35 dB	Nayak and Padhye ⁴⁴
Use of somnifacient drugs	40 dB	
Waking up in the night or waking up too early in the morning, self-reported sleep disturbance, environmental insomnia	42 dB	
Nocturnal awakenings, eye pupil dilation	55	
Moderate to serious annoyance	50-55 dB	Mehdi et al ⁶
Possible hearing impairment	110 dB	
Temporary hearing impairment	60-dB (A)	Olayinka ²
Permanent impairment	100-dB (A)	
Hypertension, myocardial infarction	50	Durduran et al ⁸
Psychic disorders	60 dB	
Disturbance, concentration discomfort, wrath, and sleeping disorder	30-65 dB (B)	
Heartbeat and respiration, increase in blood pressure, reflexes and decrease of pressure in brain fluid	65-90 dB (B)	
Headaches	90-120 dB (B)	
Imbalance and permanent damages in inner ear	> 120 dB (B)	
Serious brain damages	> 140 dB (B)	
Acute cochlear damages	165 dB	Goines and Hagler ²³

Table 2 Results of the questionnaire survey

Reference	Responses	Percentage
Zannin et al ⁹	Not bothered by the noise levels	52%
	Noise of tolerable intensity	49%
	Intense noise levels	16%
	Low intensity noise levels	20%
	Perceptible noise levels	10%
	Did not perceive an increase in the noise levels	60%
	Felt difficulty in concentrating	43%
	Felt annoyed due to noise	25%
	Get headaches due to noise	12%
	Felt nothing	13%
Swain and Goswami ⁴⁵	Not satisfied about the noise levels	56%
	Noise they would like to get rid of	51%
	Highly annoyed by noise levels	41%
	Irritated with the air-horn noise from motor cycles	36%
	At least one experience of temporarily "deafened" by loud noise	14%
	Identified headache as the main health effect of noise pollution	34%
	Felt mental stress	24%
	Suffered from insomnia	8%
	Suffered from hearing loss	0.1
	Suffered from sleep disturbance due to traffic noise during night-time	11%
Garoum et al ⁴⁶	Very sensitive to noise	54%
	Considered the road noise unbearable	51%
	Found noise stressful	45%
	Found noise aggressive	29%
Pathak et al ⁴⁷	Extremely disturbed by traffic noise	65%
	Headache	51%
	High blood pressure	58%
	Fatigue	53%
	Irritation	49%
	Dizziness	54%
Murthy et al ⁴⁸	Headache was identified as the main health effect of noise pollution	43%
	Noise level at their places were not satisfactory	60%
	Visited doctors due to different problems associated with noise	47%
	Students disrupted by the high pressure horns of vehicles	92%

lead to hyperlipidosis and hyperprotenemia, heartburn, indigestion²², cogwheel rigidity, pupil enlargement, tachyon⁸, dilation of pupil, sexual impotence²³, migraine,

muscle tension, higher cholesterol levels¹⁷, increased metabolic, pulse and respiratory rates²⁴, increased risk of stroke, sore throat and allergy⁵.

Psychological effects

Noise can cause numerous psychological effects such as sleeplessness, sleep disturbance^{21,25,26}, lack of sleep²², deterioration of sleep quality⁵, insomnia, going to sleep late, irritability, stress^{14,22}, oxidative stress²⁷, mental stress⁵, ill temper, bickering, mental disorientation, violent behavior, frustration, anxiety^{6,28}, anger, disappointment, unhappiness, depression²⁹, behavioral disorder, neurotic disorder, horror, discomfort, deceleration in mental function⁸, increases antisocial behavior²³ and annoyance^{25,26,30-32}. Different people exhibit different annoyance reactions to same noise levels. Noise pollution may cause or contribute to argumentativeness, increase in social conflicts, changes in mood, hysteria, neurosis and psychosis²³. Long-term exposure to noise is associated with mood disorder, neurocognitive functions, and neurodegenerative disease in exposed persons³³. State of helplessness or chronic sympathetic arousal is also caused by noise.

Effects on work performance

Noise pollution also reduces the work performance^{6,16,21} by causing misunderstanding what is heard, reduction of productivity¹⁴, may interfere with verbal communication³⁴. It also adversely affects the cognitive performance such as reading, and difficulties in solving and memorization¹⁷ and logical reasoning.

Effects on the hormonal systems of the body

Noise causes disruption in the body hormones such as endocrine disorders²¹ and can trigger both autonomic nervous system and endocrine responses. Acute exposure to noise increases the levels of cortisol, epinephrine and norepinephrine²³. Noise exposure is also related to raised catecholamine secretion and activation of the sympathetic nervous system.

Vulnerable groups

Noise adversely affects the fetal, infants, neonates and children health²¹ by causing cognitive impairments²⁹, development of premature infants, disruption to the normal growth⁵. It also decreases the intellectual development of students by impairing their learning abilities, causing speaking and writing difficulties and limitations in reading comprehension⁹. People living or working near highways are more vulnerable³⁵ and may suffer from short term as well as long term effects of noise³. Ristovska and Lekaviciute³⁶ found that people living in the noisy streets had more night awakenings,

difficulties in falling asleep and suffers from tiredness thus making them vulnerable group. Similarly, Ozkurt et al³⁷ found that hypertension and sleep disturbances are significant in the people living around airports. Noise exposure also affects patient outcomes³⁸. Elderly people with underlying depression and those with mental or physical illnesses may also be vulnerable to noise²³. People who are sensitive to noise may suffer from neuroticism, psychological disturbances and noise induced sleep disturbance³⁶. According to Joshi et al¹⁷ noise induced hearing loss is more apparent in the group aged from 16-35 years. Noise also adversely effects the quality of life of bus drivers and psychiatric symptoms such as anxiety and depression are more pronounced in them²⁸.

Secondary/other effects

Noise may cause other effects such as speech interference¹⁶ that may in turn causes annoyance, frustration, irritation, injuries, accidents⁶ and restlessness⁵. It is also considered as a source of friction between individuals¹⁰. Effects of noise are not only studied on humans but also on plants, animals and buildings. Few researchers have also attempted to quantify the effects of noise pollution on the costs of residential areas. Vienneau et al³⁹ estimated the external cost for cardio respiratory health burden in Switzerland from transportation related noise and found that estimated burden amounted to 22,500 hospital days.

Threshold levels and people's perception about noise

According to Agarwal⁴⁰ a noise level of 100 dB may cause permanent hearing loss if the person is exposed for a longer duration. Further, exposure to the noise level of 120 dB should not be allowed for more than 30 seconds. If noise is loud enough and continued for long duration it can cause temporary or even permanent hearing loss⁴¹. Sudden variations in noise levels are associated with the malfunctioning of Eustachian tube which may lead to the rupture of tympanic membrane and hemorrhage in the middle and external ear. In the cases where the noise intensity is not very high, the stretching of the tympanic membrane may occur which will cause mild to severe pain in the ear⁴². According to National Institute for Occupational Safety and Health (NIOSH) and Centre for Disease Control and Prevention, (CDC) United States, (2002) the permissible exposure time to noise of 85 dB is 8 h. For every 3 dBs, over 85 dB, the permissible exposure time is cut in half before

possible damage can occur.

Individuals exposed to noise levels of 45 dB may suffer difficulty from falling asleep and time to fall asleep can increase by few to 20 minutes at the same noise level and may provoked nocturnal awakenings at noise level of 55 dB³⁴. It may also be linked to chief mediating mechanisms, learning difficulties in school children, sleep disturbance and physiological stress. According to WHO (1993) guidelines, noise should not exceed 50 dB so as to protect individuals from being moderately annoyed and during daytime the Leq level should not exceed 55 dB so as to protect people from being highly annoyed². Threshold levels of noise responsible for various health issues according to different studies are summarized in Table 1.

Zannin et al⁹ carried out questionnaire survey at University campus of the Polytechnic Center of the Federal University of Paraná, Brazil by using the intentional sampling technique to collect information involving 389 people from the study area to know their perception about noise. Similarly, Swain and Goswami 45 interviewed 351 persons using questionnaire in Baripada Town, India. Garoum et al⁴⁶ used ISO-15666 recommendations to carry out questionnaire survey in Agdal district in Rabat city, Morocco. Pathak et al⁴⁷ interviewed 500 individuals in Varanasi, India and observed problems related to noise pollution in the respondents. Murthy et al⁴⁸ interviewed representative sample of public in Banepa, a semi urban town of Nepal using a questionnaire to delineate public perception about the noise and its significance on health of the community. Loss of concentration, headache, hearing problem and bad temper were some of the significant effects of the noise pollution according to the studies. The results of the questionnaire surveys are given in Table 2.

A comparative research study conducted by Caciari et al¹ on policemen and control groups showed that high frequency (4000–8000 Hz) of noise does not have significant effect on hearing, however, significant differences were encountered at mid and low frequencies (250–2000 Hz). Similarly, high risk of hypertension was observed amongst the residents exposed to 63Hz, 125Hz and 1000 Hz, but highest risk was found for 125 Hz⁴⁹. Hammer et al⁵⁰ estimated that 104 million Americans were exposed to Leq (24h) levels > 70 dBA in 2013 and at the risk of NIHL (Noise Induced Hearing Loss) and tens of millions at a risk of heart diseases and other noise related diseases.

CONCLUSION

Noise not only has physiological, physical, psychological effects but also affects the work performance. Threshold levels and number of diseases have been identified by the literature which are attributed to noise pollution. Similarly, different noise surveys have revealed that most of the people perceive noise as unbearable. It is recommended that technical control measures should be adopted and awareness must be created among the citizens regarding adverse effects of noise. Further, guidelines and strategies regarding noise should be established and strictly implemented by the concerned authorities.

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Effects of noise pollution on the health of exposed population and its threshold levels: A Review

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Effects of noise pollution on the health of exposed population and its threshold levels: A Review

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- Nazneen S:** Compilation of all relevant literature
Khan S: Editing and technical support
Ishtiaq M: Critical analysis of categorization of diseases
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Shakoor H: Compilation of data table

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